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THE RURAL PIPED WATER PROGRAMME IN MALAWI

A Case Study in Community Participation

by

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ABSTRACT

It is generally accepted that community participation in water supply projects greatly strengthens the community's commitment to the supply and encourages better operation and maintenance. Yet, at a time when most developing countries are preparing for a major concentration of effort for the International Drinking Water and Sanitation Decade, there is very little practical information available to planners and engineers concerning the experiences of other countries in the field of community participation. This report is a first-hand, detailed case-study of a rural water programme in Malawi. It describes how the programme originated and developed and how it operates today. It pays particular attention to pilot projects, the field level management of project staff and self-help labour, technical issues and the maintenance organization. The report suggests that the experience gained in Malawi has important implications for the Decade.

AUTHOR'S NOTE

The programme described in this report is the product of a decade of hard work on the part of all programme staff and the rural communities concerned. The inspiration behind the programme, however, has come from Lindesay Robertson, without whom it would never have developed in the way described here.

I gratefully acknowledge the support of the Overseas Development Administration for making possible the academic interlude which has enabled this report to be written.

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The views and opinions expressed in this report are my own, and do not necessarily reflect the views of the Malawi Government or any of its employees.

Currency Equivalents

Currency Unit	=	Kwacha (K)
1970 K1	=	US $ 1.24
1975 K1	=	US $ 1.15
1979 K1	=	US $ 1.23

Abbreviations and Acronyms

AC	Asbestos Cement
CCD	Commissioner for Community Development Chief Community Development and Social Welfare Officer
CD	Community Development
CDA	Community Development Assistant
CEBEMO	Dutch Catholic Church Aid Organization
CIDA	Canadian International Development Agency
CSC	Christian Service Committee of the Churches in Malawi
CTB	Central Tender Board
DANIDA	Danish International Development Agency
DC	District Commissioner
DDC	District Development Committee
GNP	Gross National Product
GSD	Geological Survey Department
ICCO	Dutch Protestant Church Aid Organization
JCE	Junior Certificate of Education
MANR	Ministry of Agriculture and Natural Resources
MCDSW	Ministry of Community Development and Social Welfare
MCP	Malawi Congress Party
MLG	Ministry of Local Government
MP	Member of Parliament
MWS	Ministry of Works and Supplies
NRDP	National Rural Development Plan
OPC	Office of the President and Cabinet
OXFAM	Oxford Committee for Famine Relief
PA	Project Assistant
STA	Supervisor (Senior Technical Assistant)
SWE	Senior Water Engineer
TO	Technical Officer
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization
WPS	Water Projects Section

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CHAPTER 1

INTRODUCTION

1.1 THE PERSPECTIVE

The use of global water supply statistics as an introduction would tend to give an inappropriate perspective on the subsequent contents of the report. For, although the problem may be appreciated in global terms, possible solutions can only realistically be understood on a more local scale. Instead of a picture of countless millions without water, the reader should keep in mind an image of a finite number of rural communities for each of which, somewhere, there is a water source that can be developed. The communities themselves are all too aware of their water problem, and national leaders, most of whom have experienced rural life, remember how deeply water affects the pattern of family and village life. The government, however, has primarily been concerned with economic development and has so far been unable to allocate a sufficient proportion of the country's limited resources to improve rural water supplies.

1.2 THE DECADE

The international community has declared the period 1981 to 1990 to be the International Drinking Water and Sanitation Decade (hereafter called the Decade) with the expressed goal of providing clean water and sanitation for all by 1990. It is estimated that, to achieve this goal, the current level of investment in the rural sector will have to be increased four times, and massive funds have already been pledged by international agencies and national governments.

1.3 POLICIES FOR THE DECADE

Countries are now faced with the immediate task of developing policies to ensure that this massive effort will have a real and lasting effect on the water supply situation, and not result in a profusion of rejected and broken-down supplies. Part of the process of developing realistic policies is for each country to look at its own programme and those of other countries in order to avoid repeating past mistakes and to incorporate those successful features that may be appropriate.

The present situation in a country may best be ascertained by carrying out an evaluation of the country's programme to date. In addition, the World Health Organization (WHO) and the World Bank are assisting governments by conducting a Sector Study of each country. However, although an evaluation may indicate what is wrong with a programme, it may not necessarily offer the best solutions, and in this context experience gained in other countries would be particularly useful.

Unfortunately there is very little information available on the programmes of other countries, and the few studies of specific programmes tend to evaluated in terms of the number of schemes constructed and the number still working, and fail to analyse the organization and management of the programme in sufficient depth at all levels.

1.4 THIS REPORT

This report is offered as a contribution to a pool of information that should be available to national policy-makers and engineers in rural water programmes who may wish to learn from the mistakes and successes of others. It may also be of interest to international bodies involved in the Decade. It is a detailed account of the rural piped water programme in Malawi, with which the author was intimately involved from 1971 to 1977 as Project Manager in Mulanje. It is not an evaluation, nor does it attempt to make comparisons with other programmes. It is primarily a record of how and why the programme developed as it did, and how it operates today. The fact that this report cannot claim to be objective may be balanced by the genuine advantages inherent in its being a first-hand account.

One of the principal themes in this report is the nature of the development process. An account of the stage by stage growth of the programme is a vital factor which most studies seem to miss, possibly because first-hand knowledge is so essential.

Another key theme is the importance of management at all levels. Some evaluations rightly point out the need for efficient and co-ordinated management structures, but tend to focus mainly at the "office" level rather than the field level, which is the "business end" of the programme.

This report describes an engineering approach which may be more humble than most engineers are familiar with, but which appears to have been relatively successful compared with more technocratic and sophisticated approaches. It describes a technology which is not only appropriate in technical terms, but which is also appropriate to the real situation in rural communities.

CHAPTER 2

MALAWI - COUNTRY AND WATER SECTOR BACKGROUND

2.1 GEOGRAPHY AND CLIMATE

Malawi is a long, narrow, land-locked country in southeastern Africa, bordered by Tanzania, Mozambique and Zambia, measuring 840km long and between 80 and 160km wide. It has a land area of just over 100000sq km, roughly three quarters the size of England and Wales, plus a water area totalling 24000sq km. Lake Malawi is the third largest lake in Africa, and is a feature of the Great Rift Valley that runs through East Africa. The lake is drained by the Shire River which joins the Zambezi about 400km to the south.

Topographically the country can be divided into three regions. The Northern Region is mountainous with altitudes up to 2400m. The Central Region consists largely of a plateau of about 1400m in height, with a strip of lower-lying land along Lake Malawi. The Southern Region has some highlands and mountains rising from low-lying plains of about 500m. An escarpment divides the Southern Region, to the south of which lies the Lower Shire Valley descending to only 60m above sea level.

These great variations in altitude contribute to Malawi's considerable diversity of climate. Temperatures in the Lower Shire Valley may rise to 46^{o}C while in the highlands temperatures may average 16^{o}C. There are also great variations in rainfall, with Mulanje Mountain in the Southern Region receiving a high annual rainfall of over 2450mm whereas 50km to the north, in the mountain's rain shadow, Lake Chilwa only has 635mm.

The hot wet season begins in late November and lasts through to April. The dry season lasts from May to November, May to August being relatively cool, with temperatures and humidity then building up until the rains break again in November.

2.2 POPULATION

According to provisional figures of the 1977 census, the population of Malawi is 5.57 million, with an average growth rate of 2.9 per cent and a mean density of 59.2 persons per square kilometre.

Over 50 per cent of the population live in the Southern Region, with about 35 and 15 per cent in the Central and Northern Regions respectively. Population density varies considerably throughout the country, from a maximum of about 250 persons per square kilometre in one district in the south to a minimum of about 15 persons per square kilometre in one district in the north.

Over 90 per cent of the population live in traditional rural villages. Three quarters of the urban population, live in the four main centres, namely Blantyre, Zomba, Lilongwe and Mzuzu, the remainder living in the district at administrative and trading centres with populations generally less than 5000. In 1972 the growth rates of the rural and urban populations were estimated to be 2.3 and 4.7 per cent respectively.

The age distribution is characteristic of a high fertility/high mortality demographic pattern. 16 per cent of the population are under five years old and 42 per cent under 15.

2.3 GOVERNMENT

2.3.1 National Level

Since Malawi gained independence from Britain in 1964, the country has been characterized by a strong and centralised government under the personal leadership of the President. There are about 15 Cabinet Ministers and 60 Members of Parliament, 15 of whom may be appointed by the President. The remaining MPs are elected by popular franchise from candidates put forward in each constituency by the Malawi Congress Party. Parliament meets once a year to debate and approve legislation.

The Civil Service structure is similar to that of other former British colonies. There are fourteen ministries, each administered by a Permanent Secretary with supporting levels of administrative and professional staff. All ministry headquarters are situated together in new government buildings in Lilongwe.

The Government's socio-economic goals are stated in the "Statement of Development Policies 1971-80". Development expenditure has concentrated on the country's infrastructure, with transport, communications, and power generally taking over 50 per cent of the development budget. Agriculture has also consistently attracted a high proportion of the development budget, while health and education have been considered lower priorities. Government expenditure patterns are shown in Tables 2.1 and 2.2.

National development is the responsibility of three divisions within the office of the President and Cabinet. The Development Division is responsible for the administration of the national development programme, implemented through a rolling three-year public sector investment programme. The Division works closely with the Ministry of Finance. The Economic Planning Division is responsible for advice on national economic policy, especially on the research, planning and evaluation of development projects. The Physical Planning Division is responsible for advice on the development of the country's infrastructure, with particular reference to integrated development projects.

2.3.2 District Administration

The country is divided into three regions and 24 districts. Each district is administered by a District Commissioner (DC) who is chiefly responsible for the administration and maintenance of traditional and civil authority. The functions of the chiefs, known as Traditional Authorities (TAs), are supported by court clerks and messengers appointed by the district administration. In addition, the district administration is responsible for tax collection, implemented by tax clerks appointed to the chief's courts. The maintenance of civil authority is exercised by the police and magistrate's court.

TABLE 2.1 GOVERNMENT EXPENDITURE ON DEVELOPMENT ACCOUNT

(in millions of Kwacha)

	1970/71	1974/75	1977/78 (budget)
Agriculture and Natural Resources	6.6	13.1	15.6
Education	2.9	1.2	6.1
Health	0.1	2.1	1.7
Community Development		0.1	0.1
Transport	17.6	10.7	32.6
Post and Telecommunications	0.9	1.7	4.3
Power	0.8	1.1	9.3
New Capital City	2.6	1.8	2.8
Other	3.7	9.0	13.1
Total	35.2	40.8	85.6

Source: Public Sector Financial Statistics 1975, Budget Documents 1977/78

TABLE 2.2 GOVERNMENT EXPENDITURE ON REVENUE ACCOUNT

(in millions of Kwacha)

	1970/71	1974/75	1977/78 (budget)
General Administration	6.1	9.0	13.7
Defence	1.2	3.5	12.6
Justice	4.2	5.7	6.6
Agriculture and Natural Resources	3.2	5.5	9.8
Education	8.0	11.3	14.0
Health	3.8	4.9	6.4
Community Development	1.3	2.9	2.8
Transport	1.3	2.5	3.3
Post and Telecommunications	0.9	1.2	1.6
Other Services	4.7	6.3	6.4
Total Services	34.1	52.8	77.2

Source: Public Sector Financial Statistics 1975, Budget Documents 1977/78

Each district is served by an office of the relevant government ministries, which include Agriculture, Works and Supplies, Education, Health, Community Development, Labour and Posts and Telecommunications. Each office is usually staffed by a professional officer who is responsible, through the Regional Office, for all activities of his Ministry at district level.

The District Council consists of elected councillors and appointed civil servants of the Ministry of Local Government. The council has responsibility for those schools, roads and water supplies that are not under the control of central government ministries. It is maintained with central government funds.

Local development activities are co-ordinated through the District Development Committee (DDC). The committee is chaired by the District Commissioner and its members include the District Officer of each development ministry, representatives from the District Council, local Members of Parliament and district level party officials. All development initiative from the district is discussed by the DDC and selected projects are then forwarded to the responsible ministry via the Development Division.

The Malawi Congress Party plays an important role in development projects, particularly where self-help is involved. In general, the party and traditional leadership hierarchies run in parallel, and both groups are involved in all committees and public meetings.

2.4 THE ECONOMY

In 1977 the per capita gross national product (GNP) was K143, placing Malawi among the 25 poorest countries in the world; yet any comparison based on real social and economic welfare would lift the country out of this category. Since independence, Malawi's economic progress has been remarkable, the GNP having grown annually at a rate of 6.8 per cent in real terms. This has been made possible by strong government commitment to growth and to rational planning. Relative political stability and liberal government policies have encouraged foreign investment in the private sector, which is seen as the main motor of economic growth. Public investment has mainly been directed towards infrastructure and smallholder agriculture. The government attaches high importance to the balancing of its revenue budget, which it has achieved since 1973. On the other hand, the development budget is heavily supported by external finance, with some 90 per cent coming from foreign loans and grants. This level of support reflects the reputation that Malawi has earned for the effective use of funds in the pursuit of realistic and appropriate development policies.

Malawi's economy is based firmly on agriculture, which occupies 85 per cent of the labour force and contributes 50 per cent of the GNP. There are about 1.3 million hectares under cultivation in the traditional sector and 0.6 million hectares under fallow. A further 0.6 million hectares of potentially good arable land remain to be cultivated. 78 per cent of the total cultivated area is occupied by smallholders, but estate production is growing at a rapid rate, nearly double that of smallholders. The principal export crops are tea and tobacco, while maize is the principal domestic crop.

The manufacturing sector is still small, but is expanding, particularly in the field of import substitution and food processing. The sector accounts for about 12 per cent of the country's total output, and 12 per cent of the total wage employment. While Malawi has few other mineral resources of economic importance, it has the good fortune to be self-sufficient in cement. The recent development of a small PVC pipe extruding industry is of particular relevance to this report.

Communications within the country are facilitated by an extensive network of roads which are generally well maintained even in rural areas. Railway traffic is significant between the South and Central Regions of the country, while heavy traffic to the North may go by road or lake transport. For foreign trade, however, Malawi is dependent on two single track rail links to the Mozambique ports of Beira and Nacala. Recent upheavals in that country have caused costly delays in the movement of goods in and out of Malawi.

In terms of wage employment, about 8 per cent of the population aged 15 years and over were employed in 1975, only 10 per cent of them being women. In addition, up to 1975, there were a further 250000 migrant labourers working abroad, principally in the mines of South Africa and Rhodesia, who contributed substantially to Malawi's foreign exchange earnings. Malawi suspended recruitment in 1975 and most of the migrant workers returned home, but recruitment has since been resumed at a reduced rate.

2.5 EDUCATION

In 1966 22 per cent of the adult population were said to be literate, and 36 per cent of the population over five years had attended school at some time. In 1976 about 50 per cent of primary school aged children were enrolled, with a significantly higher proportion of boys than girls.

Only about 2 per cent of pupils proceed to secondary school, where they take Junior Certificate examinations (JCE) after two years and Malawi Certificate of Education (MCE - equivalent to O-Level) after four years. About one in three secondary pupils proceed to higher education, including teacher training. Higher education is provided principally by the Malawi Polytechnic for technical and business related studies, and by the University for more academic studies leading to a general degree. There are, however, no degree courses in engineering and students wishing to pursue a career in one of the professions have to secure their own places and obtain scholarships to foreign universities.

The development of educational output has not kept up with the other fields of development, and the country is still dependent on expatriate professional and trained manpower in both the public and private sectors. This may be the inevitable result of the calculated government emphasis on the development of infrastructure, but the government has now decided to increase investment in education to relieve what is now seen as a major constraint to further development.Of particular significance are the plans to provide a new 4-year diploma course and a 6-year general engineering degree course at the Polytechnic, with an annual intake of 72 for the diploma, and some 20 proceeding to the degree. This contrasts with the present annual output of some 15 diplomates in civil technology.

2.6 HEALTH

While statistics cannot accurately express all the significant dimensions of health status, they can be approximate indicators and are sufficient for broad descriptive purposes. Table 2.3 gives some selected health data, and Table 2.4 gives some indication of the major diseases affecting the population.

Although health expenditure has been a relatively minor part of the national budget, Malawi has made significant advances in the provision of basic health services. A comprehensive plan is currently being implemented, designed to provide the following structure of rural health facilities by 1988:

1. Primary Health Centres - one per 50000 population, headed by a Clinical Officer, able to treat most cases not requiring specialist care. Each centre also serves as a Sub-Centre and Health Post for the nearest population.

2. Sub-Centres - one per 10000 population, four per Primary Health Centre. Headed by a Medical Assistant. The Sub-Centre deals with curative and maternity cases, and is a base for health education. It operates a mobile clinic to support Health Post activities.

3. Health Posts - one per 2000 population, staffed by one Maternal and Child Health (MCH) Assistant to deliver basic preventive care, first aid and simple treatment.

Table 2.5 shows the distribution of health resources. The missions provide about 40 per cent of total health services delivered in Malawi, but their plans and programmes are carefully co-ordinated and integrated with those of the government.

2.7 SOCIO-CULTURAL ASPECTS

The African people of Malawi are of Bantu origin, descending from a number of tribes which moved into the area between the sixteenth and nineteenth centuries. Although tribes are still generally associated with certain areas of the country, there has been some geographical inter-mixing and it is common for people of more than one tribe to live and work together. Tribal differences have deliberately been played

TABLE 2.3 SELECTED HEALTH DATA

Life Expectancy at birth (years)	Male	40.9	(1970)
	Female	44.2	(1970)
Crude Birth Rate (per 1000 pop)		50.5	(1978)
Crude Death Rate (per 1000 pop)		28.2	(1978)
Infant Mortality Rate (per 1000 live births)		163.8	(1978)
Maternal Mortality Rate (per 1000 live births)		1.9	(1978)
Nutrition: per centage children under 5 with weights below 80 per cent Harvard Standard		29.6	(1976)

Source: Selected from Malawi Ministry of Health Statistical Tables and Documents

TABLE 2.4 1977 OUTPATIENT FIRST ATTENDANCES BY DISEASE CATEGORY AND AGE GROUP

Disease Category	under 5 years	5 years and over	Percent under 5 years	Percent 5 years and over
Malaria	1040517	1105858	27.7	20.1
Respiratory Diseases	658952	777975	17.6	14.1
Diarrhoeal Diseases	444376	372061	11.8	6.8
Other Gastro-intestinal	269371	444908	7.2	8.1
Trauma	158657	407165	4.2	7.4
Skin Conditions	240915	321583	6.4	5.8
Eye Diseases	273282	249219	7.2	4.5
Measles	155977	50773	4.2	0.9
Hookworm and other Heminthiases	17171	137827	0.5	2.5
Schistosomiasis	29123	152567	0.8	2.8
All others	463430	1486944	12.4	27.0
Total	3751771	5506880	100.0	100.0

Source: Modified from Malawi Ministry of Health Statistical Tables for 1977

TABLE 2.5 HEALTH RESOURCES

Government Recurrent Health Expenditure (million Kwacha)	9.0	(1978/9)
as per centage of total Recurrent Expenditure	6.8	
Recurrent Expenditure per capita (Kwacha)	1.7	
Government Development Health Expenditure (million Kwacha)	3.5	(1978/9)
as per centage of total Development Expenditure	2.0	
Development Expenditure per capita (Kwacha)	0.66	
Mission Recurrent Health Expenditure (million Kwacha)	3.0 (a)	(1978/9)
Mission Development Health Expenditure (million Kwacha)	0.85(a)	(1978/9)
Other Health Expenditure (inc. traditional sector) (million Kwacha)	3.6 (a)	
Total Health Expenditure per capita (Kwacha)	3.64	
Total Health Expenditure as per cent GNP	2.2	
Population per physician	39044	(1978)
Population per nurse	1188	
Population per primary health worker	5619	
Population per medical bed	552	

Sources: Selected from Malawi Ministry of Health Budget Documents and Statistical Tables

(a) Estimates by Family Health Care Inc (1978) down by both the Party and the government, and one language, Chichewa, has been introduced as the national language.

Both matrilineal and patrilineal kinship systems are found in Malawi. While these different systems clearly have a major effect on social and cultural life, they do not appear to have had a noticeable effect on rural development. Women bear the greatest burdens of village life in terms of rearing children, domestic chores and agriculture. As drawers of water, they perceive particular benefits in water supply projects, and provide the major part of the self-help labour. Although it is the men who ultimately make the decisions, the women form the most powerful and united pressure group, and the success of any rural development programme will ultimately depend on their support.

The country has traditionally been divided into areas, each under the jurisdiction of a chief. The chief is principally a figure-head but plays an important role in the administration of traditional law and custom, resolving land disputes and inter-community quarrels. Villages are highly conscious of allegiance to their chief, and rural development projects have to take careful account of chiefs' boundaries.

The headman is the nominal leader at village level, and is the bottom rung of the adjudication procedure, dealing with minor disputes and anti-social activities. More serious cases are passed to the group village headman, and ultimately to the chief. The role of the village headman in leadership and decision-making varies according to his personal qualities; if he is weak, this role may be taken over by another leader or group of leaders. Although elections for committees are not generally held at village level, leaders are not effective unless they enjoy a general consensus of support from the community.

Village size varies greatly. A small village may have 50 to 100 persons, a large one 1500 to 2000. In the Central Region, settlement is commonly nucleated, a cluster of houses surrounded by agricultural land, while in the south houses are generally dispersed broadly within the village boundary.

Traditionally there is no individual ownership of land. The land belongs to the community as a whole, but is administered by the chief through his headmen, who allocate it to private individuals. Once allocated, it becomes to all intents and purposes private property in that the individual has rights over it to the exclusion of others.

There is a strong tradition of both mutual aid and self-help in rural communities in Malawi. For example individual villagers frequently group together to build each others' houses and virtually all primary schools in rural areas have been built by the villagers themselves. Both Government and Party have maintained a major emphasis on support for self-help activities and have initiated programmes seeking a self-help response.

2.8 WATER SUPPLY SECTOR[1]

2.8.1 Water Resources

Groundwater has been classified into three hydro-geological zones, the plateau highland zone where good quality water is found, the escarpment zone which is disregarded because of the steepness of the landform, and the rift valley zone which provides water of variable quality, sometimes showing high iron and chloride concentrations. In general, average borehole yields are not sufficient for city or industrial supplies, but are adequate for rural areas and smaller urban centres.

Surface water is abundant, with several major rivers and perennial mountain streams. Runoff averages 17 per cent. The dry season supply situation is eased by natural storage provided by lakes and dambos (shallow basins with impervious strata at depths of about 5m). Lake Malawi itself provides enormous storage, and artificial control of the Shire River ensures supply for hydroelectric power generation.

Water use is dominated by the agricultural sector and by power generation. In 1973, 90 per cent of all water abstracted was used for irrigation, 10 per cent for drinking water supply and 0.1 per cent for industry. The gross water availability is of the order of 9000 litres per capita per day, whereas total use of water (excluding hydroelectric power generation) abstracted under licence averages 225 litres per capita per day.

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1. Much of the data for this section has been drawn from WHO/World Bank (1978).

2.8.2 Urban Water Supplies

The distribution of responsibilities in both the urban and the rural water supply sectors are detailed in Tables 2.6 and 2.7. WHO/World Bank (1978) estimates that in the urban sector 347000 people were served in 1977, representing 69 per cent of the urban population.

Blantyre and Lilongwe Water Boards supply 0.5 and 0.125 m^3/s respectively, mainly for domestic consumption through metered connections. Blantyre water is pumped from the Shire River, while Lilongwe water is impounded in a reservoir. Both supplies receive full physico-chemical treatment to achieve WHO Standards (WHO, 1971).

The Ministry of Works and Supplies (MWS) is responsible for all other urban areas and operates 32 systems which, with the exception of Zomba, are on a considerably smaller scale. About 50 per cent of these supplies are from boreholes, the rest using rivers or the lake. Apart from very few public standpipes, MWS supplies are metered or flat-rate connections.

2.8.3 Rural Water Supplies

WHO/World Bank (1978) estimates that 1.4 million people were served in 1977, representing 30% of the rural population.

2.8.3.1 Borehole Supplies

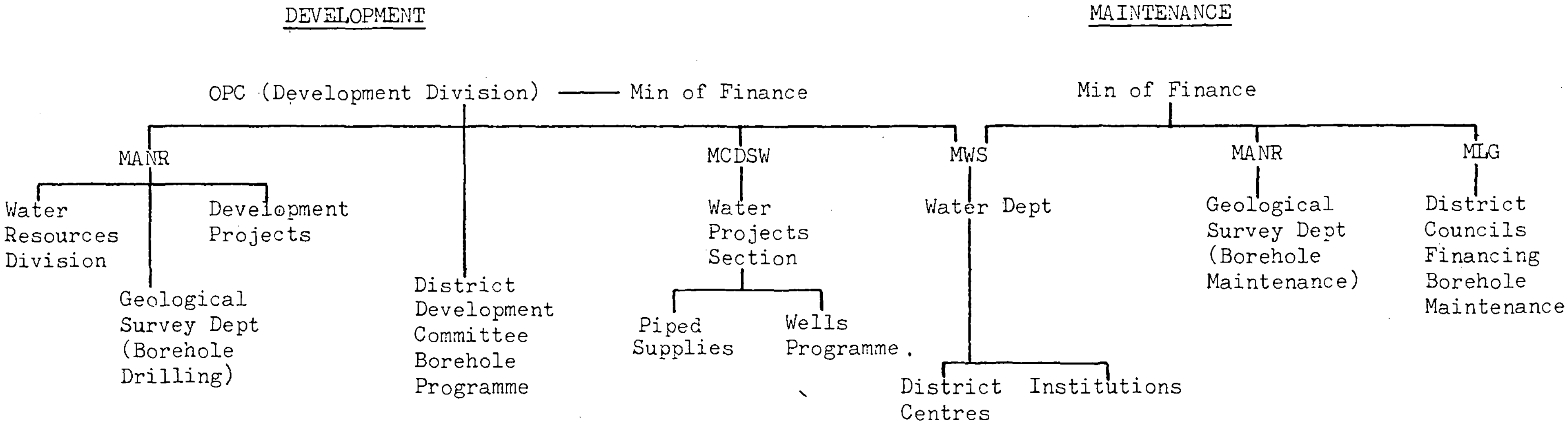
The Geological Survey Division (GSD) of the Ministry of Agriculture and Natural Resources (MANR) carry out ground water investigations and deep well drilling for boreholes, which are normally fitted with handpumps. Each borehole is estimated to serve on average 300 people; the water is free. In 1977 there were about 3700 boreholes drilled in rural areas, and about 300 new boreholes are completed every year. The average cost of a borehole complete with handpump was K3400 (1977) and funds are obtained either through MANR's agricultural development projects (200 boreholes p.a.) or from the Christian Service Committee (CSC) (100 boreholes p.a.) channelled through the Development Division and DDCs.

TABLE 2.6 DISTRIBUTION OF RESPONSIBILITIES IN THE WATER SUPPLY SECTOR IN MALAWI 1977

MINISTRY	UNIT	AREA OF RESPONSIBILITY
Office of the President and the Cabinet	Development Division	Control of the District Development Committee Borehole Programme
Trade, Industry and Tourism	Blantyre Water Board	Water Supply for Blantyre
Local Government	Lilongwe Water Board	Water Supply for Lilongwe
	District Councils	Financing part of the Borehole Maintenance Programme
	Local Authorities Services Branch	Financing part of the Borehole Maintenance Programme
Works and Supplies	Water Department	Urban Water Supplies apart from Blantyre and Lilongwe Institutional Water Supplies
Community Development and Social Welfare	Water Projects Section	Rural Piped Water Supplies Rural Shallow Wells Programme
Agriculture and Natural Resources	Development Projects	Financing of Boreholes in Agricultural Development Projects Financing part of the Borehole Maintenance Programme for initial 5 years
	Geological Survey Department	Groundwater Resources Investigations Borehole drilling and equipping Borehole Maintenance Programme
	Water Resources Division	Surface Water Resources Investigations Compilation of Ground and Surface Water Resources Data Servicing the Water Resources Board
	Water Resources Board	Administration of the Water Resources Act
Health	Preventive Health Services	Water Quality Surveillance Health Education Improvement of wells Promotion of Latrine Programmes

Source: Adapted from WHO/World Bank Water Supply and Sewerage Sector Study 1978.

TABLE 2.7 ORGANIZATION OF THE RURAL WATER SUPPLY SECTOR IN MALAWI UP TO 1979



KEY

OPC	Office of the President and Cabinet
MANR	Ministry of Agriculture and Natural Resources
MCDSW	Ministry of Community Development and Social Welfare
MWS	Ministry of Works and Supplies
MLG	Ministry of Local Government

Borehole maintenance is carried out by GSD teams, but the maintenance cost of K60 (1977) per borehole per annum is met by District Councils, Ministry of Local Government or MANR, depending on which is responsible.

2.8.3.2 Piped Water Supplies

The Water Projects Section (WPS) of the Ministry of Community Development and Social Welfare (MCDSW) has developed a programme[1] of constructing gravity piped water supplies with self-help labour. By January 1979 22 projects had been completed, with 2109 standpipes serving 308000 people. The mean per capita cost of projects under construction is K6.27 (1979); funds have been obtained through international and bilateral agencies. There are no house connections and the water is free.

Maintenance is the responsibility of WPS but is carried out with the active involvement of the community. Maintenance costs, which are minimal for gravity systems, are met by WPS, with the exception of repairs to standpipes which are the responsibility of the village concerned.

2.8.3.3 Protected Shallow Wells Supplies

WPS has also developed a separate self-help programme for the construction of shallow wells, equipped with simple locally assembled handpumps. This programme is concentrated in the Central Region where there is a shallow water table throughout the year. The programme is in its early stages, with a few hundred wells completed to date; the ultimate goal is to construct 5000 wells in the Region, each serving 100 people. The estimated per capita cost is K1 (1977) per head. Cement for the construction of the well, a concrete slab and the pump assembly is provided by the programme, while local village committees provide transport by ox-cart, and all bricks, sand and labour to construct the well under the guidance of programme staff.

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1. This programme is the subject of this report

Maintenance is the responsibility of the village committees, who select a villager for training in the repair and maintenance of the handpump.

2.8.4 Reorganization of the Water Supply Sector

The fragmented organization of the water supply sector is a result of its haphazard historical development. Until the last decade, the activities of the various Government departments were spread relatively thinly across the sector so that duplication of effort was not a major problem. However, the increasing level of activity and the new emphasis on the sector has led to the realization of the need for a more rational approach. In 1979 the Government decided to move all departments and sections currently responsible for water supplies into a new Ministry of Lands and Water Affairs. The structure of this ministry, which will come into being in January 1980, has not yet been established. It is expected that the various programmes will function as before but with a much greater degree of planning and co-ordination. One of the first tasks of the new ministry will be to formulate a master plan for the development of the water resources of the country.

CHAPTER 3

HISTORICAL DEVELOPMENT OF THE RURAL PIPED WATER PROGRAMME IN MALAWI

3.1 INTRODUCTION

It is only through an understanding of the way in which the programme originated and developed that a true appreciation of the current situation can be gained. The historical aspect can also give a valuable indication of factors that help or hinder the successful development of a programme. This chapter describes how the programme in Malawi developed at its own pace, from small beginnings into a major organization. Before proceeding, the reader may find it helpful to refer to Appendix 3 for a summarised description of the present programme.

Table 3.1 shows the principal developments in chronological order, and Figures 3.1 to 3.4 record the growth of some key parameters with time.

3.2 PILOT PHASE

3.2.1 Chingale Project

In 1968 the Ministry of Community Development and Social Welfare (MCDSW)[1] designated sixteen villages in the Chingale area on the south-western corner of Zomba Mountain (see map in Appendix 2) to be a community development project area. A ministry engineer was sent to assist the people

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1. This ministry was actually formed later but the title is used throughout this report for consistency.

TABLE 3.1 CHRONOLOGICAL DEVELOPMENT OF THE RURAL PIPED WATER PROGRAMME

1968	Chingale selected as a Community Development Project Area. Water identified as main problem
1968-69	Construction of Chingale Pilot Water Project (pop 3000)
1969-70	Construction of Chambe Project (pop 30000) in Mulanje District
1971	Formation of Water Projects Section (WPS) within MCDSW
1971	Appointment of Assistant Engineer and transfer of 3 Community Development Assistants to WPS
1971	Preliminary work on Mulanje West and Phalombe Projects
1971-74	Construction of five small projects in all three Regions
1972	Selection and training of 20 Project Assistants - appointed to Mulanje West (15) and Phalombe(5) for in-service training
1972	Commencement of Mulanje West (pop 75000) funded by UNICEF
1973	Commencement of Phalombe (pop 90000) funded by DANIDA
1974	Selection and training of 10 Project Assistants - appointed to Phalombe for in-service training
1974	Commencement of minor projects programme supported by UNICEF and CSC[1]
1975	Mulanje West complete - staff transferred to Phalombe and minor projects
1975-77	Establishment of operation and maintenance procedures for Mulanje West
1975-76	2 Technical Officers appointed to minor projects programme Southern Region (1) and Northern Region (1)
1976	Selection and training of 20 Project Assistants
1976	Commencement of Namitambo (pop 60000) funded by DANIDA and Sombani (pop 40000) funded by ICCO (Holland)
1977	Completion of Phalombe - establishment of operation and maintenance procedures
1977	Commencement of Zomba East (pop 100000) funded by CEBEMO (Holland)
1977	Appointment of 2 engineers - 1 to take over as Project Manager, Mulanje, 1 as Project Manager, Zomba
1978	2 Technical Officers, after 2 years field training, sent overseas for university degree courses
1978	WHO/World Bank Sector Study Report
1979	Commencement of Mulanje South (pop 45000) funded by CIDA. Recruitment and training of 24 Project Assistants
1979	New career structure for field staff, changing over to technical grades
1979	Decision to transfer Water Projects Section from MCDSW to a new Ministry of Lands and Water Affairs

1. Christian Service Committee of the Churches in Malawi.

FIGURE 3.1 POPULATION ACTIVELY ENGAGED IN PROGRAMME IN EACH YEAR

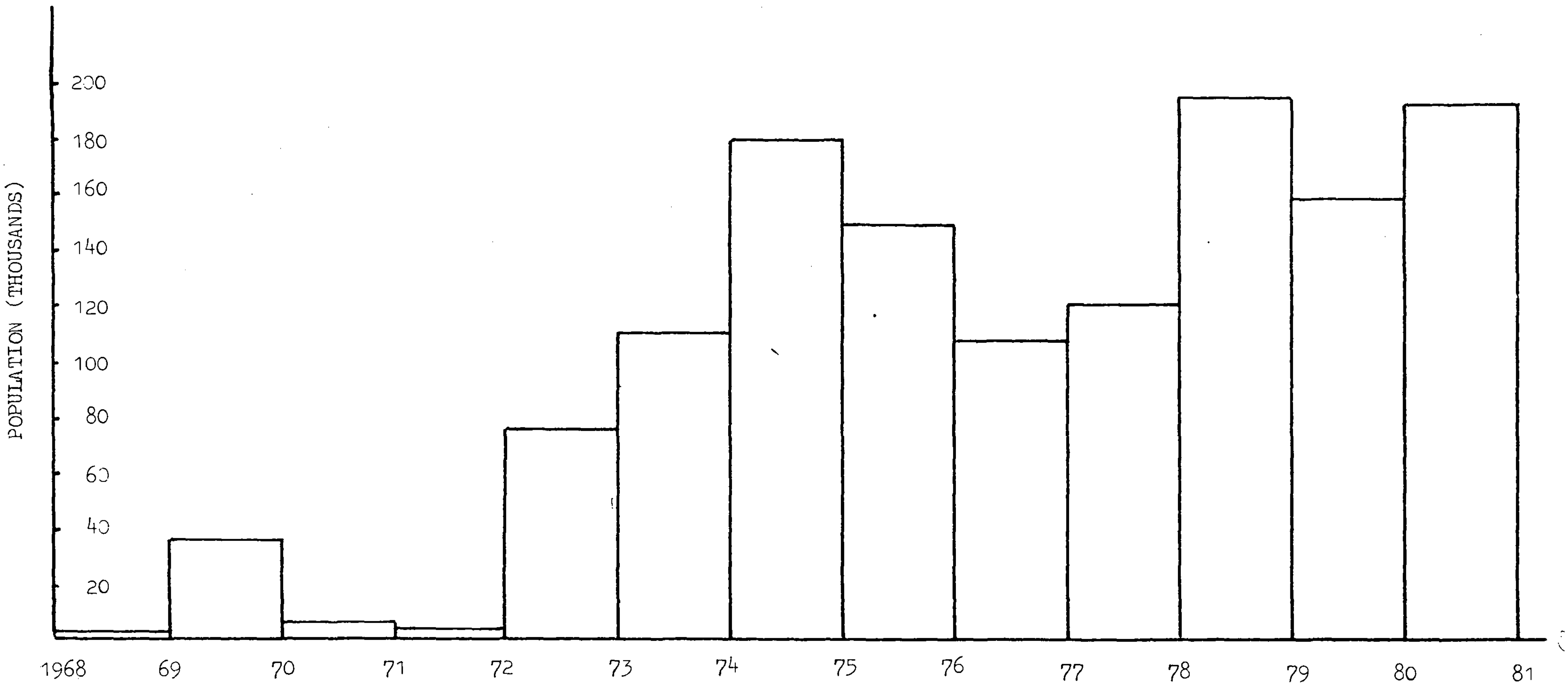


FIGURE 3.2 CUMULATIVE POPULATION SERVED BY PROGRAMME

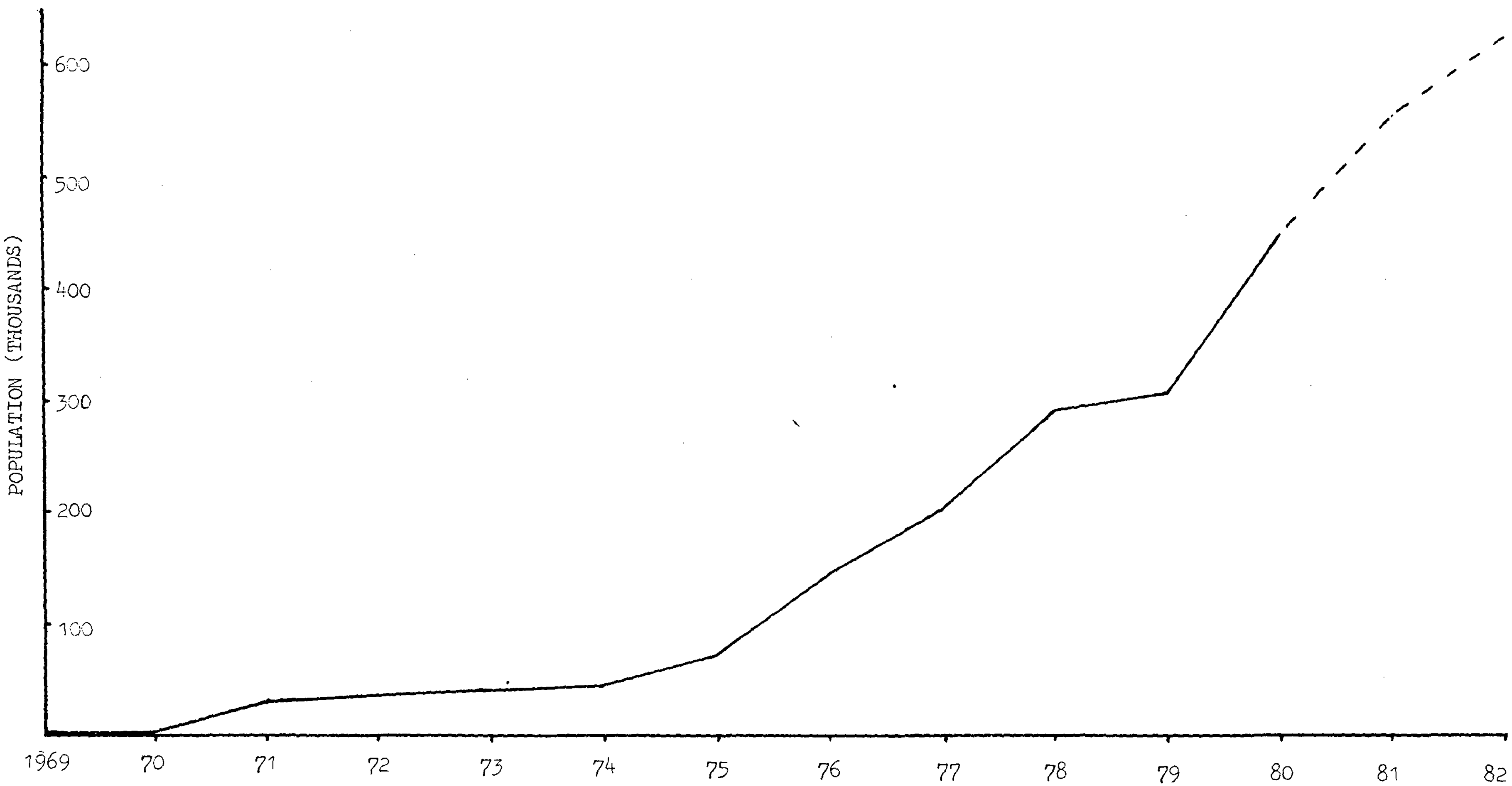


FIGURE 3.3 POPULATION SERVED AS PERCENTAGE OF RURAL POPULATION

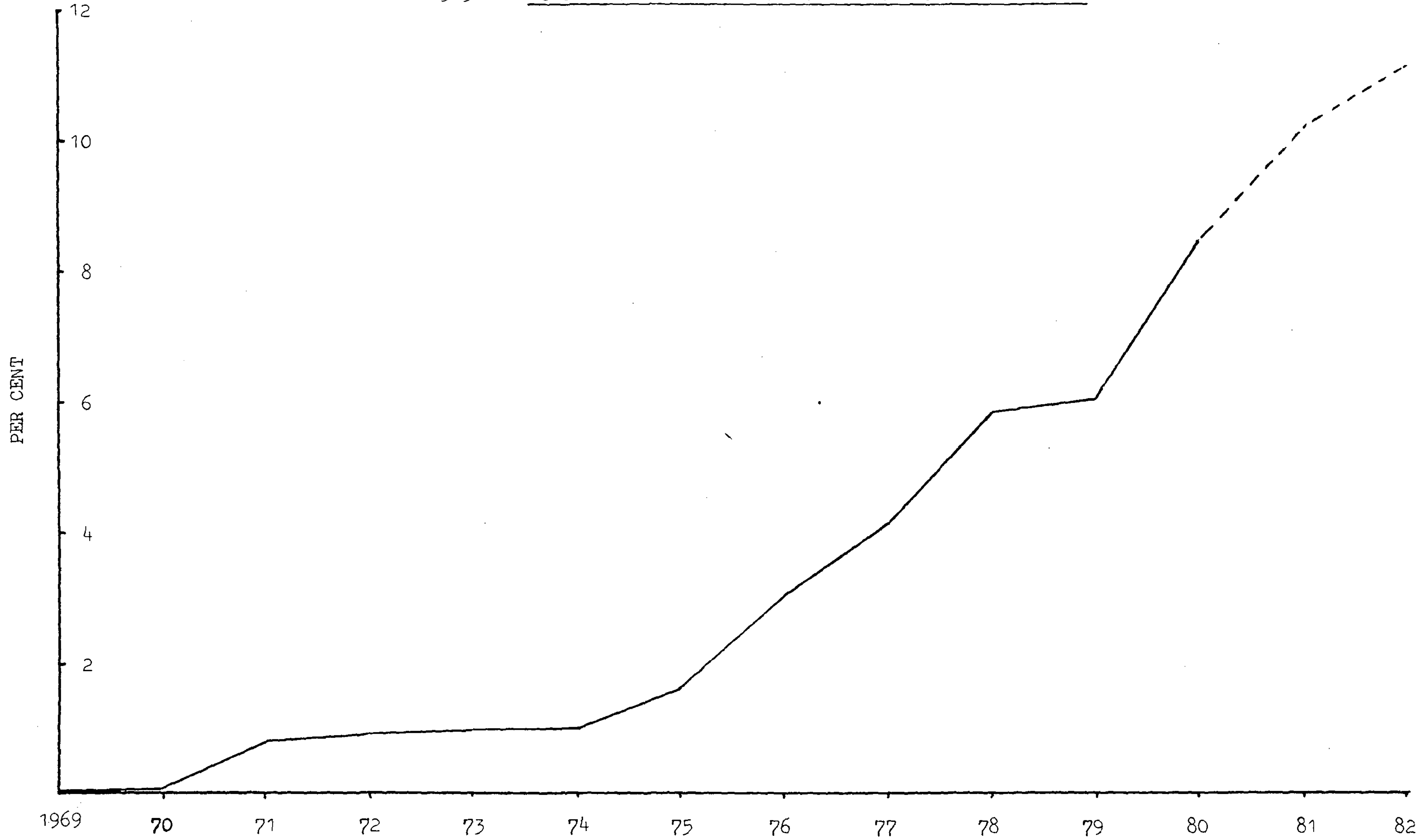
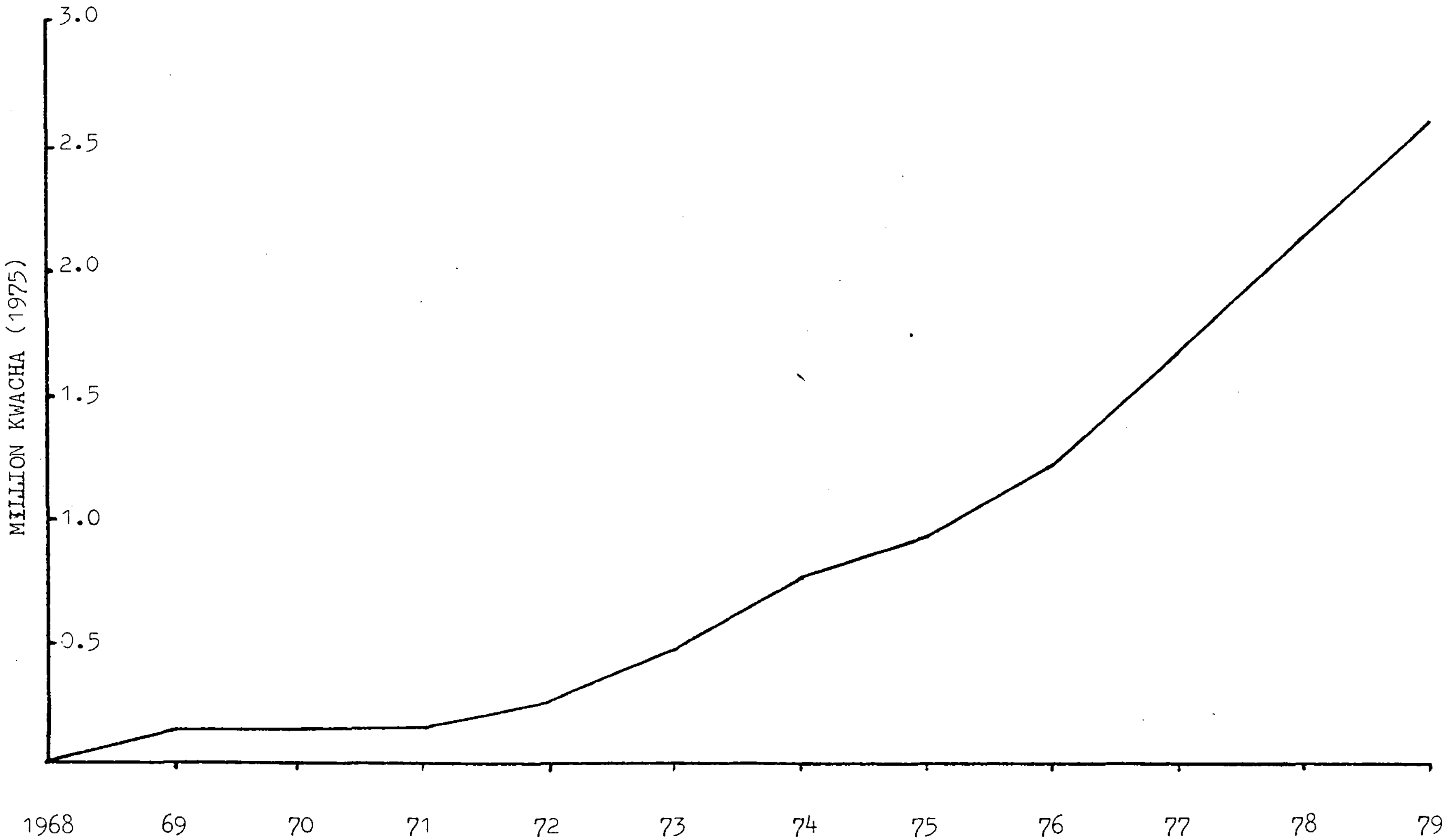


FIGURE 3.4 CUMULATIVE PROGRAMME EXPENDITURE ADJUSTED TO 1975 PRICES[1]



1. Using United States Wholesale Prince Index for Industrial Commodities 1968-79

in identifying possible community construction projects. From discussions with the project committee it became clear that one of the major problems facing the community was their water supply. In the wet season they used shallow hand-dug unprotected wells, while in the dry season the women had to walk several miles to dig in the river bed.

At the engineer's request, the committee took him up to a perennial stream on the lower slopes of the mountain. It was clearly feasible to build a small intake and pipe water by gravity to the villages. The committee was sceptical but agreed to mark a route for the pipe-line as they walked back to the village. At a committee meeting soon after, the engineer stated that MCDSW would provide pipes and materials if the people would dig the trench. The committee agreed to this proposal.

The engineer drew up the design and schedule of materials and the United States Agency for International Development (USAID), who were funding the CD project, agreed to provide the K6000 (1969) for the purchase of pipes and materials.

With the help of the Community Development Assistants (CDAs) the committee organised the villagers into a programme for digging the trench. Once the trench was dug, they laid the pipes, backfilled and finally installed their public standpipes.

Chingale project was completed one year later at a cost of K6000. There were initially 25 standpipes, supplied by 25km of piping serving 3000 people with 25 litres per head per day.[1] The supply is functioning today, being operated and maintained by the people with some technical and material assistance from the Water Project Section (WPS) of MCDSW.

3.2.2 Chambe Project

3.2.2.1 Background to Mulanje District

Although Chingale was not originally planned as a pilot project, MCDSW

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1. The supply was later extended to serve a further 2000 people.

was quick to realise its implications. The ministry now turned its attention to Mulanje District, which was seen as an area of great potential for piped water supplies.

The district occupies 3500sq km of fertile land in the south-eastern corner of Malawi (see maps in Appendices 1 and 2), and supports an estimated population of 500000 in about 700 villages. Mulanje Mountain, which covers 500sq km and rises to 3000m, is the source of several perennial rivers and streams, which together have the potential to serve the entire population of the district by gravity.

Despite the abundance of water flowing off the mountain, the water supply situation for the majority of the population living on the plain was very poor. In the wet season surface water and shallow wells became badly polluted as the result of a relatively high density population with virtually no sanitation, and in the dry season the water table dropped so that streams and wells dried up completely.

The water supply situation had become progressively worse in recent decades with the increase in population raising overall demand, and the increase in cultivation leading to greater run-off and a lower water table. As wells dried up communities were forced to migrate towards the larger rivers of the plain, where water could still be found in the dry season by digging in the river bed.

3.2.2.2 Description of the Project

The Chambe area on the west side of the mountain had been receiving assistance from MCDSW in the form of an adult literacy programme and support for the construction of some primary schools by self-help. The Likhubula River was an obvious potential source of water, although the river itself bypassed most of the area on reaching the plain. The ministry engineer this time designed a much larger project to serve 30000 people in 60 villages, piping water by gravity from an intake in the Likhubula on the lower slopes of the mountain.

The engineer was posted from Ministry headquarters and five Community Development Assistants (CDAs) were appointed to the project under the

District Community Development officer.

In order to mobilise support for the project, leaders from Chambe were taken to the completed project at Chingale, where they were met by the Chingale water supply committee. The committee were naturally proud to show the visitors their supply, and to explain how the work had been carried out.

The leaders then returned to their villages in Chambe and were given some time to discuss their visit within their own communities. Once public interest was aroused, the Chief called a public meeting at which the project engineer made an offer of Government help if the people would agree to do the work.

Committees were formed, and the work got off to an enthusiastic start, with all villages digging the main line from the intake, and then starting work on their branch lines. The intake and sedimentation tank were constructed; the PVC pipes arrived and were distributed to dumps along the lines. However this stage coincided with a period of political unrest in some parts of the country, and gradually progress on the project slowed down. The project itself became the victim of political discord and the self-help programme all but ceased. Fortunately, however, project staff were able to maintain a low level of self-help activity, particularly at the point where water was now flowing.

Partly because the political unrest died down, and partly because of the inherent momentum of the project now that water was approaching the villages (see next section), progress gradually recovered and the project was eventually completed in 1970 at a cost of K64000 (1970). The project involved 95km of PVC piping, distributing water to 180 public standpipes.

3.2.3 Lessons Learnt from Pilot Phase

The pilot phase was partially successful in that it proved to the Government and potential donors that piped water supplies could be installed by self-help, and it proved to the people that the Government was sincere and that water really could flow long distances in pipes.

However, the problems experienced on Chambe exposed some of the weaknesses in the Government's methods, and the lessons learnt indicated that changes were necessary to avoid such problems in the future. It is now clear that Chambe was the critical point in the development of the rural water programme.

3.2.3.1 The Problem of Project Size

As the initial enthusiasm on Chambe project waned it became apparent that there was a credibility gap between what the leaders had seen at Chingale and what they were able to convey to the people. The people were asked to make an "act of faith" by committing their labour for a cause whose motives they doubted. Although the people of Chingale had made a similar act of faith, a much smaller community had been involved and because divisions within the community were not exploited, the Chingale project was able to reach a successful conclusion without significant problems.

In the case of Chambe, however, natural doubts were exploited by clandestine political elements opposing the ruling Malawi Congress Party (MCP). Rumours were spread about the Government's motives in supplying water and there were some isolated violent incidents. The people either became genuinely disaffected, or were too scared to continue to participate in the project.

Political difficulties cannot usually be avoided but a programme must have sufficient popular support if it is to survive political tensions. The lesson learnt from Chambe was that the project was too large for a pilot project in a new area. A smaller project would have been less vulnerable to exploitation because there would have been closer communication between project staff, community leaders and the people. Once a pilot project has been successful larger projects are likely to receive greater popular support and have a greater chance of surviving political tensions.

3.2.3.2 The Need for Appropriate Training for Field Staff

The experience with Community Development Assistants (CDAs) indicated that, with a few exceptions, they were not generally suited to carry out the technical and labour management tasks required. Two years of rather academic training in a modern training college meant they had difficulty in identifying themselves with the problems and aspirations of the rural communities from which they had come. Instead they felt themselves attracted to the administrative functions of the Civil Service. They were also reluctant to engage in the more physical tasks such as helping the people move a rock or join a pipe.

The lesson learnt was that field staff should be drawn directly from rural communities and that they should receive a short period of appropriate training that would concentrate on technical operations and the organization and management of village labour.

3.2.3.3 The Need for a Greater Degree of Supervision

The experience of both Chingale and Chambe showed that it was impossible to ensure an adequate technical standard without closer supervision. Pipe trenches were rarely straight and rarely dug to the correct depth. Standpipe aprons and drains were of a poor quality and sometimes non-existent. It was clear that greater attention would have to be paid to measures to reduce erosion along the pipeline.

The lesson learnt was that a project required a greater number of field staff to ensure a higher technical standard and greater attention to detail.

3.2.3.4 The Limitations of Self-Help

The experience of Chambe indicated that, while self-help was suitable for tasks requiring unskilled labour, it was not so suited to skilled work. Self-help labour was suitable for trench digging and backfilling, the excavation of tank sites and collection of construction materials, the carrying of pipes and even the joining of PVC pipes. The construction of the intake, tanks and other concrete works was carried out by artisans selected by the committee, who were paid from public subscriptions. Problems were experienced with the raising and accounting of these funds and also with ensuring an adequate quality of work.

It became clear that there was a need for a properly trained building team to be paid for out of project funds.

3.2.3.5 The Need to Maintain Project Momentum

Failure to overcome or survive such problems may cause the whole programme to die a premature death. At best, the programme will continue at a sub-optimal level, installing supplies of a poor technical standard, enjoying little community enthusiasm and creating serious problems in operation and maintenance.

A significant reason why the Chambe project survived the problems was that work was never allowed to stop completely. If work does stop in a self-help project, any residual enthusiasm will be lost very quickly and it will be far more difficult to resurrect a failed project than it was to initiate it in the first place.

There are a number of factors that ensured work could continue:

1. Significant progress was made in the first spate of enthusiasm. Although it is common for self-help projects to start off enthusiastically, the effort is not always efficiently utilised. On Chambe there was sufficient organization to ensure that the efforts were well directed and rapid progress was made. This meant that by the time the problems began to have an effect much of the main line had already been dug.

2. The intake was completed early in the project. This meant that water could flow in the main line as soon as the pipes were connected.

3. Pipes and other materials were on site early in the project, so that pipes could be laid in the main trench at the end of each day's digging. Water was turned on each day and left flowing out of the end of the last pipe as visible evidence that water was getting nearer to the villages. This had a tremendous psychological impact on the villagers who had an acute water problem. If the pipes had not been available, the work would undoubtedly have stopped.

4. The field staff were closely supported by their superiors. There is a temptation, reinforced by community development theory, for field staff to stop work until the community has resolved its problems. It

is natural for them to become despondent when these problems arise, especially when they are not of their own making. Field staff therefore need the leadership of their superior officer and sympathetic support from the controlling ministry.

3.2.4 Action Resulting from Pilot Phase

The experience of the pilot phase led MCDSW to formulate more specific plans to replace the ad hoc arrangements that had been made so far. MCDSW activities in rural water supply now began to adopt the nature of an established and rational programme.

The ministry created the Water Project Section (WPS) under the control of the engineer, later known as the Senior Water Engineer. The Senior Water Engineer was appointed to be Project Manager in Mulanje, where the initial effort of the programme was to be concentrated. In addition an engineer was recruited as assistant to the Project Manager, and 3 CDAs who had proved themselves in early projects were transferred to WPS to act as supervisors.

The Project Manager was authorised to recruit and train 20 field staff, to be known as Project Assistants, and to find a suitable local builder to train and form a construction team specialising in intakes and tanks.

3.3 MAIN CONSTRUCTION PHASE

3.3.1 Major Projects

Following the successful completion of Chambe project, WPS drew up plans for the Mulanje West project, to the south of Chambe, and Phalombe project to the north (see map in Appendix 2). Mulanje West was designed to serve the areas of Chiefs Chikumbu and Mthiramanja with a combined population of 75000 in 120 villages. Phalombe was to serve the area of Chief Mkhumba with a population of 90000 in 135 villages.

Although these projects were major undertakings for a relatively new organization, WPS had three reasons for feeling confident. First WPS had gained confidence in itself from the pilot phase, and felt that the lessons learnt would enable problems in future projects to be avoided or resolved.

Secondly, there would now be an adequate number of appropriately trained field staff. Thirdly, and most important, WPS felt that this time it was genuinely responding to the demands of the people, who no longer needed to be persuaded or convinced. The visible evidence of Chambe nearby had convinced the people that they wanted standpipes in their own villages, and that WPS would help them. Thus the people were now urging their leaders, and the leaders were putting pressure on WPS. This was a healthy situation.

Preliminary work[1] was carried out on these projects under the supervision of the 3 CDAs, while 20 Project Assistants were recruited and trained[2] by the engineers. It was decided to concentrate first on Mulanje West until the project was well under way, and then to transfer some staff to Phalombe. The organization and technical details of these two projects are as described in general terms for major projects in Chapters 5 and 7. From a historical point of view their significance lies in three major developments that have influenced the character of the subsequent programme.

The first was the development of a strong team consciousness in the project staff, with close communication between Project Manager, Supervisors and Project Assistants. The team spirit was generated partly by the field training course, and partly by the experience of working together. This was an important factor in the motivation of field staff.

The second was the development of standardised procedures and techniques for all the operations carried out by field staff. The main bulk of experience was gained during this time and procedures were tested and improved by the team as a whole, so that the results represented the collective experience of all staff.

The third development, closely related to the above, concerned the raising of the technical standards of installation. Trenches were now dug straight and to the correct depth, standards were laid down for standpipe aprons and drains and measures were adopted to reduce the erosion of pipelines.

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1. Project initiation procedures and schedules are described in Chapter 5.
2. Selection and training procedures are described in Chapter 6.

These three developments are key elements in the Malawi experience, and will come under closer study in the respective chapters of this report.

Details of other major projects that followed are given in Appendix 4. All major projects so far constructed have been in Mulanje District, and the neighbouring districts of Zomba and Chiradzulu. Together they account for 75 per cent of programme expenditure and 70 per cent of the total population served by the programme.

3.3.2 Minor Projects

The success of the pilot phase in the south also led to demand from other areas of the country. Requests reached WPS from the District Development Committees (DDCs) of Rumphi in the Northern Region and Mchinji in the centre. WPS agreed to carry out two small projects (N'gonga and Muhuju) in Rumphi, a small project in Mchinji, and two small projects (Migowi and Chiringa) in Mulanje District. But because WPS was so heavily committed to the major projects in Mulanje, it was only able to appoint one of the CDAs to Mchinji, and MCDSW arranged for the other projects to be supervised by the District CDAs. All projects were nevertheless visited regularly by the Senior Water Engineer.

As these projects were completed they stimulated still further demands from DDCs and it became clear that a policy was needed to govern the development of the programme in the rest of the country.

As WPS manpower was limited both in terms of numbers and experience, it was clearly unwise to commit WPS to numerous projects all over the country. Even if new staff could be recruited, it was considered that they would need at least two years experience on Mulanje projects before being capable of supervising a small project of their own.

It was therefore decided to concentrate the programme on a few focal areas of outstanding potential for the development of piped water supplies, rather than to spread the programme thinly over the whole country. This would also ensure that the programme would grow from these areas in response to the real demands of the people (once stimulated by a pilot project) rather than in response to the demands of DDCs who were possibly more enthusiastic than their people (who had never seen a project).

In 1974 the first Project Assistants, who had by now had two years' experience, were appointed to 6 small projects situated in all three Regions of the country. UNICEF and the Christian Service Committee (CSC) combined to support this part of the programme with a rolling fund, enabling new projects to be undertaken in nearby areas as the first projects were completed. In 1975 WPS appointed a Technical Officer (TO) to one focal area in each Region, namely to Rumphi, Ncheu and Kasupe.

Details of minor projects are given in Appendix 4.

3.4 THE DEVELOPMENT OF DONOR INTEREST

3.4.1 USAID

The Chingale pilot project was financed by a modest fund administered by USAID specifically for small self-help projects. In 1971 the same fund supported Migowi and Muhuju projects. It is not clear whether USAID realized the full implications of this critical support at an early stage. The projects were apparently financed on a "one-off" basis as USAID have not subsequently supported the programme. Nevertheless, USAID's support is a practical example of the seminal role a small donor (in this case a small fund) can play in helping to initiate a programme.

3.4.2 OXFAM

Chambe project was supported by OXFAM (a British charity) who were attracted by the self-help element and the concept of water as a basic need. These attractions were clearly strong as not only was the financial commitment relatively high for OXFAM, but also the support of a project for 30000 people in a new area involved an element of risk. However, as Chambe was successful and also turned out to be the critical point in the formation of the programme, OXFAM's support was more than justified. It can now be seen as an example of the role of a small donor as catalyst in the development of a programme to a stage when it can attract major donors.

3.4.3 UNICEF

Mulanje West, which followed Chambe, was funded by the United Nations' Children's Fund (UNICEF). It is significant to record the almost accidental manner in which this organization became involved. UNICEF supported a dairy project in Malawi which included a proposal to build a dairy close to the Chambe water supply area. The dairy project officials approached WPS concerning the possibility of linking the proposed dairy to the Chambe supply. This was, however, technically impossible as no provision had been made in the design for the amount of water required. WPS therefore suggested to the dairy officials that a supply to the proposed dairy could be incorporated into the Mulanje West project which at that time was being designed but was not yet funded. UNICEF learnt of this suggestion through the dairy project officials and immediately informed the Malawi Government of its interest in the water project. The proposal for the dairy was subsequently dropped, but UNICEF decided to fund the water project, and has continued to be a major donor to the programme ever since. It is principally interested in the health benefits to children that may be expected from an improved water supply.

3.4.4 DANIDA

The Phalombe project, on the other side of Chambe, was proposed as a result of the demand from the people of the area. However, the Phalombe plain was also the subject of a proposal for an agricultural development project. MANR viewed the water project as an important part of the infrastructure of the area, and hoped that the provision of domestic water would encourage settlement in uncultivated areas of good agricultural potential. It was principally this agricultural significance that attracted the Danish International Development Agency (DANIDA) as part of its commitment to the international Freedom from Hunger Campaign. DANIDA has continued to be a major donor to the programme, concentrating on large projects.

3.4.5 Christian Service Committee

The Christian Service Committee of the Churches in Malawi (CSC) is a joint-church organization which channels church aid from overseas into development projects. It funded two of the early projects in 1972 (N'gonga and Chiringa) and has continued its support as the programme developed, becoming a major donor to smaller projects in collaboration with UNICEF.[1] As a Malawi-based organization CSC concentrates on local costs. The flexibility and speed with which it can respond to requests has made it a particularly valuable contributor.

3.4.6 Other Funding Agencies

In response to the success of the programme, and because of increased interest in the development of rural water supplies, several other major funding agencies have now become involved. The agencies involved are listed against their respective projects in Appendix 4.

3.5 CONCLUSION

Several aspects of this historical account will be brought out in later chapters. There are, however, two main points that deserve consideration here.

3.5.1 The Stimulation of Popular Demand

There is a need to differentiate between the principal motivating forces in the two phases of a programme. In the pilot phase the Government takes the initiative by inviting a particular community to participate. Although this initiative may be in response to the community's request for assistance, the Government should not confuse a generally expressed felt need with a genuine community commitment to the success of a project. This lack of commitment means that the Government, as the main motivating force, has to guide the project through to a successful conclusion.

However, once the pilot project is successfully completed, and provided it satisfies the expectations of the people, it becomes a potent advertisement

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1. CSC has also been the principal donor to the Shallow Wells Programme run by WPS.

for the programme (what might be called the "shop-window" effect) and neighbouring villagers who have seen the result and spoken to the beneficiaries will be far more easily persuaded than they could ever be by Government, or their own leaders. This stage, when the genuine popular demand becomes the principal motivating force, is the point of breakthrough. No self-help programme can grow in strength unless this point is reached.

3.5.2 The Controlled Growth of the Programme

The second main point to be considered follows on from the first, for the programme can be endangered if the stimulation of popular demand gets out of hand. After the first pilot projects in the south, requests from District Development Committees in other parts of the country were expressions of general community interest rather than genuine popular demand. It was clearly beyond the resources of WPS to embark on numerous pilot projects all over the country. With insufficient supervision, such projects would have been excessively prone to failure, and even if, by good fortune many succeeded, the resulting popular demand would have been politically impossible to resist and yet beyond the capacity of WPS to satisfy. WPS's capacity to expand the programme was limited by the time it took to produce sufficient numbers of experienced field staff to take on new projects. The decision to select a few focal areas for the expansion of the programme ensured adequate supervision and limited the stimulation of popular demand to an acceptable rate.

CHAPTER 4

PROGRAMME ORGANIZATION AND MANAGEMENT

4.1 INTRODUCTION

Organizational structures and administrative procedures are generally characteristics of particular countries, and it is not suggested that the system described here is applicable elsewhere, nor that it is an ideal system. Nevertheless, a broad understanding of the programme would be incomplete without a consideration of the institutional and administrative framework in which it operates. Furthermore, the project selection criteria are of particular relevance as they convey the principal elements of programme policy.

4.2 PROGRAMME OBJECTIVES

In effect, the objective of the programme is to provide clean water to as many rural communities as possible who can be served by a gravity supply. This objective is implicit in the nature of the programme and has not been stated in formal terms. Government support for the programme is seen in general terms as part of its overall policy of rural development. The Government has not tried to quantify or even identify the benefits of an improved water supply in specific terms, although popular support for the programme would indicate that the social benefit is more significant than less definable health or economic benefits. Government support for the programme must also be seen in political terms, as a response to genuine public demand.

With the current reorganization of the water sector, and the proposal for a water master plan, it is likely that more specific objectives and targets will be laid down.

4.3 ORGANIZATION OF WATER PROJECTS SECTION

Water Projects Section (WPS) operates as a self-contained organization within the Ministry of Community Development and Social Welfare (MCDSW). The growth of the section from 1970 to 1978 is shown in Figures 4.1 and 4.2. All the other activities of the ministry are run through three regional offices and 24 district offices; field level Community Development Assistants (CDAs) run adult literacy and homecraft programmes and assist the District Development Committees (DDCs) with self-help construction projects (schools, bridges, etc.). WPS however is run on a project by project basis, with the field staff of the projects responsible directly to the Senior Water Engineer (SWE) at ministry headquarters.

This system of organization is highly centralised and has led to a high order of operational and managerial efficiency within the section. SWE has maintained a very close link with field staff at all levels, who are themselves very conscious of his support when problems arise. The chain of authority works principally on the basis of personal communication, and there is a minimum of paperwork. This system has been possible within a relatively small organization, and is a major factor in the successful development of the programme. As WPS grows, however, it may be necessary to break down into smaller units, with an intermediate level of authority between headquarters and individual projects.

4.4 MANAGEMENT OF THE PROGRAMME

4.4.1 Relationship Within Ministry

Within ministry headquarters, the Senior Water Engineer, as head of the programme is responsible to the Chief Community Development and Social Welfare Officer (CCD).[1] Apart from day-to-day management, relating to the execution of current projects, SWE is primarily concerned with the future development of the programme, working on proposals for new projects, estimating

1. Originally the Commissioner for Community Development.

FIGURE 4.1 ORGANIZATION CHARTS OF WATER PROJECTS SECTION AS AT 1970, 72, 74, 76

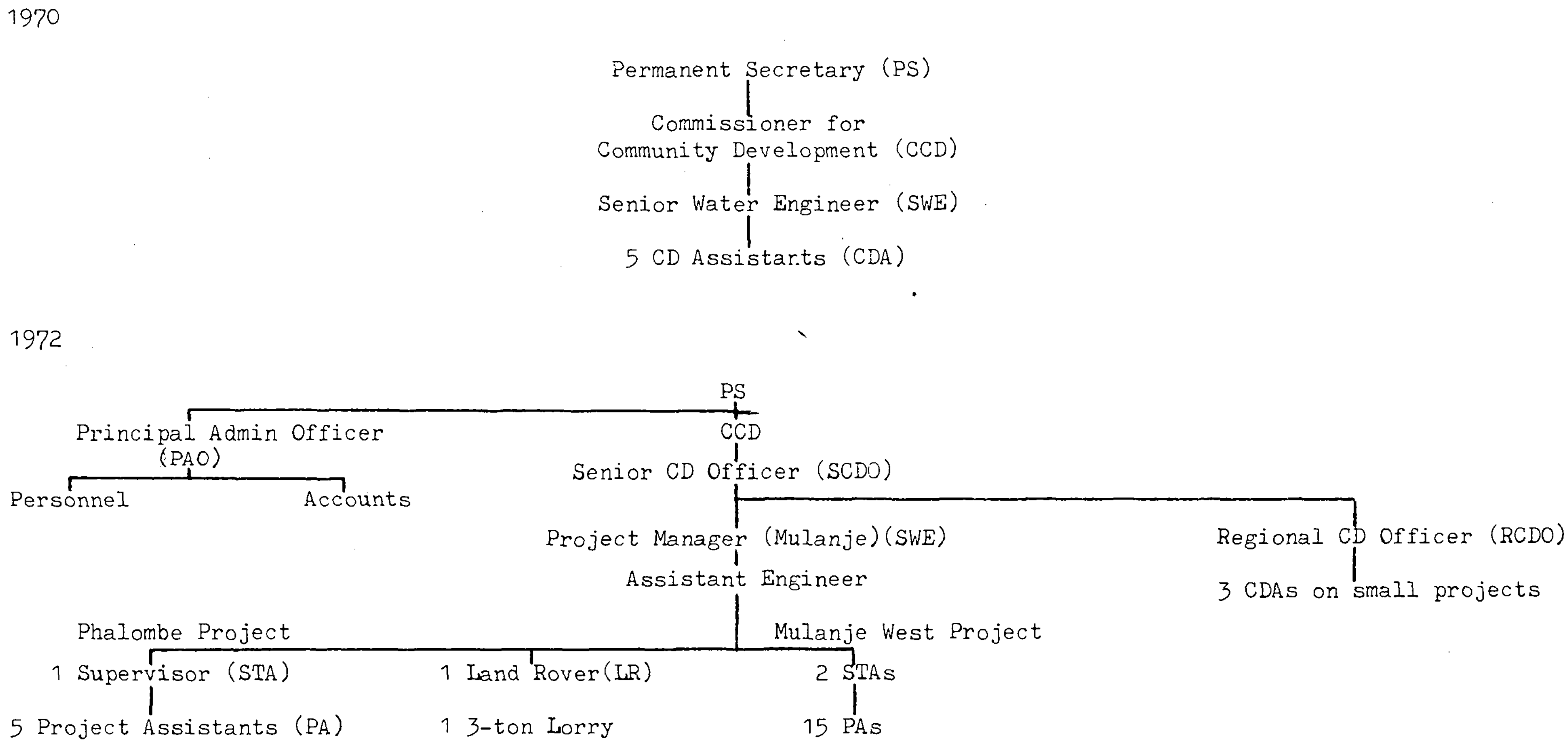


FIGURE 4.1 (continued)

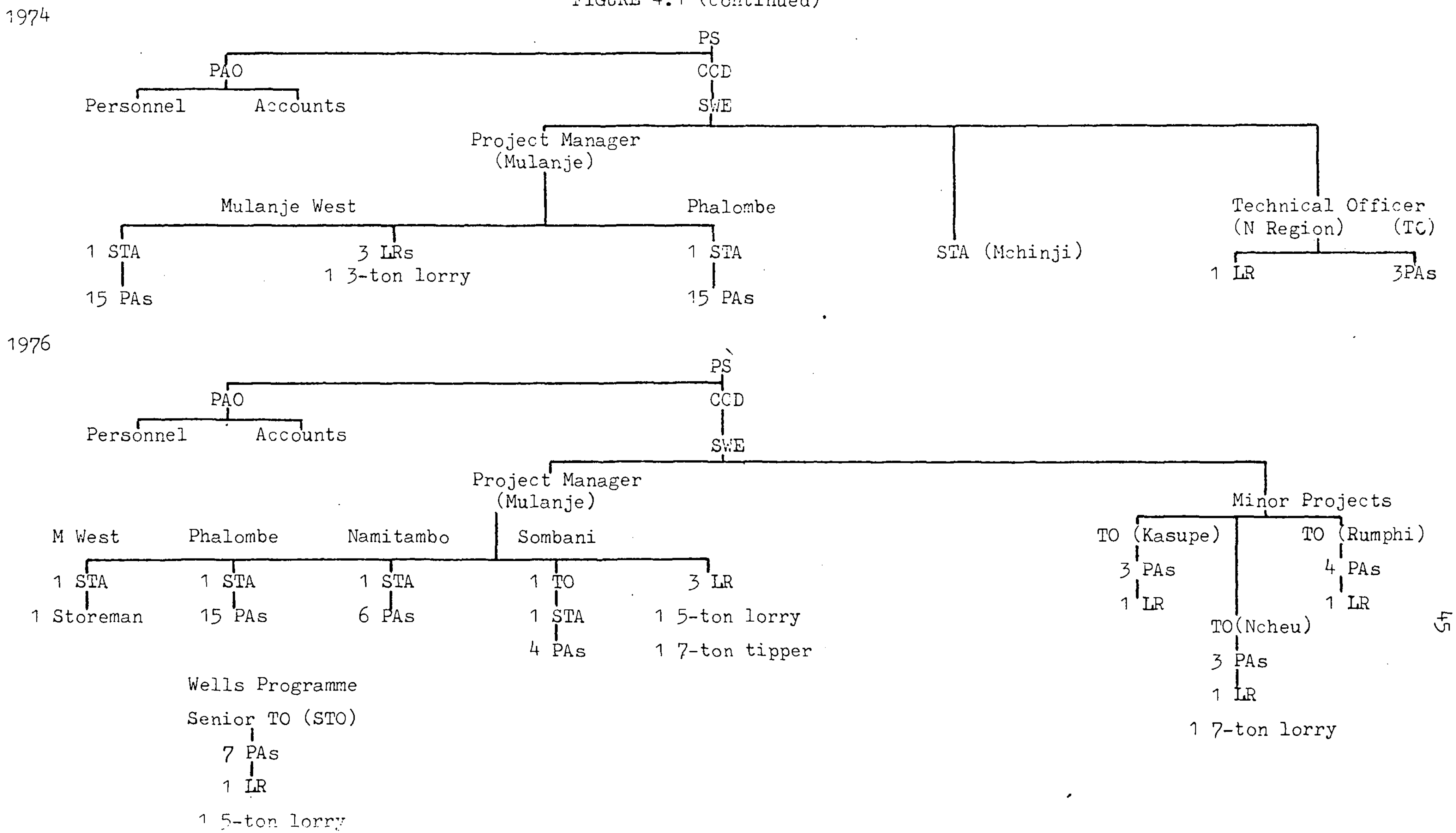
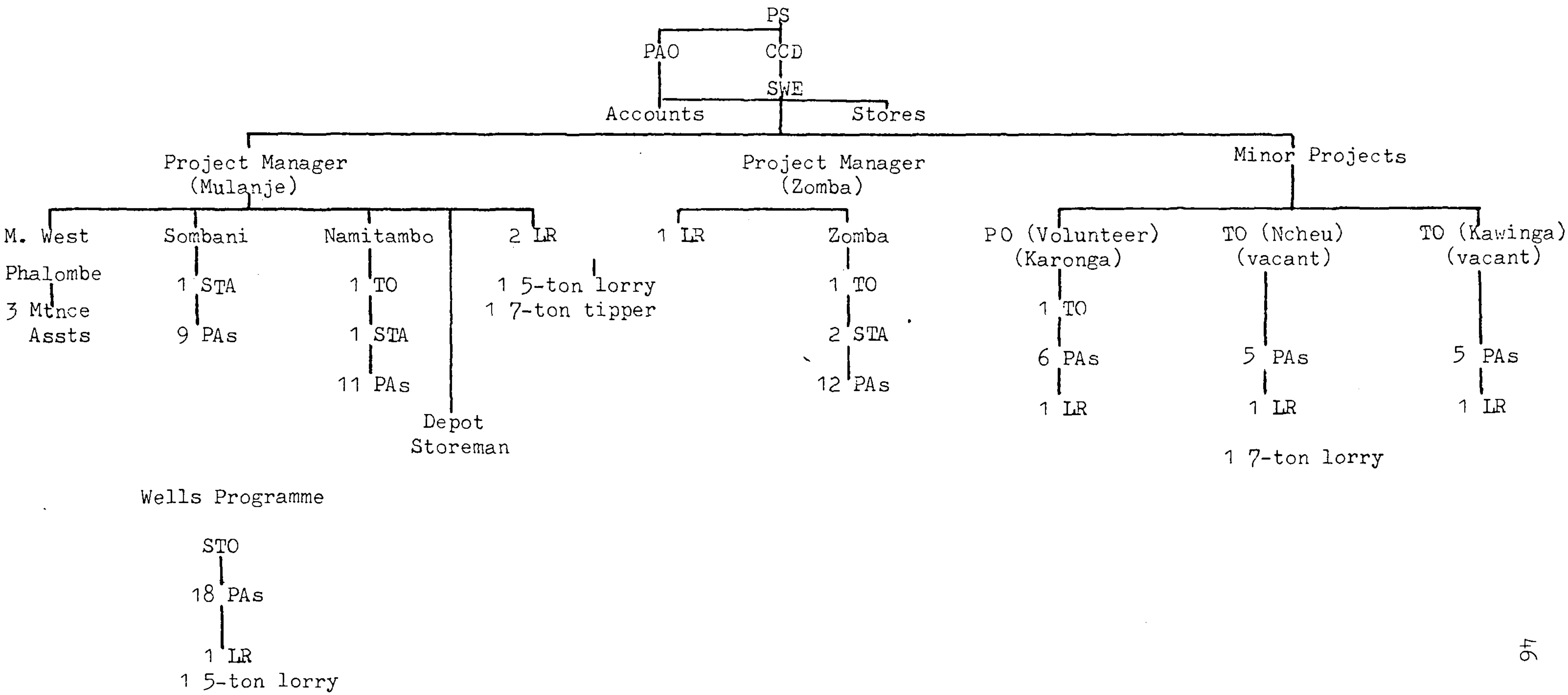


FIGURE 4.2 ORGANIZATION OF WATER PROJECT SECTION AS AT 1978



costs and staff requirements and producing formal project submissions.[1]

According to routine civil service practice, SWE passes any proposals to CCD who, after discussing the issues with the administrative staff, forwards them with his recommendation to the Permanent Secretary (PS). The PS's decision returns via the same route. This procedure can at times be rather slow, and can create problems in a developing programme in which the timing of events can be very important. Many engineers would prefer to be allowed to manage the programme in their own way, but programmes that try to operate autonomously gain efficiency at the expense of life expectancy and long term effectiveness. Such programmes rely too heavily on a few high officials and are unlikely to be integrated into a permanent feature of Government.

4.4.2 Initiative for Projects

A proposal for a project may originate from one of three sources:

1. Local Initiative through District Development Committee (DDC).
WPS sends out a circular letter once a year to all DDCs inviting suggestions for possible projects. The DDCs are asked to submit as much information as possible by completing a questionnaire for each proposal. Proposals must be received by WPS by a certain date.

2. National Rural Development Plan (NRDP)
The Ministry of Agriculture and National Resources, which is responsible for NRDP, may identify areas of agricultural potential where the lack of domestic water is a constraint to settlement. If a gravity scheme is considered possible, WPS is asked to carry out a feasibility study.

3. Water Resource Planning
Potential project areas are also identified by WPS as a result of studies of water resources, maps and other data.

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1. See Appendix 6.

4.4.3 Annual Feasibility Survey

At the end of the dry season, when water yields are at their annual lowest, the Senior Water Engineer and a small survey team tour the country visiting the site of each request. Information is sought on water yield, potential head, existing and potential population, nature of terrain, location of natural or man-made boundaries, existing water supply and attitude of the people.

4.4.4 Guidelines for Project Selection

While no strict criteria have formally been laid down, certain general guidelines are followed:

1. Projects are located in focal areas of the country

There are two reasons for this. First, the programme can only grow in strength after it has successfully stimulated popular demand. In order to ensure that programme commitments do not outstrip capacity, this demand must be confined to selected areas. Secondly, a high degree of supervision and technical support is required to ensure that the demand is both successfully stimulated and satisfied. This is most efficiently achieved by concentrating limited resources on focal areas.

The areas are chosen for their potential for gravity systems. In the Southern Region, Mulanje has been the major focus, with Zomba taking over now that Mulanje is nearly completed. In the Central Region, Ncheu is the area with the greatest potential, and Mchinji is a lesser focus. In the north, Karonga is now taking over from Rumphi as the main centre of activity.

2. Projects are considered on an area basis to maximise the potential from available water resources

Requests from DDCs are usually concerned with a single village or small group of villages, generally those that have been most active in presenting their case. When reference is made to the map and hydrological data WPS may see that the water source mentioned could in fact serve a much larger number of villages. This may be confirmed by an on-site survey and WPS would then make a feasibility study based on the largest possible project from that source.

3. In a new area a smaller scheme will be selected as a pilot project
The importance of a pilot project has been discussed in Chapter 3. Although project staff have by now developed confidence in the programme, the people of a new area still need to be convinced. This is best achieved by a small, relatively "easy" pilot project. However, the experience already gained by project staff, and the fact that some confidence is already established by widespread knowledge of the programme, has enabled larger pilot projects to be undertaken. Mwanza Valley project, for example, is situated in a new area (Chikwawa District), yet is designed to serve 20000 people.

4. Areas of agricultural potential receive special consideration
Lack of domestic water is a serious constraint to the development of potentially fertile land. MANR has usually provided domestic water in agricultural project areas by sinking numerous boreholes, a technology chosen more out of habit rather than out of careful consideration of alternatives. Now that WPS does provide an alternative, gravity systems are being installed in accordance with agricultural priorities. There is, however, the proviso that there are enough people already settled to carry out the work.

The installation of a water supply by self-help can have special significance for an agricultural project. While a self-help water project does not necessarily lead villagers to undertake other development activities of their own accord, the experience, confidence and motivation gained by leaders, committees and the people can create favourable conditions for the success of further Government initiatives that seek a self-help response.

5. The Government favours those projects with a lower per capita cost
While this was an important criterion in the early stages when funds were at a premium, it has become of secondary importance now that the availability of funds is no longer a constraint. Donor agencies find that the per capita cost of even the more expensive projects in Malawi compare favourably with costs in other developing countries. Thus,

although Phalombe, which was one of the earlier projects, was relatively expensive for Malawi at about K6 per head (1973), it was still approved by government as other considerations (1, 2 and 4 above) were considered more important.

6. <u>These guidelines are not mutually exclusive</u>
It has already been mentioned that these are guideliness rather than rigid criteria, which implies that they are a general framework within which the respective merits and drawbacks of proposed projects will be judged. The final list will represent a mixture of all considerations, each project ultimately being chosen for a variety of different reasons.

The following two criteria are technical considerations which are more rigidly applied:

7. <u>The programme concentrates initially on gravity systems</u>
In view of the immense potential in Malawi for gravity systems, and the great advantages of cost and maintenance inherent in them, the programme is initially confined exclusively to such systems. This concept of a specific programme for a specific technology is a significant feature of the rural water sector in Malawi (there are separate programmes for boreholes and protected shallow wells).

8. <u>The programme concentrates initially on water sources that do not require treatment</u>
Malawi is also fortunate in having a vast number of unpolluted upland surface water sources which do not require treatment.[1] By concentrating on these, costs and maintenance requirements are kept to a minimum. The need for treatment is replaced by catchment protection and surveillance. All water is extracted from within forest reserves where no habitation or cultivation is permitted, and which are patrolled by forest rangers.

WPS is now considering some projects where treatment will be necessary and is planning to build some pilot scale slow sand filters to gain experience in construction and operation under local conditions.

1. Other than screening and sedimentation.

9. Political considerations

Along with all development activities, water supply has important political implications. The relatively scientific or objective guidelines given above can lead to an imbalanced geographical distribution of programme activities. The government on the other hand is keen to spread benefits throughout the country, particularly in areas which may have been neglected in the past and it is particularly anxious to redress the imbalance of development, which historically has favoured the Southern Region. This does not mean that projects are chosen solely for political reasons, but that political considerations will influence the final list.

4.4.5 Procedure for Project Selection

The information gained during the annual feasibility survey and from follow-up studies is analysed by WPS. Preliminary estimates of costs and manpower requirements are made, and a short list of selected projects is drawn up in accordance with the above guidelines. Projects are divided into major schemes suitable for individual submission to funding agencies, and minor schemes suitable for inclusion in the small projects rolling fund. The list is processed through MCDSW to the Minister for approval.

Once approved, the list is forwarded to Development Division for further scrutiny to ensure that it is in line with the government's overall development policies, and then returned to WPS.

4.5 FUNDING PROCEDURES

The next stage is the preparation of detailed designs and estimates for all the approved projects. For major projects, formal project submissions are drawn up in accordance with a standard government format.[1] These are then passed through Development Division to the Ministry of Finance for

1. See Appendix 6

forwarding to potential aid donors. In practice, donors may already have expressed interest, and their representatives may have visited the country and received draft proposals. The project submission then becomes almost the final stage of the funding procedure, rather than an exploratory stage. Once agreement is reached, the funds are either transferred immediately by the donor to the Ministry of Finance, or the donor may reserve some funds until expenditure has been made, and then pay the supplier direct.

Minor projects (generally those serving less than 30000 people) are those that are too small to be individually attractive to major donors. They are therefore grouped together into a sub-programme, and funded from a rolling fund. This fund is maintained jointly by UNICEF and the Christian Service Committee (CSC), who commit a predetermined sum of money each year. Having completed the designs and estimates, WPS submits a list of small projects with details and descriptions through the Ministry of Finance to these donors, who release the funds as expenditure is incurred. UNICEF concentrates on the purchase of materials abroad, principally pipes, fittings and vehicles, while CSC concentrates on local construction costs and project running costs.

4.6 ADMINISTRATIVE PROCEDURES

All routine administrative procedures are important but only the more relevant ones are considered here.

4.6.1 Procurement of Supplies

Because of the variety of funding agencies, supplies for major projects are dealt with on a project by project basis. Supplies for the smaller projects, however, are considered together as a whole.

4.6.6.1 Tendering

For major orders, principally for PVC and asbestos cement pipes and fittings, WPS seeks quotations from three or four manufacturers, and submits them to the Government's Central Tender Board (CTB) with recommendations. This system encourages competition among suppliers, but it is important that the quotations are subjected to engineering scrutiny as the cheapest is not necessarily the best choice.

As all Government orders over K200 have to be approved by CTB it is desirable to submit a comprehensive list of all stores required, so that as much as possible is approved at a time. However, it is impossible to foresee all expenditures and urgent stores are sometimes required at short notice. It can then be a problem to obtain CTB approval as the Board only meets once a month, and there is a need for an emergency procedure to obtain provisional authority as long as the expenditure can subsequently be justified.

4.6.1.2 Ordering

Orders are placed after CTB authority has been received and the funds assured. The timing can be critical as it is essential that the project is not delayed through lack of supplies. The manufacturer's delivery time and shipping times are a major consideration for supplies from overseas. Major orders are placed by SWE in ministry headquarters. Minor orders that do not require CTB authority may be placed directly by Project Managers or Technical Officers. These are principally for construction materials, such as cement and aggregate, miscellaneous supplies and vehicle maintenance and repair costs. Officers are responsible for keeping expenditure within the funds available.

4.6.1.3 Stores Administration

Stores for major projects are delivered directly to the project headquarters and administered by the Project Manager. Stores for minor projects are received at the central pipe depot and distributed as required. It has been possible to build up a stockpile of PVC pipes and fittings to cushion the effects of delivery delays which could seriously harm the programme. The depot also stores items which are usually available locally, but which are subject to frequent shortages. A storeman is employed to maintain stock records and to handle incoming and outgoing stores.

4.6.1.4 Accounting

All accounts are handled by the accounts office within MCDSW. Separate accounts are kept for all major projects while a single account covers the minor projects. Despite the appointment of an accountant specifically for

WPS, the prompt payment of accounts has always been a problem. This is partly due to the Government's difficulty in attracting well-trained accountants from the more lucrative private sector.

Expenditure is broken down into categories and charged against the funds available for that category. Thus, for example, out of the total project funds, certain amounts are allocated for the purchase of water supply materials, vehicles, the construction of buildings, transport costs, personnel emoluments and contingencies. Funds may be transferred between categories and over-expenditure may be carried forward to the following year with Treasury approval.

4.6.2 Staff Administration

The appointment, pay, allowances and conditions of service of all field staff are administered in accordance with the Malawi Public Service Regulations. All matters relating to field staff must be processed through the Personnel and Accounts officers of the ministry headquarters.

4.7 COMMENT

The programme in Malawi, as in some other developing countries, has grown within a Community Development ministry. There can be problems when a relatively minor, non-technical ministry suddenly finds itself controlling a major rural development programme of a highly specific technical nature. Unless the ministry is expanded and upgraded, it is likely that its administrative resources will be inadequate to cope with a rapidly developing programme.

On the other hand, the programme is strictly rural-oriented, and requires a blend of the technical and social disciplines. In this respect Community Development has the advantage over, for example, the urban-oriented and highly technocratic Ministry of Works and Supplies.

Ideally, the programme should function within a rural oriented, technical ministry, but such a ministry does not always exist. The Malawi Government has now decided to move the programme into a new water-oriented ministry in which the urban and rural interests are reasonably balanced. This is a major step forward, and should provide the right conditions for the continued expansion of water sector activities.

CHAPTER 5

PROJECT ORGANIZATION AND MANAGEMENT

5.1 INTRODUCTION

The successful mobilization and application of self-help labour, and the performance of project staff is heavily dependent upon the organization and management procedures at field level. These aspects are considered here in some detail.

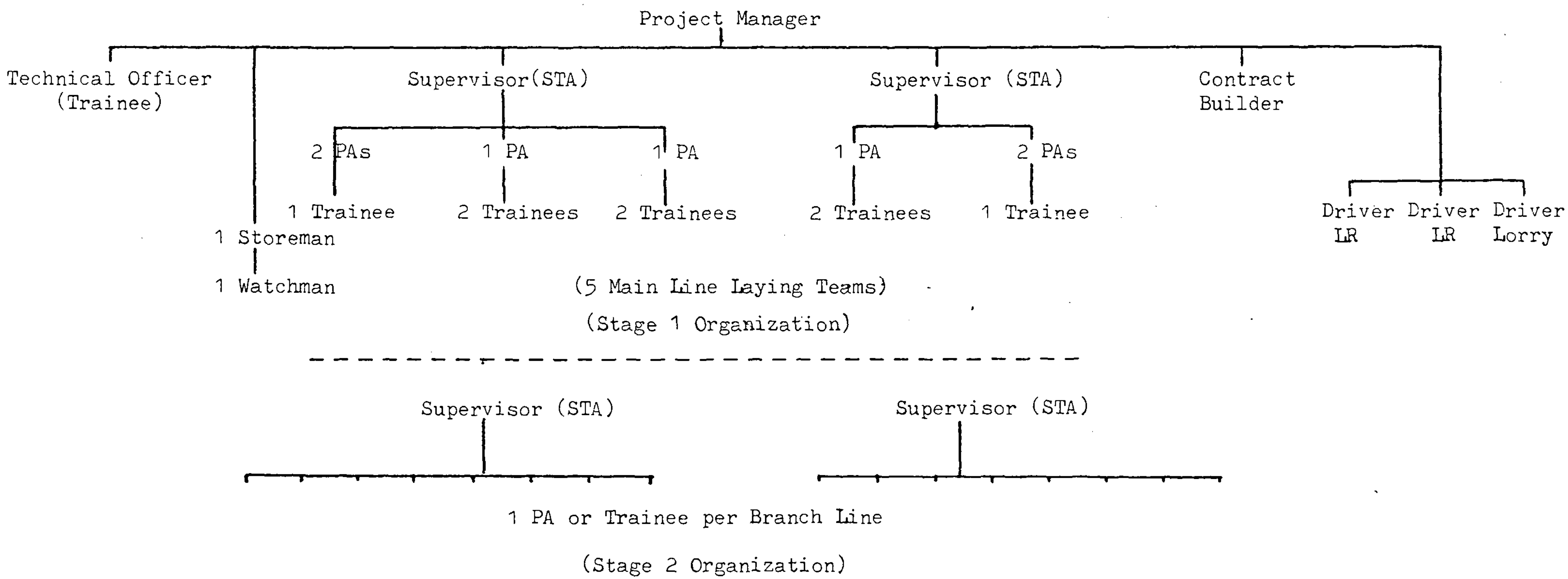
5.2 PROJECT ORGANIZATION

5.2.1 Field Staff

Figure 5.1 shows the field staff organization of a major project for 75000 people. The role of the staff is to provide the technical supervision to ensure that the job is done properly. The Project Manager is a professional engineer with overall responsibility for the project. He is assisted by Supervisors who are experienced in the social and technical skills required, and are responsible for the day-to-day supervision of Project Assistants and the maintenance of the self-help programme. The Project Assistants are responsible for the routine management of self-help labour, the maintenance of technical standards and the performance of certain technical tasks. Job descriptions for field staff are given in Appendix 5 and further aspects are discussed in Chapter 6.

A project of this size is executed in two stages. The first stage involves the installation of the main pipelines, for which a team of two or three Project Assistants is allocated to each section. The second stage concerns the installation of branch pipelines, for which a Project Assistant is allocated to each branch.

FIGURE 5.1 STAFF ORGANIZATION FOR A MAJOR PROJECT



5.2.2 Community Organization

The role of the community organization is to set up and maintain the self-help labour programme. The organization is quite distinct from that of the field staff, although naturally there is close co-operation between the two. Figure 5.2 shows the organization for the two stages of a major project, and the relationships between project staff and the community structure. This relationship is not rigidly defined, and the overlap reflects the close collaboration between all levels of staff. The roles of the individual committees are discussed in Section 5.5.

5.3 PLANNING A MAJOR PROJECT

The smooth running and ultimate success of the project is highly dependent on careful planning and preparation. It is essential to avoid delays that could jeopardise the self-help commitment. Particular attention is given to the timing of staff appointments, the delivery of pipes and vehicles, the transport of materials and the motivation of committees. Exact timing and sequence varies from project to project, but certain activities are fixed by seasonal factors. These are:

1. The construction of the intake in August, September and October, before the rains.

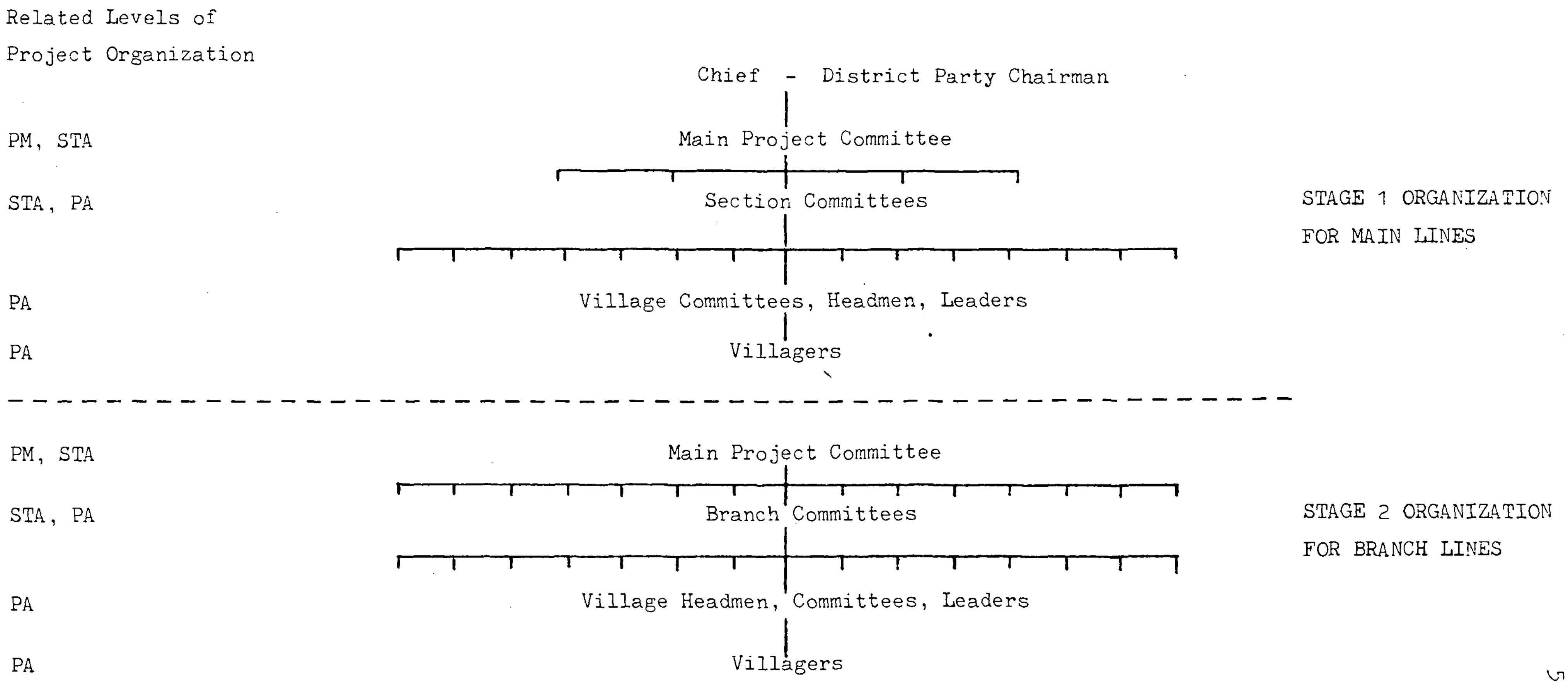
2. The marking of the pipeline in October, before crops are planted.

3. The start of the main digging programme in February or March in a period of relative lull in agricultural activity between planting, weeding and harvest (some special sections may be started earlier).

4. The start of the main laying programme in May or June, the target for the year's work being calculated on what may be laid in the five or six months before the rains.

Other project activities are planned around the dates. Table 5.1 show a schedule for a major project of three years' duration including one year of asbestos cement pipelaying. The table is also useful as a list of all the activities involved in the execution of a project. The letters P and C show whether the activity is carried out by project staff or the community.

FIGURE 5.2 <u>COMMUNITY ORGANIZATION FOR A MAJOR PROJECT</u>



KEY PM Project Manager
STA Supervisor
PA Project Assistant

TABLE 5.1 SCHEDULE FOR A MAJOR PROJECT

(The letters P and C indicate activities in which the Project Staff and the Community are involved respectively)

Year 1

1.	Apr	- beginning of financial year, funds become available (P)
2.	Apr/May	- procurement of plant and vehicles (P)
3.		- staff transfers, at least sufficient to initiate project (P)
4.	May/Jun/Jul	- site and construct project headquarters/store and any staff houses (P)
5.	Jun/Aug	- public meetings to announce the project (P,C)
6.		- forming main project committee to start initial programme (P,C)
7.	Jun/Jul	- site intake, screening and sedimentation tanks (P)
8.	Aug/Sep	- construct intake (P,C)
9.	Aug	- survey and site main line storage tanks and river crossings (P)
10.	Aug/Sep/Oct	- mark main line from aerial photographs (P,C)
11.		- chain and label main line (P)
12.		- clear road along main line for asbestos cement (AC) pipe delivery (P,C)
13.	Aug/Sep/Oct/Nov	- delivery of AC pipes from station to pipeline (P,C)
14.	Oct/Nov	- survey main line (P)
15.		- construct pillars at river crossings if required (P)
16.	Oct/Nov/Dec/Jan	- construct screening and sedimentation tanks (P)

Year 2

17.	Feb	- formation of section committees to organize the main line trench digging programme (P,C)
18.	Feb/Mar	- start trench digging programme (P,C)
19.	May/Jun	- start AC laying as soon as possible (P,C)
20.	Jul/Aug	- completion of trench digging though some obstacles may still remain (P,C)
21.		- PVC pipe arrival, delivery from station to pipe store(P,C)
22.		- excavate main line storage tanks (P,C)
23.		- stock building materials (P,C)
24.	Sep/Oct	- connection of main line sluice valves, air valves flush points and river crossings (P)

25.	Oct	- all AC laying sections link up and main line pressure-tested (P)
26.		- start construction of main storage tanks (as soon as water is 'on') (P)
27.		- survey and site branch line storage tanks (P)
28.		- mark branch lines from aerial photographs (P,C)
29.	Oct/Nov	- inspect and protect main line from surface rain water damage. Check after first heavy rain (P)
30.	Dec/Jan	- sow paspalum grass seed to mark main pipelines (P,C)
Year 3		
31.	Feb	- formation of branch committees to organize branch line digging programme (P,C)
32.	Feb/Mar	- start branch line digging programme (P,C)
33.	May/Jun	- start PVC pipelaying as soon as possible (P,C)
34.	Jul/Aug	- excavate branch line storage tank sites (P,C)
35.		- stock construction materials (P,C)
36.	Sep/Oct	- completion of pipelaying on major branches, though lesser branches may continue through rainy season (P,C)
37.		- start construction of branch line storage tanks (P)
38.	Oct/Nov	- inspect and protect major branches from surface rainwater damage. Check after first heavy rain (P)
39.		- commence construction of standpipe aprons (P,C)
40.	Nov	- commence connection of village taps to standpipes (P)
41.	Dec/Jan	- sow paspalum grass seed to mark branch lines (P,C)
Year 4		
42.	Jan/Feb/Mar	- complete connection of taps (P,C)
43.		- set up maintenance procedures (P,C)
44.		- carry out project inspection (P)
45.	Mar	- project completion by end of financial year (P)

5.4 PLANNING A MINOR PROJECT

The plan is the responsibility of the Technical Officer in charge. It is also affected by the seasonal considerations given above, but the smaller size of the task enables a greater degree of flexibility in the schedule. The main digging programme can start in March or April of the first year, but the survey work and siting of intakes and tanks can be done in the previous dry season. It is sometimes possible to work on tank sites and the marking of main lines in the year before the project officially starts, provided that the project has been approved. No funds may officially be spent, however, until the beginning of the financial year in April. An early start depends on the availability of project staff, and is facilitated by the proximity of the new project to a current one. Table 5.2 shows a schedule for a minor project of one year's duration.

5.5 COMMUNITY PARTICIPATION

The strength of the self-help labour programme is dependent on the way in which the community is invited to participate, and on the establishment of proper authority for committees to carry out their work.

5.5.1 Initiating the Project

The Chief and the political leaders of the project area are consulted as to a suitable date for a public meeting to announce the project. If more than one Chief's area is involved a separate meeting is arranged for each.

The meeting is conducted jointly by the Chief and the political leaders; all project staff are present. A political leader (either a Member of Parliament or a District Party Chairman) announces that the Government has selected their area for a water project and is offering to provide the pipes and materials if the people are prepared to provide the labour. The Chief then asks his people the rhetorical question whether or not[1] they accept

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1. It should be stressed that the attitudes of the people have already been sounded out during the feasibility survey, and the project would not have reached the stage of initiation unless community support was a foregone conclusion.

TABLE 5.2 SCHEDULE FOR A MINOR PROJECT

(The letters P and C indicate activities in which the Project Staff and the Community are involved respectively)

Preliminary Work

1.	Sep	- survey possible intake sites and alignment of pipelines from headworks; profiles sent to Senior Water Engineer (P)
2.	Oct	- construct intake (P)
3.		- site main tanks (P)
4.		- prepare access roads to tanks (P,C)
5.		- excavate tank site (P,C)
6.		- stock construction materials (P,C)
7.	Nov	- mark main pipelines from aerial photograph (P,C)

Year 1

8.	Feb/Mar	- public meeting to form project committees (P,C)
9.		- organize trench digging programme (P,C)
10.	Mar/Apr/May/Jun	- trench digging programme (P,C)
11.		- tank construction programme (P)
12.	May/Jun/Jul/Aug	- PVC pipelaying programme[1] (P,C)
13.		- construction of river crossings (P)
14.	Aug/Sep/Oct	- construction of standpipe aprons (P,C)
15.		- connection of village taps to standpipes (P)
16.	Oct/Nov/Dec	- protect lines from surface rainwater damage (P)
17.		- carry out project inspection (P)
18.		- train committees in maintenance procedures (P,C)
19.	Dec	- sow paspalum grass seed to mark pipelines (P,C)
20.		- project completion (P)

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1. Assuming PVC pipes available from stockpile. Otherwise pipelaying is delayed until pipes arrive in July or August.

the Government's offer (or he may accept the offer himself on the part of his people). This procedure establishes the self-help commitment from the very start.

The project staff are then introduced and the Project Manager is asked to explain the work involved. He describes the source, the rough alignment of pipelines, the positions of tanks, the project boundary and a rough schedule of the work. The Supervisor then explains what is required in terms of committees and the self-help labour programme. The election of committees is usually postponed to a later meeting of village headmen and other local leaders. These leaders may be taken to visit the committees of a current project nearby, and a film explaining the project is shown to the public at various centres in the area.

5.5.2 The Authority and Responsibility of Committees

The role of the committees is to organize the self-help labour programme to perform the tasks according to the project schedule. The self-help programme cannot be successful unless the committees are seen to have the authority to act. This authority must come from the Chief and the party leadership, and not from the project. Thus the committees are set up by the local leadership, whose authority is passed down from one committee to the next and finally to the people. With the Chief's authority behind them, the committees become responsible to him for their work, and when problems arise they feel obliged to resolve them. This responsibility is vital for the success of the self-help programmes.

If the project staff were to try to set up committees, this authority would be absent. When problems arose the committees would not have the authority, in the eyes of the people, to act, and they would pass the problems to the project staff to solve.

5.5.3 The Role of Committees

5.5.3.1 Main Committee

After the project has been announced the Chief calls a meeting to elect a Main Committee to be responsible for the overall management of the self-help programme. The first task of this committee is to organize the initial work programme. It is important that the tasks are well planned so that the project staff can make the requirements very clear. For example:

Task 1 : Intake, trench digging from intake to sedimentation tank, excavation of screening and sedimentation tank sites.
Requirement: Daily work programme involving villages living nearest.

Task 2 : Marking the main line.
Requirement: 20 men daily for about two weeks.

Task 3 : Clearing access road along pipeline.
Requirement: Daily work programme involving villages living nearest to main line for about two or three weeks.

When these have been explained it is left to the committee to decide how the requirements should be fulfilled. For example, it may delegate the organization for the headworks to one committee member from that area, who may form his own committee of the villages involved. For marking the line and clearing the road the committee may contact the villages along the line and organize a work programme. Project staff will visit the relevant villages the day before they are required to give the final detailed instructions.

Once the initial work programme is completed, the Main Committee is responsible for setting up the main line trench digging programme (item 17 in Table 5.1). This is the first major task in which all villages are involved. About a month before the programme is due to start the Main Committee meets to discuss the work. The Project Manager explains the work to be done and can suggest ways in which the work may be divided up. He is in a good position to advise on this as he has an overall picture of the project, and the location and population of all the villages involved. Nevertheless, it is left to the meeting to decide how the work should be divided, and once this decision is made the committee advises the villages concerned in each section to form their own Section Committees.

5.5.3.2 Section Committees

Villages in each section then meet to elect the Section Committee, whose immediate task is to draw up a daily programme of villages to work on the trench. It is important that the committee is provided with a list of villages and populations so that a balanced work programme can be made. The committee decides how the task will be tackled, though project staff usually advise digging to commence at the upstream end of the section and work progressively down; sometimes the committee decides to divide the section up into subsections for each village. The committee produces a rota of committee members to attend the trench each day to help supervise the work. In addition, the committee asks each village to nominate four leaders to supervise the work of the village on its day of attendance.

The secretary of the Section Committee is provided with special letter-forms to remind each village the day before it is due for work. The secretary often also keeps a record of village attendance; any village showing consistently poor attendance is given widespread publicity so that social pressure is brought to bear on that village to improve its performance. The committee is therefore active, though it rarely meets formally.

If the section's digging programme gets off to a good start, it usually settles down to a steady rate of progress. With a long and arduous section, attendance at the trench usually begins to drop after two or three months. This may be attributed both to the harvest period and to the wearing off of the initial novelty and enthusiasm.

By this stage about three-quarters of the section may be completed, and it should be possible to start laying soon. The chairman of the committee should call a meeting to discuss the problems and remotivate the programme. It may decide to re-organize the work so that each village is given a section remaining to be dug, and it may detail certain villages to help the laying programme get under way on a completed part of the trench.

If attendance continues to be unsatisfactory, the committee can refer the matter to the Main Project Committee which may itself ask the Chief or party leaders for help. A public meeting may then be called, after which attendance usually improves sufficiently to complete the work.

Once the section is dug, the same work programme continues, but with the new task of pipelaying and backfilling as described in Section 5.6.

The installation of the main line represents the end of Stage 1 of the project. The Main Committee meets again to call upon the villages of each branch line (defined by the design) to form Branch Committees.

5.5.3.3 Branch Committees

The role of the Branch Committee is very similar to that of the Section Committee. The branch lines (usually laid in PVC) are easier to dig as the trench depth is less than for asbestos cement pipes, and the villagers generally have less far to walk to work. In addition there is usually the added incentive that water pressure is already on in the main line.

The Branch Committee continues to function after the project is completed, with particular responsibilities for maintenance, cleaning of tanks, minor repairs and checking abuse of water (see Chapter 8).

5.5.3.4 Village Committees

The leadership of the village may be entirely in the hands of the village headman, or it may also involve village leaders and, sometimes, a village committee. The village leadership is responsible for supervising the village labour on its appointed day of work, and for ensuring that village attendance is maintained. It is also responsible for selecting the sites for all standpipes allocated to the village by the project. After project completion, the village leadership is also involved in maintenance as described in Chapter 8.

5.6 MANAGEMENT OF SELF-HELP LABOUR

5.6.1 Trench Digging

A large project may require the digging of some 150km of trenches in six months. This can only be achieved by efficient utilization of a large labour force. The methods are described here in some detail to show that self-help is possible on this scale if sufficient attention is paid to detailed organization.

In the first days of the programme village attendance is likely to be abnormally large. It is therefore essential that adequate preparations are made to ensure a smooth start. If there is chaos and confusion at the start, little progress will be made and the people will feel their journey has been wasted.

Preparations are made on the day before the programme is due to start. The first 300m of the line is cleared and marked to avoid hundreds of villagers having to wait around the following morning while this is being done. Tools, marking string and measuring sticks[1] are all prepared beforehand, a measuring stick being placed every 20m along the line.

Once the digging programme starts it is essential that adequate organization is provided for all the necessary activities. One leader is sent ahead with about 25 villagers to clear the line of bush[2] for the next day's work. Another leader with about 10 men are taught how to mark the trench outline on the ground using the string provided, and to divide the trench into 3m sections. They do not mark across gullies and streams as these are not dug until the rains stop.[3]

A third leader, preferably a committee member, is selected to allocate each villager to a section as he or she arrives for work. A common allocation is one man and one woman for each 3m section of ordinary clay soil.

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1. These are pieces of bamboo cut to exact lengths of 1.2m for AC lines or 0.75m for PVC.
2. The route will have been marked some months before with posts every 100m. Although crops are not planted on the line, the grass grows up rapidly and it is necessary to clear it again prior to digging.
3. This is to ensure all surface water is able to cross the line and does not break into the trench where it would cause serious damage. These sections are eventually dug immediately before laying.

All village leaders are given a measuring stick to ensure each section is dug to full depth before the villagers are permitted to leave. Great emphasis is laid on this procedure so as to establish the routine from the very beginning. The standard is then much easier to uphold throughout the programme.

The project provides a selection of picks, shovels, crowbars, axes and 7kg hammers, which are distributed by the Project Assistants. Villagers are expected to bring their own hoes for digging.

The Project Assistants assist the leaders generally in their supervision and concentrate particularly where problems are encountered, such as on rocky or laterite sections. After the day's digging is over, usually by 11 a.m., they inspect the trench to check the depth and width so that a few people may be allocated the next day to clear up any minor problems. Major problems may take several days to overcome; it is preferable to overcome these at the time rather than to leave them to be tackled later.

5.6.2 Asbestos Cement Pipelaying

AC pipelaying is carried out on each section by a team of two or three Project Assistants with the assistance of self-help labour. High laying standards can be achieved under close and sustained supervision by Supervisors and the Project Manager. To ensure maximum supervision laying is started on one section at a time with a Supervisor working with each team for its first week.

Efficient laying is dependent on organization and preparation. The task of the self-help labour is to carry out all the preparatory unskilled work:

1. One leader and about ten people clear the trench ahead of earth and debris that may have fallen in.[1]

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1. The pipes are laid in a trench that may have been dug some months before.

2. One Project Assistant and about six people backfill about 75mm of soft soil into the trench and rake out the bed to a smooth level surface.

3. A third group carry pipes from the dumps[1] and lower them into the levelled trench end to end.

4. A fourth group fit the rubber O-rings into the collars, smear them with lubricating soap and place one collar beside each joint.

These preparations are continued until the villagers leave for home in the late morning. The Project Assistants stay behind to join all the pipes prepared. With this system about 100 pipes can be joined every day, covering a distance of 400m.

5.6.3 Backfilling

All villagers not engaged in the preparation of pipes are organized into groups for backfilling. This is one of the most important parts of pipeline installation but there is a danger that it receives the least supervision, as it appears to be the 'easy' part of the operation. To avoid large numbers of villagers enthusiastically but haphazardly heaping the soil back into the trench, the backfilling is divided into three stages:

1. The first stage is the most important and is therefore entrusted to a responsible leader with about 10 men. Relatively smooth soft soil is backfilled just sufficient to cover the pipe and then compacted by pounding with feet.

2. A second group follow at a distance of about 20m. A leader and about 20 people backfill the trench to half depth and compact again.

3. The final stage is carried out by the rest of the villagers. All the remaining soil is backfilled and built up into a ridge over the

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1. AC pipes are delivered by lorry to dumps every 100 or 200m along the line, usually before the trench is dug. A temporary access road is cleared by self-help for this purpose.

pipeline. The ridge is discontinued across gullies and waterways, which must be left free for rainwater to cross unhindered.

It was found through experience that backfilling should be completed at the same time as the pipelaying programme. Originally the practice was to backfill half the trench and leave the collars exposed until the pipeline had been pressure-tested. But problems were experienced in remotivating the villagers weeks or months later to complete the backfilling at a time when they were usually busy digging their branch lines. With plenty of labour it is relatively easy to dig up burst pipes exposed during testing.

5.6.4 PVC Pipelaying

The preparations for PVC pipelaying are similar to those for AC pipes, but the flexibility and robustness of PVC allows a greater margin for error. One group clears the trench ahead while another carries the pipes out and lays them alongside the trench. Joints are made beside the trench and solvent cement joints are allowed to stand for 30 minutes before the pipeline is laid into the trench. Backfilling is completed in one operation, but is not carried out after 9 a.m. to avoid warm pipes being backfilled in an extended state (see Chapter 7).

5.6.5 Other Self-Help Activities

Other self-halp activities that are managed by Project Assistants are: the marking of pipelines from aerial photographs, the clearing of temporary access roads to tanks and along main pipelines, the excavation of tank sites and the collection of river sand for tank construction, the loading and unloading of AC and PVC pipes from the nearest station to the project, the planting of paspalum grass seed to mark completed pipelines and the construction of village standpipe aprons.

5.7 MANAGEMENT OF PROJECT STAFF

The degree of responsibility given to project staff is a highly significant feature of the programme in Malawi. A team of three Project Assistants, for example, may be responsible for an 8km section of main asbestos cement pipeline involving 15000 people; or a single Project Assistant may be responsible for 25km of branch lines involving 5000 people. The selection, training and motivation of these Project Assistants play an important part in preparing them forthis responsibility (see Chapter 6). Once in the field, however, the Project Assistants need to be supported within a framework of standard procedures, regular visits from Supervisors and regular staff meetings.

5.7.1 Standard Procedures

In the pilot phase of the programme, before the development of routine procedures, project activities had to be carried out on an ad hoc basis. The recruitment of the first Project Assistants in 1972 led to the need for standard procedures to facilitate supervision and ensure the raising of technical standards. Most of the procedures evolved from the experience gained on the early Mulanje West and Phalombe projects, and are now laid down in a handbook for Project Assistants. The contents of this handbook, which is the manual used for initial training, is given in Appendix 7.

Technical operations, such as the making of joints in AC, PVC or steel pipes or the construction of standpipe aprons are spelt out in step-by-step detail. Procedures for the management of activities involving self-help labour, including trench digging and pipelaying as described in Section 5.6 above, are also laid down in detail. Forms and check-lists are provided to assist Project Assistants with special activities.

5.7.2 Fortnightly Work Programme

Project Assistants are required to submit a work programme to their Supervisor every fortnight. This is of particular relevance during the installation of branch lines when several activities are running concurrently. There may be four or five lines being dug, standpipe aprons to be constructed, and other lines where the Project Assistant's presence is required for pipelaying. The purpose of the fortnightly work programme is to encourage him to plan out his work as efficiently as possible and so that he can give sufficient notice to the various villages of the day that he intends to visit them. The work programme is also part of the process whereby the Project Assistant is made to feel responsible for his work. However he is not expected to adhere rigidly to his programme as circumstances inevitably change. The programme also lets the Supervisor know where his staff may be working on any day.

5.7.3 Weekly Report

Project Assistants are also required to submit a report for every week. Again, this is of particular relevance during the installation of branch lines. The purpose is to record progress of trench digging, pipelaying, apron construction and tap connections, as well as events such as committee meetings and pipe bursts. It is possible that this report is superfluous as it duplicates information that is recorded on master charts during the weekly staff meeting. However, the discipline of having to write a report is a contributory factor to the overall motivation of Project Assistants, as long as the report is strictly factual and easily completed.

5.7.4 Weekly Staff Meeting

The weekly meeting of all project staff is an event of major importance in the work programme, and deserves more detailed description. The meeting is held at project headquarters during the afternoon, after the morning's work. Before the meeting starts, Project Assistants write out and submit their work programmes and reports to their Supervisor, and take the opportunity of this weekly visit to the store to draw whatever fittings and materials are needed for the coming week. Each Project Assistant in turn makes a verbal report to the Project Manager who plots the progress of work on the master aerial photograph mosaic displayed in the headquarters. The Project Manager also brings up to date the progress charts for the tank construction and transport programmes.

After all this preliminary activity, the meeting itself starts with each Project Assistant giving a very brief progress report. This gives all Project Assistants the opportunity to hear how their fellows are progressing and is an important factor in the maintenance of the team spirit. The Project Manager and Supervisors raise points concerning the work they have observed that week, and certain procedures may be re-emphasized and practised, particularly for the benefit of trainee Project Assistants. The coming week's programme is discussed, particularly the transport programme which is arranged by the Supervisors in response to the requirements of the Project Assistants.

The meeting is also an opportunity for the raising of general administrative points and the discussion of complaints and suggestions from Project Assistants.

5.8 TANK CONSTRUCTION

5.8.1 The Contract Builder System

Experience gained during the pilot phase of the programme showed that the construction of reinforced concrete tanks was generally beyond the capabilities of village level artisans. This experience led to the decision to employ a local builder on a contract basis, and to give him and his team sufficient training and technical support to carry out all construction work, with materials supplied by the project.

This system has developed in Mulanje to the point where the contract builder employs four construction teams to work simultaneously on different tanks, enabling the rate of tank construction to keep up with other project work.

For projects in a new area, a suitable builder is sent to a construction team to build a tank of representative size. He then returns to his own project to build an identical tank under close supervision.

This system has proved to be ideal for the construction of tanks of adequate standard at minimum cost. In 1976, the material and labour costs for a $225m^3$ (50000 gallon) tank were K4000, of which K750 was paid to the contract builder. An urban-based civil engineering contractor would find it very expensive to construct relatively small installations scattered throughout the rural area. In any case, the use of a local rural builder is preferable as it contributes both to rural development and to the rural economy. The direct labour system is an alternative but it would increase the administrative and supervisory load on the project, and could result in a lower rate of construction due to the lack of incentive compared with the contract system.

5.8.2 Procedure for Tank Construction

The tank site is chosen by the Project Manager according to the elevation required by the design, the ease of access and ease of excavation. The site is then excavated by self-help labour, to a depth at least sufficient for half the tank to be buried below original ground level (which should leave sufficient backfill to cover the tank). An access road is also cleared so that heavy transport can reach the site. River sand and foundation stone are collected by self-help and delivered to the site in advance, along with stone aggregate and reinforcing bars.

Two of the construction team are sent in advance to build up the foundation with rough stone to the level of markers set by dumpy level. The rest of the team are then transported with all their equipment, which includes a concrete mixer and vibrator, shuttering, tools and temporary sheds for accommodation and storage.

The builders are invariably illiterate and certainly cannot read a construction plan. However, as a team specializing in the construction of tanks, they have no difficulty in remembering the stages of construction and the principal dimensions. For simplicity, the thickness of the floor, wall and roof, and the height of the wall and central roof support pillar are standardized for all tank sizes. The only information the builders need to be given is the diameter of the tank and the distribution of reinforcing bars in the wall. For this purpose, the contract builder is given a Tank Construction Check Sheet which indicates the distribution of reinforcing bars in diagrammatic form. Other information on the form can be read by the Project Assistant, who is also responsible for supplying the builder with the right pipes for casting in the walls of the tank (inlet, outlet, overflow and drain).

The construction itself proceeds under the supervision of the contract builder with regular visits from the Project Manager (or Technical Officer in the case of a smaller project). The Project Manager is responsible for planning the tank construction programme to tie in with the laying of pipelines, so that water is available at the tank site when required. Tank construction can proceed throughout the wet season, but transport of materials and the digging of river sand is ideally scheduled for the dry season.

5.9 TRANSPORT

Table 5.3 shows the transport requirements of a major project for about 75000 people.

5.9.1 Bicycles

Project Assistants are expected to have their own bicycles for which they receive a monthly allowance for maintenance. Those without a bicycle are encouraged to buy one with a Government loan repayable over two years. This system avoids the problems inherent in maintaining a fleet of project bicycles.

5.9.2 Motor Cycles

Supervisors and Technical Officers are issued with motor cycles (ca 100c.c.) which are maintained and operated with project funds. The motor cycle is probably the most efficient means of personnel transport in rural areas, especially if long distances have to be covered daily along village paths and pipelines. A bicycle is inefficient as the Supervisor's travelling time would be excessive in relation to his supervision time. On the other hand a four-wheeled vehicle is inappropriate as it is limited to roads, tracks and bridges, and is in any case prohibitively expensive.

5.9.3 1-ton Pick-Up Vehicles

Project Managers have the use of a 1-ton pick-up vehicle. This vehicle is suitable for the relatively long distances that a Project Manager has to travel, both within a large project area and between projects. The load-carrying capacity enables stores to be delivered at the same time as supervisory visits are made.

5.9.4 Four-Wheel-Drive Pick-Up Vehicles

Four-wheel-drive vehicles are used for the distribution of stores within the project area, principally PVC and steel pipes carried on an overhead frame, and construction materials for village standpipe aprons. A driver is employed for each vehicle. The day-to-day management of the vehicles is in the hands of the Supervisors, while the Project Manager is

TABLE 5.3 TRANSPORT REQUIREMENTS FOR A MAJOR PROJECT

VEHICLE	QUANTITY	USER/CONTROLLER	FUNCTIONS
Bicycle	15	Project Assistants	Personal transport (personally owned)
Motor Cycle	3	2 Supervisors 1 Technical Officer (Trainee)	Personal transport for field supervision
1-ton Pick-up	1	Project Manager	Personal transport for field supervision Stores collection and delivery
4-Wheel Drive Pick-up with overhead frame	2	Supervisors	Distribution of PVC and steel pipes Distribution of construction materials for standpipe aprons Distribution of miscellaneous tools and materials as required
7-ton Tipper	1	Project Manager[1]	Delivery of stone aggregate, sand, cement, for tank construction
5-ton Flat lorry	1	Project Manager[1]	Delivery of AC pipes, cement, reinforcing rod Transport of tank construction teams and equipment
7-ton Flat lorry with high-sided superstructure	1	Project Manager[1]	Bulk delivery of PVC pipes

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1. These three lorries would be shared with other projects in the programme, on a rota basis controlled by WPS headquarters.

responsible for overall operation and maintenance. These vehicles are not used as personnel carriers except when a large group of people need to be transported.

5.9.5 Heavy Transport

Heavy transport is used for the delivery of AC and PVC pipes and tank construction materials. A 3-ton lorry is most suited to rural areas as it can relatively easily be pushed out of trouble, but transport costs are high per unit load and 5-ton and 7-ton vehicles are preferable where longer hauls are required. Larger vehicles are generally inappropriate for village tracks. Heavy transport comes under the control of the Project Manager and is usually based at a major project headquarters. Vehicles are, however, shared between projects, especially when there is a peak of transport activity, such as for AC pipe deliveries.

5.10 PROJECT STORES ORGANIZATION

5.10.1 Asbestos Cement Pipes and Fittings

AC pipes are delivered by the manufacturer[1] according to an agreed schedule convenient for both the production and distribution processes. They are delivered by rail in monthly consignements over a period of about four months and transported directly to dumps marked along the pipeline. Self-help labour is used for all loading and unloading, and it is remarkable that breakages[2] due to careless handling are almost nil. Although the pipes may remain at the dumps for several months, they are regarded as community property and are left alone. Accessories and fittings, however, require closer control and are stored at the project headquarters until required.

5.10.2 PVC Pipes and Fittings

Most projects have been supplied with pipes imported from Europe. The pipes arrive by rail nested and packed in wooden crates which are too heavy

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1. The nearest manufacturer is 500km away in neighbouring Mozambique.
2. AC pipes are notoriously brittle and prone to handling damage.

to manhandle. The crates are therefore broken open on the wagons and the pipes transferred to waiting lorries.

Major projects receive their pipes in one consignment which is delivered straight to a shade[1] prepared at project headquarters. The pipes for smaller projects are ordered together and arrive as one consignment. They are transported to the programme pipe depot for storage and distribution.

Fittings for PVC pipes are also stored at project headquarters or the pipe depot.

5.10.3 Other Project Stores

Tank construction materials are delivered direct to site from the supplier. All other stores are delivered to the project headquarters and reissued from there. These stores are usually purchased as required, though a small stock of the most common items (cement, plumbing materials, etc.) is maintained at project headquarters.

5.10.4 Stores Requisitioning

A simple chit system is used for Project Assistants to requisition stores from the project headquarters. Most fittings are freely available for Project Assistants to help themselves, but the more attractive items (taps, cement) are issued personally by a Supervisor. Stocks are maintained by the Project Manager who either requisitions from the programme pipe depot or purchases direct from the nearest supplier.

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1. PVC pipes must be kept out of sunlight. The shade is usually constructed from the wooden crates of the previous consignment of PVC pipes.

CHAPTER 6

FIELD STAFF

6.1 INTRODUCTION

It is a key theme of this report that the motivation of field staff is crucial to the success of any rural development programme. The field staff are the vital link between the project and the people and the success of the programme in Malawi is largely due to the strength of the link. To understand how this works, it is necessary to look at the recruitment, selection, training and career structure of the field staff, particularly Project Assistants.

6.1 THE DEVELOPMENT OF STAFF AND TRAINING POLICY

From 1968 to 1971 the water projects were staffed by personnel already employed by MCDSW. At the height of the work these included 1 engineer, 4 CDAs, 5 trainee CDAs and one driver. As a result of the pilot phase MCDSW realised in 1971 that if the programme was to expand it would require:

1. A closer degree of field level supervision.

2. A more specific and appropriate level of training than that given to CDAs.

3. A rapid increase in staff, implying a much shorter training period.

After Chambe the immediate problem was to staff both the Mulanje West and Phalombe major projects that were getting under way. The Project Manager studied the field staffing policies of other ministries and found that the grade of Development Assistant in MANR most closely suited the projects' requirements. These Development Assistants were Primary School leavers, given about one month's training and then appointed for the duration of an agricultural project, to work under the supervision of the regular field staff.

Staffing policies in any civil service are naturally strictly controlled and the administrative procedures for creating new posts, let alone new levels of staff, can be lengthy. The fact that MANR had recently been through the appropriate procedures with the Government's Personnel Division encouraged MCDSW to model their staff on these Agricultural Development Assistants. Once Personnel Division had agreed to the creation of the posts, the funds for 20 Project Assistants were included in the Mulanje West and Phalombe projects, and they were appointed in April 1972.

Following the decision to expand the programme to smaller projects in other parts of the country, experienced Project Assistants from Mulanje were selected for appointment to the new projects. These posts involved a higher degree of responsibility as they could not receive as close supervision as was possible on major projects. To replace those appointed, and to train staff for future projects, ten more Project Assistants were recruited in 1974 and appointed to Mulanje West and Phalombe.

Thus we see the major projects serving as a training ground for the whole programme. This training period under close supervision is the key to the creation of a competent and well-motivated team. More Project Assistants were appointed in accordance with the requirements of the programme in 1976 (20), 1977 (10) and 1979 (10).

6.3 SELECTION CRITERIA FOR PROJECT ASSISTANTS

6.3.1 Age

Applicants must be at least 25 years old. Project Assistants are expected to communicate with community leaders who are usually senior and respected citizens. A person less than about 25 years of age is normally regarded as a youth, and would not be able to gain the respect and confidence of leaders or villagers.

6.3.2 Education

The minimum educational requirement for the Project Assistant grade is laid down in Public Service Regulations. The applicant must hold a Passed Primary School Leaving Certificate, which is evidence of eight years of successful primary education. Holders of the Junior Certificate of Education, representing two successful years of secondary education, are also invited to apply. Those with higher educational standards are not sought, as it is found that they generally aspire to "white collar" jobs in the urban sector, and regard employment in the rural area as second-best.

Applicants are expected to have a basic knowledge of English which is the language of Government. Written instructions, reports, forms and letters are generally written in English, although most of the spoken business of the project is conducted in the local language.

6.3.3 Previous Employment

In general, preference is given to applicants who have had some form of satisfactory previous employment, as it is felt that such people will be more able to bear the considerable responsibility given to Project Assistants. Applicants displaying outstanding qualities are, however, considered even without previous employment.

6.4 RECRUITMENT PROCEDURE

6.4.1 Timing

The recruitment and selection process is usually carried out in February or March, so that successful candidates can be appointed at the beginning of the financial year in April. From the time of advertising, one month is allowed for the receipt of application forms, a further two weeks before interviews take place, and the selection/training course begins two weeks after the interview.

6.4.2 Applications

Applications are mainly sought from districts in which the programme is active. The vacancies are advertised by public notices displayed at the

Boma, Labour Offices, Tax Offices, Post Offices, Chief's Headquarters, markets and any other places where villagers regularly meet. Application forms are also available at these points and applicants forward the completed forms to the Project Manager, giving basic information including age, education and previous work. These forms are then sorted according to the criteria above and a reasonable number (about six times the number of vacancies) are called for interview.

6.4.3 Interview

The interview board consists of the Project Manager, one Supervisor, one representative from ministry headquarters and one "outsider", usually a district officer of another ministry.

As candidates arrive at the place of interview they are given a simple written intelligence test of the multiple choice type, lasting about thirty minutes. This test is not used to grade candidates, but it may affect the decision on a borderline case.

The purpose of the interview itself is to form an initial impression as to whether the candidate is the right material to proceed to the second stage of the selection process. In order to interview as many candidates as possible, each interview lasts only five minutes, which includes one minute for awarding marks. The candidate is encouraged to talk about himself, his family and his previous work so that he is given an opportunity to portray his personality to the board. Appropriate personal qualities are considered to be most important, for experience has shown that the extrovert, smart and articulate candidate does not necessarily make a good Project Assistant. The attitude of the candidate to rural life is particularly important.

After the interview, the board discusses the candidate briefly and each member gives him a mark. This method relies heavily on the judgement and experience of the interview board, but it has worked well in Malawi. When all the interviews are completed, the candidates are placed in order of merit according to marks awarded, and the appropriate number (twice the number of vacancies) are then called for the selection/training course.

6.5 SELECTION/TRAINING COURSE

6.5.1 Purpose of the Course

This is the most important stage of the selection procedure. Normal Government selection procedures finish with the interview, after which selected candidates are appointed and sent for training. However, experience has shown that, especially for this level of personnel, performance at an interview can be very misleading, and success in rural development depends so heavily on the quality of field staff that an interview alone is not sufficiently rigorous to eliminate unsuitable candidates. By contrast, a candidate's true qualities can be revealed remarkably quickly during an intensive course.

The purposes of this course can be summarized as:

1. To give all candidates the time and opportunity to display their true qualities.

2. To give the selecting staff time and opportunity to get to know each candidate.

3. To teach the technical skills and organizational procedures required of Project Assistants.

4. To impart a spirit of motivation.

6.5.2 Site of the Course

Project Assistants live and work in the rural areas, sometimes under difficult conditions and in temporary accommodation. It would be inappropriate and misleading, therefore, to run the course in one of the formal Government training institutions, which generally follow an urban oriented academic pattern; it is more realistic and appropriate for the course to take place in a rural area similar to where the work is to be carried out. A certain amount of privacy and isolation is nevertheless desirable to avoid the distractions and constant scrutiny of village life.

A camp-site in or near a project area is ideal for the purpose, as it has the additional advantage that the resources of the project are available for the benefit of the course. In the Malawi programme, courses have always taken place near the headworks of the Phalombe project, which is about 1km from the nearest village.

6.5.3 Description of the Course

The maximum number of candidates for the two-week course is considered to be twenty. The course staff, consisting of the Project Manager and three experienced Supervisors, are accommodated at the camp site in caravans, while candidates are accommodated in tents which they erect on arrival.

The candidates are divided into four groups for the duration of the course, and are issued with name badges, and some stationery. They are given two days to elect a camp leader who is responsible for domestic arrangements, including buying food at the local market. A local villager is employed as a cook.

The daily programme is divided into three sessions (see Appendix 8). During the morning sessions, from 6 a.m. to 9 a.m., each group progressively digs a length of trench, specially selected to give the candidates training in the use of all tools at their disposal. The purpose of this session is also to make the point that Project Assistants are expected to join in physical labour, and cannot supervise village labour "from the side-lines". In addition, the experience of working in a small group on a specific task, with a certain element of competition with other groups, helps to develop that team spirit which is a hallmark of the Malawi programme. During the morning sessions of the second week each group practises the laying of AC pipes in their trench until the procedure is perfect.

The middle session, from 9.30 a.m. to 12 noon, is used for practical instruction in all aspects of handling and connecting AC, PVC and steel pipes and fittings. Later in the second week the candidates are taught how to construct a tap apron, and a competition is held at the end of the course for the group with the best apron.

The afternoon session, from 1 p.m. to 3 p.m., is the "classroom" period, for lessons in project and community organization, stores, aerial photographs, work programmes, reports etc. Visits are also made to current and completed projects.

At the end of the course candidates undergo practical tests which are marked by the instructors. The marks and the performance of candidates are discussed by all instructors, and those that are considered to have reached the standard required are selected. Sub-standard candidates are not selected, even if this means leaving vacancies unfilled. Successful candidates are appointed within two weeks of completing the course.

6.6 IN-SERVICE TRAINING

6.6.1 Training Period

The course described above is regarded as preliminary training and Project Assistants continue as trainees for the first two years on a major project. During that period they develop both the technical skills learnt on the course, and the social skills which can only truly be learnt by experience. Supervisors naturally give the trainees close attention and support, and the weekly staff meetings also play an important part in the training process. Appointments are confirmed after the satisfactory completion of this two year period.

6.6.2 Annual Refresher Course

All field staff in the programme meet annually for a four-day refresher course which has four main functions:

1. To maintain and develop team spirit.

2. To remind all staff of standard techniques and procedures.

3. To update techniques and procedures in the light of collective experience.

4. To give an opportunity for discussion of problems of general concern.

This course is of particular importance for those Project Assistants working on small projects in relative isolation from the majority of staff on major projects. It is an important stimulus for morale and is always a popular event of the year.

Following the current change in career structure (see Section 6.7), these refresher courses will also be the occasion for up-grading tests for Project Assistants.

6.7 PROJECT ASSISTANTS CAREER STRUCTURE

6.7.1 The Original Career Structure

Before 1979 the career structure for Project Assistants was somewhat confused and unsatisfactory. Initially they were employed temporarily for the duration of a project only, their salaries being paid from project funds rather than from the central Government payroll. Nevertheless they were effectively civil servants of Technical Assistant grade and in reality they enjoyed continuity of employment as they moved from one project to the next.

After two years as trainees Project Assistants were confirmed in their appointments. As far as the programme was concerned this meant they were considered able to take on more responsibility, often under less supervision, on smaller projects. For the Project Assistants, however, it meant little other than a small increment in salary.

Before 1975 it was possible for any Project Assistant to be transferred to a vacant post on the permanent list on the recommendation of his superior officer. Six outstanding Project Assistants who were transferred in this way then had a full career structure open to them, namely promotion to Senior Technical Assistant (STA), Technical Officer (TO) and higher. But this avenue was closed in 1975 when the Government decided to allow only holders of the Junior Certificate of Education (JCE) to enter the permanent list.

This led to the unsatisfactory situation that the remaining Project Assistants had no real promotion prospects, except for the few with JCE. Furthermore it was no longer possible to promote any Project Assistant to the rank of Supervisor. A career structure with promotion prospects is clearly a key factor in staff motivation and morale and so WPS began to search for an alternative system.

6.7.2 The New Career Structure

It is not possible for a relatively small section of the civil service to influence the personnel policy of central Government. The best that can be done is to find an existing alternative system that suits the requirement as closely as possible.

In Malawi there is a separate career structure covering employees on hourly rates of pay, such as skilled artisans, plant operators, drivers, storekeepers and unskilled labourers. Each category is graded for different levels of skill and experience, ranging from Ungraded through to Grades III, II and I. Graded employees can reach a relatively high wage compared with a Technical Assistant in the permanent list.

Project Assistants will now be transferred to this system under the existing category of Pipelayer. The will have the following career structure:

1. Careful selection after a two-week field training course as before.

2. 1-2 years as ungraded pipelayer trainee.

3. Two-week upgrading course and Grade III test.

4. 1-2 years as Grade III pipelayer.

5. Two-week upgrading course and Grade II test.

6. 2-3 years as Grade II pipelayer.

7. Two-week upgrading course and Grade I test.

8. After further years of experience, Grade I pipelayers with JCE will be eligible for selection to a Foreman's course.

9. Successful candidates promoted to Water Foreman (equivalent to TO).

This system is inevitably a compromise. It satisfies the need for a proper career structure with promotion prospects and reasonable rates of pay, and also brings the Project Assistants into line with employees of other departments currently being incorporated into the new Ministry of Lands and Water Affairs. However, the system does not do justice to the real status and skills of Project Assistants, who have greater responsibilities, require social as well as technical skills, and generally live and work in more difficult conditions than pipelayers of other departments.

6.8 MOTIVATION OF FIELD STAFF

Visitors to rural water projects in Malawi are struck by the high degree of motivation and personal involvement shown by project staff[1] and this is undoubtedly one of the major reasons for the success of the programme. It is difficult to analyse in detail how or why this degree of motivation is achieved, but this report would be incomplete without an attempt to identify some of the factors involved.

6.8.1 The Motivation Process

Perhaps the most important characteristic of motivation is that it is infectious. Let us consider a motivated individual with the task of developing a programme. If he tries to launch a large scale programme involving numerous field staff it is unlikely that his own motivation will be sufficient to motivate them. If, on the other hand, he starts with a small group of peoply to carry out a pilot phase he will be closer to his staff and more likely to motivate a reasonable proportion of them. Those who are not motivated should leave the group, and would hopefully do so of their own accord. The remaining small group of motivated individuals can then carefully select suitable individuals to join them and, assuming a rigorous selection process, these would themselves become motivated and absorbed into the team. This process can be repeated until a formidable highly motivated team is gradually built up.

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1. WHO/World Bank (1978).

This is a rather simplistic description of the motivation process that occurred in Malawi. In reality the process takes time and patience, but the result can be striking. The "take-off" point in Malawi came in 1972 when a nucleus of five motivated people very carefully selected twenty new individuals and succeeded in motivating them. Since then the process has been self-generating.

6.8.2 Factors Affecting Motivation

Some of the factors that create favourable conditions for continued motivation can be identified as follows:

1. Impressions and attitudes formed during initial training and early contacts with field staff.

2. The encouragement inherent in being a member of a team.

3. A career structure with promotion prospects.

4. Loyalty and support from superiors.

5. The challenge of a specific objective.

6. The responsibility entrusted.

7. Pressure from the community to get the job done.

The first four points have been mentioned previously. The fifth point refers to the fact that each project has a simple, clearly defined objective, namely to install a particular type of water supply for a particular community in a particular area. Motivation is easier to achieve with such a specific goal than it is for, say, maintenance crews or accounts clerks. This point is also related to the fact that the execution of a project is a dynamic process in which the field staff are applying different techniques and procedures at different times with different villages.

The sixth point refers to the stimulating effect of responsibility. Provided this is given gradually with sufficient support, field staff whose talents may otherwise have passed unnoticed can succeed in even the most difficult tasks.

The final point is undoubtedly very significant. The Project Assistant lives and works with the community and he therefore comes under social pressure to carry out what the community expects of him. If he fails them he will lose face and in a traditional society the displeasure of the community can be a powerful motivating force.

Clearly there are other conditions affecting motivation, and any country's programme may need emphasis on different factors. But however it is achieved, motivation is an important factor, and although it cannot be built into a programme, it is possible to create some of the conditions under which it can flourish.

6.9 SUPERVISORS

Some of the Supervisors in the programme were among the original CDAs who were involved in the pilot phase and were later transferred to WPS. The other Supervisors were promoted from the ranks of the Project Assistants before the change of Government policy in 1975 which insisted on JCE as the minimum qualification. Under the new career structure, Grade I pipelayers will have to pass a Foreman's course before promotion to Water Foreman which is the equivalent of the present Supervisor.

6.10 TECHNICAL OFFICERS

6.10.1 The Role of Technical Officers

The principal role of Technical Officer (TO) is to manage a group of minor projects within his area, with duties similar to those of a Project Manager on a major project. However, the post also has major significance for the future development of the programme. As there are insufficient numbers of Malawian engineers to recruit directly for the professional posts in the programme, the Government's policy is to appoint TOs for one or two years to gain experience in running minor projects, and then to send them abroad to study for professional qualifications. On return they will be appointed as Project Managers of major projects and will eventually take over management of the whole programme.

6.10.2 Recruitment

Holders of the Diploma in Civil Technology from the Malawi Polytechnic are invited to apply for the vacant posts which are advertised at the end of each academic year. Applicants are interviewed by the Public Service Commission and successful candidates are appointed for one year on probation.

6.10.3 Training

Newly appointed TOs are sent for three months' initial training on a major project. They are issued with motorcycles and live in a caravan in the project area. They follow a training programme to familiarise themselves with all aspects of project work, usually under the guidance of one of the Supervisors. They are also given certain technical tasks, such as survey work and the marking out of construction sites. After this field training period they are sent to the ministry headquarters for a further three months to carry out design work on minor projects for the following year's programme, under the guidance of the Senior Water Engineer. They also familiarise themselves with administrative procedures and the stores and accounting systems. TOs are then appointed to one of the focal areas of programme activity where they implement the projects which they have themselves designed. They are made responsible for all project work, concentrating particularly on the siting and construction of headworks and tanks, while the experienced Project Assistants under them manage the self-help programme and carry out the routine technical tasks.

6.10.4 Problems Experienced

The policy concerning Technical Officers has met with limited success. WPS has always experienced extreme difficulty in attracting applicants from the Polytechnic and in holding those TOs that have been appointed. Of the ten TOs appointed since 1974 the majority have left the section and only two have proceeded to studies abroad.

One of the principal problems has been the insufficient number of Diploma holders graduating from Polytechnic each year to satisfy the demand from the private and public sectors. The majority of graduates are attracted by the greater rewards offered by the private sector, and also prefer office work associated with drafting and simple design to the relative hardship associated with field work in the rural areas. The result for WPS is that there may be only one or two applicants to fill three or four vacancies, a situation that does not permit the rigorous selection procedure that is applied so successfully to other field staff.

The fault not only lies in the insufficient numbers graduating, but also in the education system itself, which is oriented towards the values of an urbanised, high technology society. It is not surprising that graduates from the upper levels of this system prefer the attractions and prestige of urban life and sophisticated technology to life in the rural areas, which most of them have worked so hard to leave behind. Ironically the difficulties of rural development work require higher quality staff than the more institutionalised urban sector.

The second problem has been the failure of WPS to give adequate support and supervision commensurate with a relatively high degree of responsibility. It has been mentioned that Project Assistants have been able to live up to their responsibilities because they were supported within a framework of standard procedures, regular supervision and staff meetings. Technical Officers, who work in relative isolation on minor projects, are not given a similar framework in which to work. This has led first to technical problems affecting some projects, usually associated with faulty surveying or an inappropriate engineering appreciation of a problem. These problems have further led to loss of confidence and morale which, coupled with the relative rigours of rural life, encouraged the TOs to return to the comradeship of their peers in the urban sector.

There is, therefore, a serious need for WPS to re-examine the policy concerning Technical Officers, to achieve the immediate aim of the efficient management of minor projects and the longer term aim of training future engineers to manage the programme.

Some of the problems outside the control of WPS are already being tackled. The Polytechnic has plans for extending the Diploma course to four years and increasing the annual intake by 400 per cent to 72. In addition there are plans for 20 students per year to proceed for a further two years for the award of a general engineering degree. This will avoid the necessity of Malawians having to go abroad for professional training.

However, by the time these measures have had a significant effect on numbers, the national demand will also have risen. Furthermore, it is unlikely that the new system will produce engineers with significantly greater rural orientation that the present one. WPS is therefore faced with the continued prospect of having to compete on unfavourable terms for a limited number of graduates who will themselves be unlikely to make WPS their first choice.

The only way to achieve an adequate increase in this level of staff is to ensure that the few TOs that are appointed remain with the programme. This in turn requires the introduction of more standard procedures applicable to TOs and of regular supervision, at least once a month, from a professional engineer specially appointed for the purpose. Within this framework TOs will be able to develop their self-confidence and become capable of the responsibilities conferred upon them, which will certainly be greater than the responsibilities of their peers still working in urban drafting offices. Once this has been established the TO posts will be seen in a new light, the programme will be able to attract more recruits and gradually build up a firm technical and engineering base for the future.

6.11 PROJECT MANAGERS

6.11.1 The Role of the Project Manager

In general terms the Project Manager is responsible to the Government for the execution of the project to a satisfactory standard within the time allocated. These priorities may not, however, initially be shared by the community, who are usually unfamiliar with the concept of technical precision and the discipline of working to a time limit. The Project Manager must therefore inject a sense of precision and urgency into the execution of the project that may otherwise be lacking.

The duties of the Project Manager of a major project are specified in more detail in Appendix 5. His main responsibilities are project design, procurement and distribution of materials and the management and supervision of all project staff.

6.11.2 Recruitment and Training

Because of the grave national shortage of Malawian engineers the Government has so far recruited expatriates to fill the Project Manager posts. This has been done in accordance with routine Government recruiting procedures. A newly appointed Project Manager ideally should spend at least one month working with the Project Manager of another project to familiarise himself with the procedures and characteristics of the programme. Once on his own project, he will initially rely on the Supervisor and the experienced Project Assistants for the routine management of the project. WPS has produced a handbook for the assistance of Project Managers and TOs, which is a useful reference book particularly for the early period of an officer's appointment.

6.12 CONCLUSION

The success of any rural development programme depends heavily on the quality and training of field staff. One of the problems experienced in Malawi has been finding the appropriate employment structure within a civil service whose personnel policies are more geared to urban-oriented institutional requirements than to the needs of rural development. In addition, Government policy is to encourage the attainment of educational qualifications by raising educational standards for civil service posts. Paradoxically, this militates against rural development, for the education system is such that higher education is synonymous with greater urban orientation. Meanwhile, there is a great reservoir of talent and ability among people in the rural areas with relatively lower educational standards who have no wish to join the urban unemployed and who will welcome the chance of rural employment. Such people, with suitable training and motivation can become effective agents of rural development. This factor more than any other is at the root of the strength of the programme.

CHAPTER 7

TECHNICAL ASPECTS

7.1 INTRODUCTION

Water supply is a field in which the engineering profession can make the most immediate contribution to the quality of life of rural societies. The experience of the rural piped water programme in Malawi shows how engineering and social disciplines can be combined to construct socially acceptable and beneficial water supplies that are also technically robust and efficient. Much of this report is concerned with the non-technical aspects of the programme, as they are both the most crucial and the most difficult but success ultimately depends on the technology that evolves and it is to this point that we now turn.

7.2 DEVELOPMENT OF DESIGN METHODS

The design of the first project (Chingale 1968) was based on three simple criteria:

1. Design consumption of 27 litres (originally 6 gallons) per head per day.

2. Design flow of .075 litres per second (originally 1 gallon per minute) per tap, assuming all taps open at once.

3. Allocation of 1 tap per 300 population (i.e. up to 300, 1 tap; 301-600, 2 taps; 601-900, 3 taps etc.)

The first two criteria are still in use today, and are discussed below. The third, however, proved to be socially unfair and technically inconsistent. The social problem is illustrated by the fact that two villages of the same apparent size with populations just below and just above 300 would theoretically have one and two taps respectively. The technical problem became apparent on Mulanje West, for which the initial allocation on this basis indicated a figure of 300 taps to serve 75000 people, an average of 250 persons per tap. This average was inconsistent with the first two criteria, which indicated that even if the tap was delivering water at the design rate for an unrealistic 24 hours, it could only serve 240 people.

During the installation of Mulanje West, the Project Manager received numerous requests from villages for extra taps, many of which, on examination, proved to be reasonable. The extra taps were installed, leading to a total of 460 taps with an average of one per 163 persons.

The lesson for subsequent projects was that much greater attention to detail was necessary at the design stage. Most of the extra taps on Mulanje could have been foreseen in the light of subsequent experience. The third criterion was modified to allow the allocation of 1 tap per 160 persons, and a fourth criterion was introduced to the effect that the design is based on the assumption of 16 hours service and 8 hours storage within any 24 hour period. The design criteria currently in use are given in Appendix 9.

7.3 INTEGRATION OF DESIGN WITH CONSTRUCTION

It is a significant feature of the Malawi programme that Project Managers and Technical Officers design their own projects. This contrasts with the normal practice in the engineering profession of separating the functions of design and construction. Although this separation may be unavoidable in complex, high technology projects, it is counterproductive in simple technology, field oriented schemes. The advantages of integrating design and construction lie in the automatic feedback of field experience to show up inadequacies in the design, in the extra flexibility and speed with which design can be adjusted to requirements, and in the motivating effect on engineers who identify themselves personally with both the design and the construction processes.

In Malawi the Project Manager, as the designer is in very close contact with the field staff, gaining the benefit of feedback from their experience as well as from his own observations. Thus modifications to design details and construction procedures are easily carried out, and the effectiveness of design procedures is under continuous observation.

7.4 DESIGN PROCEDURE

To ensure the standardization of designs and to enable sub-professional staff (TOs) to design relatively large water supply systems, the design procedure has been laid down in considerable detail in a special handbook. This procedure is described in Appendix 9.

7.5 DISCUSSION OF DESIGN PRACTICE

7.5.1 Design Consumption

The design consumption of 27 litres per capita per day appears to be a reasonable figure both in the light of present consumption and the experience from elsewhere in Africa. It is clear from the operation of completed supplies that present consumption is much less than this, although it has not been accurately measured. An estimate carried out on a branch line of Mulanje West in 1976 based on the water drawn from a branch storage tank indicated the consumption was about 16 litres per capita for a particular 24-hour period. Feachem et al. (1978: 107) report a similar average consumption figure for rural communities in Lesotho.

7.5.2 Design Life

The design procedure described in Appendix 9 does not refer explicitly to the design life of the system. Instead, the system capacity is based on a design population, which is an estimate of the maximum population that the area can support with traditional agricultural methods. This concept assumes that as the pressure on the land increases, migration will occur from the over-populated to the under-populated areas of the country.

This assumption is partly true, as there is evidence that within Mulanje District people have moved from the densely populated Mulanje West to the less densely populated Phalombe area following the installation of a water supply there. However, migration is unlikely to account for all the population growth in a densely populated area, and population densities will continue to rise. The pressure on land may encourage the adoption of more modern methods of agriculture, including the introduction of higher yielding crop varieties, so that the land will be able to support a higher population.

An alternative approach is to specify a desired design life, and estimate the population growth and per capita consumption growth to arrive at the system's design capacity. This method appears to be more logical, but its effectiveness depends heavily on the accuracy of the estimates. The national figure for population growth rate could be grossly inaccurate when applied to a project area, and the growth rate of per capita consumption is dependent on so many factors, including the design figure itself, that any estimate is little more than guesswork.

It would seem, therefore, that the concept of design life for rural water supplies in developing countries is fraught with so many imponderable variables and implications as to become almost meaningless. A more practical approach is to decide on a consumption figure that allows a reasonable margin for growth without requiring an excessive capacity beyond the ability of the programme and the community to install; and to decide on a reasonable design population, based partly on the natural population growth rate and partly on the capacity of the land to support the population. This method is certainly not perfect, relying as it does on intelligent estimates and guesswork, but it is probably as effective as any other, and would appear to be reasonable for the situation in Malawi.

7.5.3 Peak Factors

From Appendix 9 it can be seen that the design procedure makes no allowance for peak factors. The design assumes that each tap is continuously in service for 16 hours at a constant flow rate. As a rule of thumb, this procedure appears to have satisfactory results, although it is clearly unrealistic. This might be explained by the fact that the system is designed for the theoretical condition that all taps on the supply are in use at the same time. It would appear that this condition does not occur, because even at the peak demand periods (6 a.m. and 6 p.m.), the flow rate at any particular tap is usually more than twice the design flow rate.

Despite the fact that the system appears to work satisfactorily without any peak factors, there is a need for more research into the effectiveness of the design, to indicate what improvements should be made. At present, very little is known about actual demand or its daily and seasonal variations. Although it is unusual to see more than two or three women waiting at a tap, it is possible that as demand approaches the design consumption figure queues will form during the peak periods. It is of interest to note that with the current re-organization of the national water supply sector, WPS has created a post for an engineer whose responsibilities will include monitoring, research and evaluation.

7.6 COMMUNICATING THE DESIGN

Project Assistants have had relatively modest formal education and it is therefore important that the design of the water supply system is presented in a simple and easily understood format.

On Mulanje West, the author made the mistake of introducing an elaborate system of symbols, colour codes, fittings charts, diagrams, maps and aerial photographs. This system totally confused the Project Assistants, because essential information was obscured in the wealth of detail and because the same information was duplicated in different forms. However, the experience did show that Project Assistants had little difficulty in learning to interpret aerial photographs.

The present system uses aerial photographs only, suitably marked with coloured chinagraph pencil to convey all essential information. The photographs show the pipe alignment, pipe sizes, the positions of valves, standpipes and tanks, and the positions, names and populations of villages. Three sets of photographs are marked up at the design stage, one for issue to Project Assistants, one for display in the project headquarters, and one for the use of the Project Manager.

Ordnance Survey maps are also marked up with similar information but do not normally need to be referred to by Project Assistants. They are mainly for the use of the Project Manager and WPS.

Examples of the aerial photograph and map may be found in the Appendices at the end of this report.

7.7 DEVELOPMENT OF TECHNICAL PRACTICE

It is most likely that any new rural programme will start with technical designs which are relatively untried in the particular environment of the programme. Some of the technical aspects will be tested at the pilot stage, but not all. There will be several modifications required during the course of the programme as experience is gained and weaknesses are shown up.

Some design modifications will have little significance at the field level, such as a decision to increase storage or spare capacity for future development. Others will have direct impact on the field staff, such as details of tap aprons or soakaway pits.

In the pilot phase it was vital to establish the fundamental principles that water could flow long distances in pipes and that the Government would provide the pipes if the people would provide the labour. These principles were so important that technical details were of a lower priority, except for the fundamental requirement for the system to work hydraulically. Once these principles were established and confidence gained, the standard of installation became the priority. This may not be a valid generalisation for any programme but it does focus on some of the fundamental goals of the pilot stage, and how they may differ from the goals of the subsequent programme.

In Chingale and Chambe projects, therefore, the main concern was to motivate the people, to install the pipeline and deliver water at the taps. The design concentrated only on the selection of pipe sizes to ensure adequate and even distribution of water. Tap aprons consisted merely of a rough collection of stones, and the tap was usually connected before the drain and soakaway had been dug.

For Mulanje West and later projects the recruitment of Project Assistants made it possible to improve the technical standards of installation. The village tap was not connected until a proper apron, drain and soakaway had been dug and all other aspects of the supply completed to the required standard. Early experience with storm damage led to particular emphasis on the protection of open trenches and completed pipelines from erosion.

7.8 TECHNICAL DESCRIPTION OF A MAJOR PROJECT

The technical simplicity of a relatively large scale project can best be conveyed by a detailed description of the system as it operates. As an example, we consider here the Phalombe Water Project, a supply completed in 1977 serving 90000 people in 135 villages via 578 standpipes. It covers an area of about 625sq km and involves 56km of asbestos cement and 435km of PVC piping.

7.8.1 Intake

Water is drawn from a natural pool in the Tuchila River, situated about 500m above the forest boundary. Five 100mm galvanised steel pipes[1] are set in a small concrete weir across the former outlet of the pool. Each intake pipe is closed at its end, and 600 holes of 9mm diameter are drilled over a length of about 1.2m. These holes have a combined surface area several times the cross sectional area of the pipe, thus reducing suction. The number of holes means that the supply is unaffected by a single flood, but in the rainy season successive floods will gradually cause the holes to become blocked with debris. A watchman is therefore employed to keep the holes clear (see Section 7.8.8).

7.8.2 Screening Tank

The purpose of this tank is to remove the pebbles, sand, twigs, leaves and grass which have passed through the intake pipes.

The tank is situated about 100m from the intake. It has an overall size of 2.8m long x 1.9m wide x 1.2m high and is covered with removalbe slabs. There are three chambers. The first is an upward flow chamber to settle out heavier matter such as stones and sand; the second is a horizontal flow chamber containing two vertical 6mm wire mesh screens on removable frames; and the third is the outlet chamber, separated by a 0.9m high baffle wall. The screens are cleaned daily in the rainy season as part of the watchman's maintenance routine, although they would take two or more floods before becoming blocked.

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1. Larger diameter steel pipes are difficult to manhandle and less readily

7.8.3 Sedimentation Tank

This is designed to give a mean retention period of about 2 hours to allow fine matter to settle. Jar tests[1] showed that clarification is complete in about one hour. The tank is also the main header for the whole supply system and is situated at an elevation of about 80m above the lowest point in the first pressure stage. For topographical reasons it is about 1.6km from the screening tank, connected by an asbestos cement main in sections of 150, 125 and 100mm pipe, calculated to give exactly the right flow to the tank. The tank is a circular, reinforced concrete structure with a fixed roof. It has a diameter of 12.8m, water level height of 1.8m and volume of 227.5m^3 (originally 50000 gallons).

The inflow first enters at the bottom of the tank into a baffled inlet chamber, and then rises up into the main body of the tank. The outlet is also at the bottom of the tank, separated by a 0.9m baffle wall. This allows about one hour's reserve storage with no inflow (or several hours with reduced inflow) and avoids letting air be sucked into the main line should the inflow be reduced. Despite the provision of air valves in the main, air entering the pipe can affect the flow considerably, and effects may be felt for some time later at remote parts of the supply. The inlet supply can sometimes vary, as it does when the intake or screening tank is being cleaned, or if the watchman neglects his duty after a flood. So the use of the sedimentation tank to provide automatic emergency storage reduces the supply's vulnerability to inflow variations.[2,3] Under normal flow conditions, the tank is kept full by the fact that the inflow exceeds the outflow, the excess passing through a bellmouth overflow set at the desired water height.

The tank is fitted with a by-pass from inlet chamber to outlet chamber so that the supply can be maintained without interruption while the tank is emptied for cleaning. This avoids having to have duplicate facilities, but

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1. *It is found that water from mountain streams in* Malawi *does not contain* much colloidal matter.
2. The temporary reduction in retention time is less harmful than the ingress of air into the system.
3. The problem could also be solved by building a second tank as a balancing storage tank, but the expense of this is not justified.

it means that the cleaning of the tank must not be done while the river is turbid,[1] as there is clearly no sedimentation while the by-pass is being used.

On Phalombe, the sedimentation tank is fitted with an outlet sluice valve. However, this is not recommended[2] as the rapid operation of this valve causes surge pressures which can lead to multiple pipe bursts in the main. Since operation by unskilled personnel is a strong possibility over the lifetime of the supply, the sluice valve is likely to cause more problems than it avoids. In the event of a burst the main supply can be cut off by closing the inlet sluice valve and opening scour pipes to empty the tank. In reality the tank would already be empty by the time the sedimentation tank was reached after a burst.

A circular sedimentation tank is not the most logical shape from a technical standpoint because of the degree of short-circuiting. Ideal plug-flow conditions are best approached by a long rectangular tank. However, from a management viewpoint it is better for the construction team that all tanks, both storage and sedimentation, are to the same basic design. A large rectangular tank is inherently more difficult to construct to a good standard than a circular tank, especially for semi-skilled rural artisans, and as only one sedimentation tank is built per project compared with several storage tanks, their unfamiliarity with the rectangular tank would lead to poor quality construction.

7.8.4 Main Pipeline

The supply is divided into six areas, each one being supplied from a main storage tank ($227.5m^3$). The main line supplies these storage tanks, although some minor reticulation is installed direct from the main to serve the intermediate areas.

The main begins from the tank in 225mm Class 12 (maximum working pressure $6kg/cm^2$) asbestos cement pipe and reduces in size progressively through 200,

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1. The river regains its normal low turbidity after a day or two without rain.
2. This sluice valve is not fitted on other supplies.

150, 125 and 100mm as it proceeds through the areas. Class 18 is used for those sections with higher maximum pressure. The mixing of classes causes problems with fittings as the exterior diameters vary between classes.[1] Ideally only one class of pipe should be used and although this leads to higher costs, the overall cost effectiveness still compares very favourably with other systems.

The pipes are buried in a trench 1.2m deep. The completed lines are pressure-tested using a hand pump to 75 per cent of the manufacturer's test pressure, or 150 per cent of the maximum static pressure, whichever is the less.

Double or single air valves are fitted at all high points in the profile or sudden changes in gradient, in addition to a double air valve situated every 3km.

Flushing valves are fitted at all low points in the profile to clean out sediment and to flush the line after the repair of a burst. All valves are protected by standard production concrete culvert rings placed on end and covered. These are superior to brick valve-boxes.

Where the main crosses a river or stream, it is usually buried well under the bed and protected with a check dam[2] to stop erosion. Where it is impossible or impractical to dig under the bed, steel pipes are supported above the maximum flood level on pillars. On two major projects, such a pipe crossing has been constructed with special railings and boards to serve as a footbridge. These river and stream crossings are potentially vulnerable spots and receive special attention in the maintenance inspection routine (see Chapter 8).

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1. The alternative system is preferable, in which the manufacturer varies the internal diameter between classes while keeping the exterior diameter the same.
2. This is a very low weir built just downstream so that silt is deposited over the pipe.

7.8.5 Area Storage Tanks

The area storage tanks are at the end of the first pressure stage, usually about 60 to 90m below the sedimentation/header tank. They act as balancing tanks so that the main line is utilised at maximum design flow continuously for 24 hours a day, the tank drawing down in the day-time and filling up again during the night. Each is fitted with an equilibrium float valve so that the inlet closes when the tank is full. This avoids the wastage of water that would occur if one tank overflows while others are still filling elsewhere.

7.8.6 Branch Lines

The area storage tanks supply a second stage trunk main which itself supplies a number of branch lines. Most branches have their own branch storage tank where the topography permits. Pipe sizes get progressively smaller according to the population served, so that equal distribution is effected by the design. Most of the second stage trunk main is in asbestos cement, being 100mm or larger. Most branch lines are 100mm and less and these are laid in rigid PVC at a depth of 0.76m. Gate valves are situated at every junction or size change involving 40mm and above, and at least every 1.6km for all pipe sizes. The valves are protected by a 0.76m length of 100mm AC pipe placed vertically over the valve, with a specially made concrete cover[1] that slides over the top of the pipe. These lengths are readily available from off-cuts or damaged pipes. The diameter of the pipe is large enough for an adult arm, but the length is too long for children to reach the handle of the valve. Nevertheless, the valves seem to be a temptation for a few inquisitive fiddlers, and so the valve handles are now removed and given for safe-keeping to the nearest householder or to the village headman or committee member. It only takes one such "fiddler" to inadvertently or intentionally disrupt the supply and, unless the valve is closed completely, it is quite a tedious problem for the Maintenance Assistant to check that all gate valves in the affected area are fully open.

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1. Manufactured in bulk quantities by a local firm specialising in concrete products.

All pipelines are marked by a ridge and planted with drought resistant paspalum grass. Particular attention is paid to streams and gully crossings which are major erosion hazards. The ridge is discontinued over the gully to allow surface water to cross the pipeline and a small check dam is built just downstream so that silt is deposited over the line.

7.8.7 Village Taps

For most people, the village tap is the most important part of the whole project. If it is not to become an unpleasant muddy mess it must have a proper apron, drain and soakaway, and the standpipe and apron must be particularly robust if they are to survive the heavy use to which they are subjected. The Malawi programme has developed a standard Village Tap Site which has to be completed before the tap is issued. The standpipe consists of 15mm galvanised steel pipe with a 15mm brass crutch-headed bibcock (tap). The PVC supply line is first connected to a 0.6m horizontal length of 15mm steel pipe which is then connected to a 1.4m vertical length as the standpipe. The tap is thus 0.6m above ground level. The standpipe is supported for its full length by a 0.75mm diameter de-barked hardwood post cut locally, to which it is tied with galvanised wire.

The standpipe is slightly offset from the centre of a 2.7m diameter saucer-shaped apron which has a depression towards the drain. The apron is constructed on a foundation of stone or broken brick which is compacted with concrete to fill the voids. The surface is rendered with a cement-sand mix. A large flat stone is concreted into position under the tap to act as a stand for the bucket and to take the impact of water which would otherwise erode the concrete.

The apron is connected to a soakaway pit by a drain at least 3m long, whose construction is the same as for the apron.

The soakaway pit is circular, 1.8m diameter and 1.8m deep and filled with large stones. Earth is heaped around the pit and edges of the apron and drain to stop surface water causing silting problems.

Each tap site is issued with two 50kg pockets of cement, which is sufficient to complete the apron and drain.

7.8.8 Maintenance

Maintenance work is the responsibility of two Maintenance Assistants and one watchman employed by WPS. The Maintenance Assistants were formerly Project Assistants on the project staff. The watchman, who is responsible for the maintenance and surveillance of the headworks (intake, screening and sedimentation tanks), is a local villager. A description of maintenance routines is given in Chapter 8.

7.9 ASBESTOS CEMENT PIPES

7.9.1 Availability and Cost

The nearest supplier of asbestos cement (AC) pipes is situated in neighbouring Mozambique, on the railway line that links Malawi with the port of Beira. Malawi is fortunate to have such a relatively close supplier, as AC pipes are extremely expensive to transport, and also very susceptible to breakages due to multiple handling. The delivered cost of these pipes makes them preferable to PVC in sizes above 100mm.

7.9.2 Handling

Undoubtedly the biggest drawback in the use of AC pipes is the danger of hair-line cracks being formed during careless handling. To reduce this risk, self-help labour is always used to handle the pipes from the railway trucks onto project transport, even though this means transporting the labour long distances.

The only serious problems with AC pipes were experienced on Phalombe Project in 1974 when an 8km section of 225mm Class 12 AC pipe yielded about thirty bursts under test. The remaining 48km of AC pipe were relatively trouble free. It is considered likely that the bursts were due to hair-line cracks sustained during transit some 40km from the rail-head along "corrugated" earth roads and finally along the self-help temporary road by the trench. The latter section passed through gardens whose former ridges and furrows, although apparently levelled out by the self-help labour, gaven the laden lorry a rough ride. This was too much for some of the Class 12 pipes in this relatively large size. No problems were experienced with the smaller pipes which were mostly Class 18. Class 18 (9kg/cm^2 working pressure) is therefore considered the lightest class suitable for transporting on rough roads in rural areas.

7.9.3 Laying

Although great care needs to be taken to level and prepare the bed of the trench, experience has shown that the high standards required can be achieved by well supervised laying teams, with relatively little training, supported by self-help labour. The actual joints themselves are the least difficult part of the laying process.

7.9.4 Unstable Soil

Experience in Malawi has shown that AC pipes can be used even in unstable soils and low-lying swamps. The heavy dark clay soils become waterlogged in the wet season and are prone to some vertical movement; in the dry season they crack severely. It seems there is sufficient flexibility at the pipe joints to cope with some vertical or lateral movement, and longitudinal stresses and strains caused by the soil cracking are either within the compressive and tensile strength of the pipes, or are balanced by the slight movement of the pipes relative to their joints.

7.9.5 Longitudinal Movement

Longitudinal movement does occur, especially when the line is first put under pressure. Some movement may also occur due to expansion and contraction, though this is minimal under normal operating, constant water temperature conditions. However, if successive pipes are allowed to butt together inside the joints, a compressive load may be set up that can cause a crack leading to a burst. To avoid this, care must be taken during the laying to leave a gap of about 12mm between each pipe-end. On larger sizes a central rubber "cushioning" ring is inserted in the collar so that pipes can be pushed "home" without damaging the ends and compressive forces are absorbed by the rubber itself.

7.9.6 Cast Iron Fittings

Apart from the problem mentioned in Section 7.8.4 concerning the mixing of classes, there have been no problems with bends, tees, reducers and flange adaptors. These fittings are always anchored by means of a concrete mass to act as a thrust block. Where possible the concrete mass is cast around a section of steel pipe connected between the fitting and the AC pipe.

7.10 PVC PIPES

7.10.1 Availability and Cost

PVC pipe is extruded in Malawi by a small private company using imported raw materials. After initial teething problems with quality control, the company is becoming increasingly competitive in comparison with overseas suppliers. At the moment they are unable to supply the volume of pipe that the programme orders every year and they have mainly supplied small projects funded by CSC and UNICEF.

Despite the high freight charges, the delivered cost of pipes from European manufacturers remains competitive with the locally produced pipes, and the quality is generally superior. It is likely that both sources of supply will be used for some time to come.

The delivered cost makes PVC pipe preferable to AC in sizes 90mm and below.

7.10.2 Handling and Laying

The relative cheapness and remarkable qualities of rigid PVC pipe have made possible large scale reticulation in rural areas, which was previously prohibitively expensive and technically impractical.

One of the most significant properties of PVC is its low density. Huge quantities of PVC pipe can be shipped in nested form, which permits relatively high density packing and reduces freight costs. Once delivered to the country pipes can be distributed to projects by road transport in compact efficient loads. For example, a 7-ton lorry with pipes stacked 1.8m high can carry 12km of 40mm and 12km of 25mm Class 10 PVC pipe with a total weight of 6 tons. Within the project area pipes can be efficiently distributed by Land Rovers equipped with a special overhead frame, and then carried by head-load to the trenches. By comparison, the physical task of distributing, say, 400km of steel pipe for a major project would be enormous.

While PVC pipes need to be handled with care, they are far more robust than AC pipes, and it is rare for damage to be caused by careless handling.

The jointing procedure using cleaning fluid and solvent cement is readily learned by rural people, who are familiar with the need for cleanliness and correct application for the repair of bicycle punctures. The alternative procedure using rubber O-rings needs closer supervision as the O-ring can easily be inserted the wrong way round. Although the process is performed by village labour, pipe-laying is always supervised by a Project Assistant.

7.10.3 Sizes and Classes

Class 10 (maximum working pressure 10kg/cm^2) piping is most commonly used, although Class 6 (6kg/cm^2) is occasionally used to reduce cost in the larger sizes (110mm and above). To ensure equal distribution of water all pipe sizes are employed, namely 12, 16, 20, 25, 32, 40, 50 63, 75, 90, 110mm. 20mm is the normal minimum size, but 16 and 12mm are used to reduce flow to a tap near a high pressure line. Above 110mm, Asbestos Cement is usually preferred but PVC has been used in sizes 125, 140 and 160mm in small quantities.

7.10.4 PVC Pipe Fittings

The Malawi programme has standardised on PVC pipes with uniform outside diameters. The principal suppliers from Europe manufacture to slightly different standards, but all have common outside diameters. This greatly facilitates the supply of PVC pipe fittings which are interchangeable for all PVC pipes, and enables a single supplier to supply all fittings.

7.10.5 Effect of Sunlight

PVC pipes are susceptible to ultra-violet rays which discolour and make them more brittle. They then become more prone to damage during handling and are liable to burst at pressures below the designed maximum. In addition, the lower rows of a stack of pipes exposed to bright sunlight are liable to distort under the higher surface temperature and the weight of pipes above them.

The early projects in Malawi used imported pipes that were dark grey in colour. The manufacturers were then asked to supply white pipes in the hope that this would reduce their vulnerability to sunlight. This has dramatically reduced the surface temperature of pipes left in the sun, and has also reduced the discolouration effect but it has not been possible to determine whether the embrittling effect has also been reduced.

It should be stressed that PVC pipes are always stored in bulk in the shade. On a major project a special shade is built while on a minor project the pipes may be stored in a naturally shady place. However, when pipes are eventually distributed to the villages, they are inevitably exposed to sunlight for a while.

7.10.6 Longitudinal Movement of PVC Pipes

PVC pipes laid during the heat of the day are naturally in a slightly elongated state. After backfilling and when the water is turned on, the cooling causes them to contract in length. This effect caused some problems on the Chambe supply where bursts in 110mm and 90mm occurred at some solvent cement joints when the spigot had pulled out of the socket. Smaller sizes were unaffected. This was attributed to the fact that the larger pipes were more rigid, and therefore laid straighter, whereas the smaller pipes were "snaked" into the trench. The smaller pipes were able to cope with the tension by "straightening" themselves a little whereas the larger ones were not.

This experience led to the decision to use rubber O-ring type joints for sizes 63mm and larger so that contraction can take place at each joint without tension building up in the line. A new procedure was also adopted for solvent cement joints whereby the line is backfilled before 9 a.m. on the morning after the pipes have been joined. This practice has reduced the problem, even in some large pipe sizes which have had to be joined by solvent cement (the local manufacturer does not make pipes with rubber O-ring type joints).

7.11 STEEL PIPES

Galvanised steel pipes are only used where mechanical strength is required. They are used at intakes, for crossing roads, rivers and gullies, and for the pipework at tanks and standpipes. They are extremely expensive and heavy to transport. Only sizes up to 100mm are generally available, and larger sizes have to be specially ordered or welded locally.

7.12 POLYETHYLENE PIPING

The programme in Malawi has not used high density polyethylene (PE). Closer consideration should be given to the merits of this type of pipe and to whether it could be appropriate for large scale reticulation involving so many different pipe sizes. The advantages normally associated with PE are resistance to freezing and ease of laying without joints from a rolling drum. However, freezing is not a problem in Malawi, nor is labour a constraint. The logistical problems associated with distributing the right lengths of all the pipe sizes to the various branch lines, and of having sufficient equipment so that laying can proceed simultaneously on several lines may be considerable. PE pipe may be more appropriate in less densely populated areas, where a single medium or small size pipeline is needed for a relatively long distance.

7.13 FUTURE TECHNICAL DEVELOPMENTS

7.13.1 Impoundments

Plans are currently in hand to build an earth dam to form an impounding reservoir to supply a population of 140000 by gravity. This dam will be built by the Irrigation Department with mechanical plant and contract labour. Once the dam is completed WPS will take it over and construct a water supply system on the usual self-help basis.

7.13.2 Pumped Mains

Many areas of Malawi have no convenient upland water source to develop for a direct gravity system. In some of these cases it may be possible to install a pumping main from the nearest satisfactory water source to supply a header tank above the area to be served. Such a scheme would need to involve contractors to install the more complex intake works, pumps and rising main, but the self-help programme could install the reticulation from the header tank as usual. The use of pumps has serious implications for operation and maintenance; this type of scheme should probably be limited to relatively large supplies to avoid the maintenance problems associated with the proliferation of small pumped schemes.

7.13.3 Water Treatment

Inevitably, some areas will not be able to be served by untreated water because the potential sources are excessively polluted. In these cases simple treatment will be required, most probably in the form of infiltration galleries, extended sedimentation and slow sand filtration. WPS has plans to develop these techniques on a pilot scale to gain design and operating experience under local conditions.

7.13.4 Village Facilities

At present clothes and personal washing is usually done at home with collected water, or at the former water source. Thus some of the potential health benefit of the improved water supply is being lost by those who wash in polluted streams and stagnant pools. The provision of a washing slab or ablution block at the village standpipe would reduce the community's exposure to water-washed and water-based diseases, and this facility could be introduced into future projects. However, this will lead to an increase in per capita consumption and may require the design capacity of future projects to be upgraded.

7.13.5 Completed Projects

Completed projects will not receive any more capital expenditure apart from that required to maintain the present level of service and to raise the early projects (before Mulanje West) to the current standards. The supplies are installed within rigid project boundaries, and it is not possible to extend existing supplies to new areas without lowering the level of service designed for the original area.

In the longer term, when the national level of economic and technical development permits, it is theoretically possible to increase the supply through the same piping system by installing booster pumps in the main.

7.14 SUMMARY

Simple technologies require the same strict design criteria and attention to detail as do more complicated ones. Many problems, both technical and community-related can be eliminated by detailed and accurate design. There is, however, a need to build in a degree of flexibility - to cater for unknown factors that emerge at the construction stage. This is facilitated by combining the roles of design and construction in one engineer to enable feedback from field experience to influence design practice.

It is desirable to have reasonably detailed design procedures laid down in a simple form so that systems can be designed under supervision by sub-professional staff.

Relatively large-scale rural water supplies have been installed in Malawi involving very simple technology. The principal features of the gravity system are an intake, screening tank and sedimentation tank, with a main line supplying branch lines via area and branch storage tanks. The system is designed for average flow, with the storage tanks balancing supply and demand. The Malawi experience has been favourable for both AC and PVC piping, as long as adequate supervision is guaranteed.

CHAPTER 8

MAINTENANCE

8.1 INTRODUCTION

The maintenance of rural water supplies in developing countries has become the subject of increasing concern in recent years. Experience has shown that it is often far easier to construct a water supply than to ensure its continued operation. In this context much has been written about the advantages of community involvement and appropriate technology.

This chapter describes the experience of the Malawi programme in the field of maintenance. It shows the development of a system in which the community can realistically play a role in maintenance, and the part that the programme must play to ensure success. It also describes what maintenance problems may be expected in a gravity system and how they may be minimised.

8.2 FACTORS AFFECTING MAINTENANCE

8.2.1 Technology

Complex technologies involving pumps and treatment plants undoubtedly require a more sophisticated level of maintenance than is normally obtainable in rural areas. A gravity system, on the other hand, relying only on screening and sedimentation for treatment, must be one of the most simple technologies that can be used in water supply. By comparison, it has a very low maintenance requirement, which is the main reason why the supplies in Malawi have continued to work despite only a minimum of maintenance. Nevertheless, no system is maintenance-free, and careful provision should always be made even for a simple system.

8.2.2 Standard of Design and Installation

The maintenance required by a system is also directly affected by the quality of the design and installation work. In the Malawi programme, the maintenance load has progressively been reduced by closer attention to detail during design and by continuously improving the standard of installation. The combination of the role of design and construction engineer enables shortcomings in the design to be rectified during the construction stage. On the other hand shortcomings in construction are very difficult to rectify. The standard of installation refers particularly to the construction quality of intakes and tanks, the standards of pipelaying, the marking and protection of pipelines and the construction of tap aprons.

8.2.3 Involvement of the Community

The involvement of the community in the installation of its water supply is of major significance for subsequent maintenance. Undoubtedly, the greater the involvement, the greater the degree of responsibility felt by the community. However, this sense of responsibility must be supported in practical terms by a realistic maintenance organization.

The principal advantage of community involvement lies in the self-help labour available for maintenance and repair activities. The community is already familiar with the concept of providing self-help labour in return for technical support, and it is easy to maintain this relationship for maintenance purposes. It is however unrealistic to expect the community to take over all maintenance duties.

The second advantage arising from community involvement in the construction stage lies in the fact that the community is familiar both with the layout of the pipe network itself and with the technical operations involved in laying pipes. With this experience they are capable of carrying out minor repairs without supervision, provided materials are available.

Thirdly, the fact that the community feels a sense of responsibility greatly improves the surveillance of the supply, and ensures that defects are reported quickly.

8.2.4 Technical and Material Support

The sense of responsibility shown by the community is not enough to guarantee maintenance. The only resources the community has to offer are its labour, and possibly the ability to raise very minimal sums of money on a small scale. It is probably beyond both the human and financial resources of the community to construct and pay for a new intake that has been washed away in a flood, or even to obtain a single steel pipe to repair a wash-out at a gully. In addition, the community is unlikely to carry out the routine preventive maintenance tasks that are necessary for the continued reliability and long life of the supply. It is therefore the responsibility of Government to supply both the technical supervision and material support necessary.

8.3 DEVELOPMENT OF MAINTENANCE POLICY

The policy regarding maintenance has evolved along with all the other aspects of the programme. The initial policy proved to be too optimistic, and has been progressively replaced by a more realistic one.

8.3.1 Original Policy

During the pilot phase (before Mulanje West) the policy was to hand over completed projects to the community with sufficient spares and materials for them to repair occasional bursts. Towards the end of each project, the committee would be instructed in the duties of maintenance, particularly in the repair of bursts and the cleaning of the intake, screens and tanks. It was implicitly assumed that WPS would offer technical and material assistance when called upon to do so.

This policy did not achieve a sufficiently high standard of maintenance. It is true that the committees did repair bursts, and the intakes and screens were cleaned when they became blocked, but these were essentially "crisis" activities carried out because the supply to all or part of the community had been interrupted. If the screens were broken, or a pipeline exposed by erosion, nothing would be done as long as the water continued to flow. Once the exposed pipeline was finally washed away, the committee would send a report to WPS, but this message would take a long time to get through, and WPS, who were usually busy elsewhere, would probably take a long time to react. Even then, WPS would have to supply the materials and carry out the repairs with the resources available from the nearest project under construction, as there were no specific funds or staff available for maintenance.

8.3.2 The Policy to Hand Over to District Councils

WPS always recognized that large projects would need a more formal maintenance system. It felt that if the community on a small project failed to maintain its supply, only the community itself would suffer, whereas on a large project the failure of one community would adversely affect all the others. In addition, the size of the system would mean that any interruption of the supply would cause the ingress of air and interfere with the supply for as much as two days after its repair.

WPS decided to approach the Ministry of Local Government to persuade Mulanje District Council to take over the Mulanje West and Phalombe supplies on completion. It was argued that the councils were already financially responsible for the maintenance of boreholes in the area which were now redundant as a result of the supply, and the funds saved could be transferred to the two gravity systems. The Ministry of Local Government initially agreed in principle, but the Mulanje District Council were naturally apprehensive, and were unwilling to take over until they were satisfied that they would be technically and financially capable to do so. WPS were conscious that Mulanje was a test case, and so were equally anxious to allay the fears of the council and ensure a smooth and successful handover. The Project Manager in Mulanje therefore developed a maintenance system in the form of a Project Assistant with a specified annual maintenance schedule, a watchman to maintain the intake and headworks, and a generous supply of spares and materials, as well as a house and store. The District Council were to take over an existing maintenance system, and the only expenses they would be expected to bear would be the wages of the Project Assistant and the watchman, and the cost of the transport of materials if necessary.

Despite progress at district level, the Ministry of Local Government became worried about the implications for all the other District Councils.

Mulanje was a relatively wealthy and well-staffed council compared with others, and the Ministry felt that the maintenance of numerous water schemes throughout the country was basically beyond the resources of the majority of councils. The policy was therefore abandoned.

8.3.3 Current Policy

WPS now realizes that the previous policies were unrealistic, and it is perhaps fortunate that District Councils did not take over as they would probably have had to fall back on the technical resources of WPS in any case. The current policy is that WPS retains responsibility for all the water supplies it constructs. This is a relatively recent development and WPS has not yet set up a formal maintenance unit within its organization. This will take place after the current re-organization of WPS into the new ministry. The unit is likely to come under the responsibility of one of the engineers in the programme and may be staffed by an experienced Supervisor and a number of experienced Project Assistants, who may be called Maintenance Assistants. The organization will probably be based in the Southern Region, with a store, workshop facilities and essential transport. A Maintenance Assistant will be appointed to each major supply and to each group of smaller supplies. Specific maintenance schedules will need to be drawn up, and a reporting system introduced to monitor the performance of each supply. Maintenance Assistants will receive regular support and supervision from the Supervisor. To maintain the motivation of staff, Maintenance Assistants may return to project work after two or three years.

The question of funds has not yet been resolved. Funds are needed principally for staff wages, transport and local material costs. Adequate spares of pipes and fittings are usually allowed for in the original project budget.

Although the organization is not yet set up, Maintenance Assistants have already been appointed to the completed major projects, and are working to a maintenance schedule. They are being paid from funds saved on other projects.

8.4 MAINTENANCE ASSISTANT

Each Maintenance Assistant so far appointed has been selected from among the Project Assistants who were involved in the project itself. He is therefore familiar with the area, the people and the layout of the system. He is given a house and a store for spares and tools, and uses his own bicycle for which he can claim an allowance. Essential motor transport is supplied by his senior officer on request.

His job is to carry out a continuous inspection of the whole supply according to an annual maintenance schedule, an example of which is given in Table 8.1. He carries out all repair and preventive work resulting from his inspection and executes routine maintenance procedures such as the cleaning of tanks, the operation of valves and the flushing of pipelines. He is also available for emergency repair work following a burst or storm damage reported to him by the community. He ensures that villages keep their taps and tap aprons in a good state of repair, and has the power to plug the standpipe of any village that is failing to fulfil its maintenance responsibilities. This power comes from the authority of the Chief, established during the construction of the project, but is only exercised after suitable warnings and after consultation with the committee.

For each activity the Maintenance Assistant is supplied with special report forms which he submits once a month to his senior officer. He is also to maintain records of all bursts, and of all stores used, and he must keep a list of all committee members.

It is expected that Maintenance Assistants will continue to operate on similar lines under the new organization.

8.5 WATCHMAN AT HEADWORKS

For each major project so far completed, WPS has employed a local villager as a watchman to carry out maintenance and surveillance duties at the headworks. His principal duties are to keep the intake pipes and screens clean, especially during the wet season. He is also responsible for patrolling the headworks and the upper part of the main line to ease the load on the Maintenance Assistant. His duties are supervised by the Maintenance

TABLE 8.1 ANNUAL MAINTENANCE SCHEDULE FOR MULANJE WEST WATER SUPPLY

MONTH	LINES	DUTIES
JANUARY	All Main Lines 1, 2, 3, 4, 5	Inspect Intake Lines, Tank, Fittings and all Taps off Main Operate all Sluice valves, Flush points and Gate valves Check all Air valves Clean all Tanks Submit Inspection Report
FEBRUARY	Main Lines 1 and 2 Branch Lines ABC (including line to Chisitu Tank)	Patrol on First Monday Inspect Lines, Tanks and Taps Clean all Tanks Operate all Gate valves Submit Inspection Report
MARCH	Main Lines 3 and 5	Patrol on First Monday Inspect Lines, Tank and Taps Clean all Tanks Operate all Gate valves Submit Inspection Report
APRIL	Main Line 4 Branch Lines GH	Patrol on First Monday Inspect Lines, Tank and Taps Clean all Tanks Operate all Gate valves Submit Inspection Report
MAY	Main Lines 1 and 2 Branch Lines JK	Patrol on First Monday Inspect Lines, Tank and Taps Clean all Tanks Operate all Gate valves Submit Inspection Report
JUNE	Main Lines 3 and 5 Branch Lines LMN (including Line to Mbiza)	Patrol on First Monday Inspect Lines, Tank and Taps Clean all Tanks Operate all Gate valves Submit Inspection Report
JULY	Main Line 4 Branch Lines OPQR	Patrol on First Monday Inspect Lines, Tank and Taps Clean all Tanks Operate all Gate valves Submit Inspection Report
AUGUST	Main Lines 1 and 2 Branch Lines STV	Patrol on First Monday Inspect Lines, Tank and Taps Clean all Tanks Operate all Gate valves Submit Inspection Report
SEPTEMBER	All Main Lines	Inspect Intake Lines, Tanks, Fittings and all Taps off Main Operate all Sluice valves, Flush points and Gate valves Check all Air valves Clean all Tanks Submit Inspection Report
OCTOBER	Main Lines 3 and 5 Branch VWZ	Patrol on First Monday Inspect Lines, Tank and Taps Clean all Tanks, Operate all Gate valves Submit Inspection Report
NOVEMBER	Main Line 4 Branch Line XY	Patrol on First Monday Inspect Lines, Tank and Taps, Clean all Tanks Operate all Gate valves, Submit Inspection Report

Assistant. It is not yet clear how the headworks of small supplies will be maintained under the new organization. At the moment the intake pipes and screens are cleaned on a voluntary basis by a committee member or the nearest villager. This arrangement is not ideal, as the intake and screens usually become blocked before action is taken to clean them, resulting in an intermittent supply. However, this does not have such an adverse effect as it would on a large system, as the supply is usually restored within hours. It would therefore be unnecessary and inefficient to employ a full time watchman on every small supply. There may be a case for WPS to pay a villager selected by the committee on the basis of, say, one hour's work per day, to be responsible for the maintenance of the headworks. If the supply is regularly interrupted through his negligence, the committee may dismiss him and appoint another.

8.6 RESPONSIBILITIES OF THE COMMUNITY

The maintenance duties of the community are divided between those that are exclusively their own responsibility and those which they share with the Maintenance Assistant.

The responsibilities that are exclusively their own are the maintenance and repair of village taps, aprons and soakaways. These responsibilities are made clear at the ceremony for the initial connection of the tap, as are the consequences of ignoring them. Occasionally the Maintenance Assistant does have to plug a standpipe, with the approval of the committee, usually to force the village to replace a leaking tap or to repair a badly damaged apron. This action has always had the desired effect, and seems to be generally recognized as justifiable as long as adequate public warnings have been given.

The responsibilities that the community shares with the Maintenance Assistant are for general surveillance, the maintenance of pipelines, cleaning of tanks and the repair of bursts. In all these activities, the community is expected to supply the labour under the supervision of the Maintenance Assistant. Individual farmers are responsible for the maintenance of the marking ridge over any part of a pipeline that passes through their land.

Overall responsibility for community participation rests with a maintenance committee. In the case of a small scheme, this is usually the same as the original project committee while on a large scheme maintenance responsibilities are usually assumed by the branch committees. The committees rarely meet, but their authority is implicitly acknowledged and can be referred to when necessary.

8.7 MAINTENANCE AND REPAIR LOAD

8.7.1 Intakes and Screens

Apart from the routine cleaning of intakes and screens, repairs are periodically needed. The intake itself is the most vulnerable point of the supply and needs to be carefully sited, well designed and strongly built to minimize the effect of a flood. This lesson was learnt when on at least three occasions, intake weirs were washed away or broken by flood water.

The galvanized steel intake pipes are subject to corrosion, especially as they are in a region of aerated water. The intake pipes for Chambe supply needed to be replaced after ten years of use. WPS now expects that all intake pipes will have to be renewed every ten years - a fact that had not been anticipated. This replacement can represent quite a major expense on a large supply.

The screens in the screening tank also need periodic repair and replacement. If the screens are allowed to become completely blocked the wooden frames may break as pressure builds up on one side. The galvanized wire mesh also corrodes and breaks under pressure. The frames can be repaired as necessary, but the mesh probably has a life of about five years.

8.7.2 Tanks

Concrete tanks require little maintenance work apart from routine cleaning. Some tanks develop slight leaks, but these are not considered a major problem, and do not appear to get worse. The new maintenance organization may include the capability to carry out minor repairs to concrete works.

Float valves connected at the inlets of tanks need to be inspected and may occasionally require the replacement of a washer.

8.7.3 General Maintenance of Pipelines

The pipeline itself is especially vulnerable to erosion during the first two wet seasons after installation. During this period the backfill and ridge over the line is less compacted than the surrounding earth, and surface rainwater will quickly expose the weak points in the line. Check dams are built at gully crossings after backfilling, but these may be washed away or new gullies may be created. Thus there is a need for regular inspection of the line and swift action to repair or build check dams. A further erosion hazard occurs where the pipeline crosses the ridges and furrows of cultivated fields. Unless taught otherwise, farmers tend to stop their agricultural ridges just short of the pipeline ridge, apparently so as not to interfere with it. Unfortunately, during heavy rainstorms, surface water runs along the furrows until it reaches the pipeline ridge, and then is free to flow downhill beside the pipeline ridge. The accumulated water from successive furrows soon turns into a stream which can seriously erode the pipeline.

Farmers are therefore instructed to connect their agricultural ridges onto the pipeline ridge so that rainwater is trapped within each furrow. Ideally this should be done by self-help labour at the time of backfilling, but it still needs regular inspection to ensure that farmers are continuing the practice.

Pipelines are planted with drought resistant paspalum grass which should eventually dominate other vegetation. The purpose of the grass is to strengthen the ridge from erosion and to act as a marker.

The use of this grass has been only partially successful. The planting of grass along hundreds of kilometres of pipeline is a major logistical exercise. The operation usually occurs towards the end of a project when most villages have already received water and project staff are very busy finishing off other jobs, and it does not get the attention it deserves. It would seem that additional methods of marking should be introduced, at least for main lines, such as concrete cairns spaced at regular intervals.

Pipelines often become paths, a practice which is to be encouraged as it has the double advantage of effective marking and regular patrolling.

Main pipelines are fitted with flushing points at low spots in the ground profile to flush out any sediment that may build up. These are opened twice a year by the Maintenance Assistant, as are all sluice valves to prevent the spindles from seizing. Air valves are also checked for leakage which may be due to a worn ball or to grass being caught after a burst has been repaired.

8.7.4 Repairs to Asbestos Cement Pipes

Experience with completed supplies shows that once the lines have successfully withstood the test pressure, subsequent bursts are very rare indeed. Only one burst has occurred in four years in 29km of AC pipe on Mulanje West, and that was due to mechanical damage following erosion. A very small number of bursts occurred after the testing of Phalombe, some of which were thought to be due to surge pressures set up by the excessively rapid operation of a sluice valve.

When a burst occurs on the AC main, the pressure drop is felt all over the first pressure stage. As soon as the Maintenance Assistant notices the pressure drop, or is told about the burst, he bicycles back along the pipeline until he finds the spot with the help of the people nearby. He then closes the nearest upstream sluice valve and opens the nearest flush point to reduce the erosion caused by the escaping water. He then instructs the nearest village headman to organize people to expose the pipeline for one pipe length either side of the burst. He also arranges for two people to collect a spare pipe from the nearest dump that has been specially left for this purpose. The Maintenance Assistant then returns to fetch the tools and spare joints needed to effect the repair, all of which he can carry on his bicycle. The repair is effected by cutting out the damaged section with a hacksaw, and connecting a new section using short collar repair joints. The line is then flushed out and the trench backfilled. The supply should be restored within 12 hours of the burst.

8.7.5 Repairs to PVC Pipes

Rather more bursts are experienced with PVC pipelines than with AC in proportion to the lengths laid. There may be several reasons for this. PVC lines are not tested beyond normal static pressure, so many of the weak pipes and joints remain undetected. These are exposed later, possibly when surge pressures occur. In addition PVC lines, which are buried at a shallower depth than AC, are more vulnerable to erosion and mechanical damage. Farmers occasionally strike a pipe accidentally while working in their fields. PVC bursts may also be caused by poor laying procedures, especially the use of excessive solvent cement (which softens the pipe) and the inadequate preparation and backfilling of the trench. It is believed that PVC pipes may vibrate slightly when water flows under pressure, and a small stone may slowly wear a hole in the pipe.

As an example of the repair load on a major supply, 23 bursts and leakages were reported[1] in seven months (in the dry season) in an overall length of 208km of pipelines. Other bursts may have been repaired without being reported. This is a surprisingly high rate in comparison with previous experience, and it is likely that the average will be seen to be considerably lower once records are available from a number of supplies.

One of the advantages of PVC pipe is the ease with which repairs can be effected by the villagers themselves. Towards the end of a project, each committee is asked to select a villager for an afternoon of training at the project headquarters. The villager is taught how to make a solvent cement joint on PVC pipe, which he usually knows already, and how to make a socket on the end of a piece of pipe. The socket is made by holding the end of the pipe in a tin of boiling oil (old engine oil) for a few minutes until soft, and then pushing the hot end over the cold end of another similar size piece of pipe, and twisting the pipes against each other as the end cools. Once cool, the pipes are pulled apart, the oil is cleaned off and the socket is then ready to be used for a solvent cement joint. The villager prepares a number of sections of pipe with sockets on each end to serve as spares for effecting repairs, and takes them home together with some cleaning fluid, solvent cement and a small brush for applying the cement. The only other piece of equipment needed is a saw to cut the damaged section of pipe, but this is a fairly common tool in the villages and can easily be borrowed when required.

When a burst occurs, the nearest trained villager is summoned to carry out the repair. He may obtain more materials from the Maintenance Assistant when his supply runs short.

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1. Personal communication, H.van Schaik, Project Manager, Mulanje.

8.7.6 Replacement of Taps

The tap itself is the most heavily used item in the whole water supply system. The programme uses ½-inch crutch-headed brass bibcocks with threaded spindles. Spring-loaded taps are not necessary as the people do not waste water which they themselves have worked for. However, on a major water supply the size of Mulanje West, over 100 taps have to be replaced each year, which implies an average working life of about four years. Replacement taps are supplied by the Maintenance Assistant on receipt of the necessary payment collected by the village.

The most common problem stems from the failure to replace a worn washer, resulting in the user screwing down the handle until the drip stops. Eventually, the thread of the spindle becomes stripped and the tap is useless. A spare washer is issued with every tap, but it is not always used in time.

The second most common problem is a fault of the tap itself, namely that the handle becomes loose on the spindle and wears away the rectangular stem head until it no longer grips. This problem has been reduced since the manufacturer was asked to pin the handle to the stem.

It would seem, therefore, that WPS should investigate the possibility of finding a more robust tap which is more able to stand up to the heavy use.

The standpipe itself is unlikely to suffer any damage due to normal wear and tear. Very occasionally, however, one is maliciously damaged by a jealous or mad villager. In such cases the village must report the matter to the police and must pay the cost of a new standpipe, which is supplied and connected by the Maintenance Assistant.

8.7.7 Repairs to Aprons, Drains and Soakaways

Although the construction of an apron, drain and soakaway with each tap was seen to be a major step forward, there is still room for improvement in the quality of both the design and construction of aprons and drains. A high proportion of aprons develop minor cracks within a few years, which need to be repaired to prevent further deterioration. The responsibility for repair lies with the villagers themselves, but, unlike the replacement of taps there is little incentive for the community to repair an apron until the damage is intolerable.

At present, the apron is constructed by the villagers under the supervision of the Project Assistant who, in the absence of any local artisans, carries out the concrete work himself. All Project Assistants receive instruction in concrete work from the project builder, but this procedure does not appear to ensure a uniformly high standard.

If the villagers are to continue to construct the apron, the project must increase its technical support. The apron must be more strongly designed to allow for limited quality workmanship, Project Assistants should have more effective training in concrete work, and the supply of cement and chipped stone to each apron should be increased. This will put a greater load on the project, but it should reduce the subsequent maintenance load on the community.

An alternative would be to develop a small team of contract builders specialising in aprons, similar to the system for the construction of tanks. This would lead to a higher and more uniform quality of work. It would, however, create a greater logistical problem when a large number of aprons have to be constructed within a relatively short period of time; it would also reduce the villagers' sense of responsibility for the apron, making subsequent maintenance more difficult.

Soakaway pits are a relatively minor problem, requiring to be emptied and refilled with stones every two or three years.

8.8 CONCLUSION

Any agency that embarks upon the construction of rural water supplies must be aware from the outset of the importance of maintenance. Ideally, the agency itself should retain overall responsibility, and set up a realistic system in which the community can make their contribution.

CHAPTER 9

FUTURE DEVELOPMENTS

9.1 RE-ORGANIZATION OF THE WATER SECTOR

9.1.1 The New Ministry

The new Ministry of Lands and Water Affairs will come into being in January 1980. It will assume all responsibility for urban supplies (apart from Blantyre and Lilongwe) and the three rural programmes, namely boreholes, piped supplies and shallow wells. It is not yet clear what form the new organization will follow, but it is likely that the separate programmes will continue to operate more or less as before, but with a greater degree of collaboration and co-ordination.

The urban supplies, hitherto run by the Ministry of Works and Supplies, and the borehole programme, run by MANR have, in their relatively long history, developed a strong institutional base from which to operate. By comparison, the rural piped water supplies and shallow wells hitherto run by WPS, have developed more recently and have been operating on an institutional "shoestring". It is to be hoped that the opportunity will be taken to reduce this imbalance by strengthening the staffing levels and administrative support of these two programmes, bearing in mind the significant population of the rural sector that they are likely to serve.

9.1.2 The Water Master Plan

A logical sequence to the formation of the new ministry is the preparation of a Water Master Plan to assess the country's water resources and propose how they should most efficiently be developed. The Sector Study Report (WHO/World Bank, 1978) proposes that the objective of the Plan should be to provide guidance on the availability, reliability and quality of the national water resource and the existing and projected demands over specified time periods. The Plan would cover:

1. Analyses of accumulated river gauging data.

2. Review of the surface hydrological network.

3. Establishment of water quality monitoring network.

4. Analysis of accumulated borehole data.

5. Establishment of observation borehole network.

6. Review of system and procedures relating to water permits.

7. Projection of water demands.

8. Water balance studies.

9. Potential for gravity and shallow wells supplies.

The Plan should recommend an overall strategy for the development of national water resources and, in the rural sector, identify the most likely distribution between boreholes, piped supplies and shallow wells. It should also recommend realistic targets for each of the three rural programmes, and indicate what inputs will be necessary to achieve them in financial, institutional and manpower terms.

9.2 THE DECADE TARGET

9.2.1 Piped Water Supplies

Before the completion of the Water Master Plan it is difficult to predict whether the Decade target is realistic for Malawi. This will depend to a great extent on how the task will be distributed across the three rural programmes. The Sector Study Report suggests that the proportion of the rural population that could be served by gravity may lie between 30 and 50 per cent. At the present population growth rate, the rural population will reach 6.5 million by 1990. By the end of 1980 550000 people will already have been served by gravity supplies, leaving between 1.4 and 2.7 million to be served by this programme during the Decade.

In the period 1972 (after the pilot phase) to 1980, the rate of implementation will have increased from 25000 to 100000 people per year, an average annual increase of 19 per cent. Table 9.1 shows that to achieve the Decade target, the piped water programme will have to grow at a rate of between 7 and 18 per cent, depending on whether 30 or 50 per cent of the population can be served. It would appear, therefore, that the required rate of increase will be feasible judging by past performance.

There must, however, be some doubt that an 18 per cent rate of increase can be sustained. First, the most suitable sites for large scale gravity supplies have already been chosen, so future projects may be technically more demanding and of a smaller average size. This will increase the load on the programme and reduce the economies of scale that were possible in the larger projects. In other words the programme will have to expend more effort per head of population served. Secondly, while it should be possible to increase the numbers of Project Assistants and Supervisors sufficiently, it is most unlikely that there will be sufficient Malawian engineers and Technical Officers to carry out the necessary professional and sub-professional functions of design and project management. A possible solution to this problem would be to recruit overseas engineers, perhaps volunteers, to fill the vacancies, but the Government may not consider it desirable to have too high a proportion of expatriates within a single programme.

Whether or not the programme will achieve its target, it is essential that it is not forced to grow at a faster pace than it can naturally sustain. It has been stressed in earlier chapters that one of the prime reasons for the present strength of the programme is that it has grown at a self-sustaining rate. If it now overreaches itself in an attempt to achieve an over-ambitious target it will be unable to maintain a satisfactory level of experienced field supervision, which will lead to a fall in technical standards, project failures and loss of confidence on the part of the people, the Government and donor agencies. Not only will the programme fail to reach its target,

TABLE 9.1 MALAWI RURAL WATER SECTOR: DECADE TARGET

			1980		DECADE TARGET (1990)		FEASIBLE SCHEDULE		
Programme	Proportion of pop. to be served[1] per cent	Total Pop. to be served 000s	Pop. already served 000s	Annual Implementation Rate 000s	Required Annual Growth Rate per cent	Final Year Implementation Rate 000s	Realistic Annual Growth Rate per cent	Year Target will be reached	Final Year Implementation Rate 000s
Piped Water Supplies	50	3250	550	100	18	523	10	1993	345
	30	1950	550	100	7	197	10	1989	235
Shallow Wells	35	2275	50	50	26	504	15	1994	354
	25	1625	50	50	20	310	15	1992	267
Boreholes	35	2275	900	90	8	194	10	1989	212
	25	1625	900	90	0	-	10	1986	159

1. This column shows the upper and lower limits of the possible distribution between the three programmes

but the rate of implementation may actually decrease.

It is suggested here that a more realistic growth rate that could safely be sustained is about 10 per cent, providing there is sufficient managerial capacity and administrative support at ministry level, and provided engineers can be found for project management. At this rate, 50 per cent of the rural population could be served by 1993, by which time the present programme capacity will have increased by a factor of 3.45 (see Table 9.1).

9.2.2 Shallow Wells

The Sector Study Report suggests that the proportion of the rural population that could be served by shallow wells may lie between 25 and 35 per cent, mainly situated in the Central Region. By the end of 1980, the shallow wells programme should have reached an implementation rate of 50000 people per year (500 wells per year). To reach its target by the end of the Decade it would have to grow at a rate of between 20 and 26 per cent, increasing its capacity by between six and ten times (see Table 9.1).

There must be some doubts that it would be wise or even possible to sustain a growth rate of 20 per cent. The programme is at an earlier stage of development than the piped water programme, and is less technically demanding, but it is administratively and logistically more complex. A growth rate of 15 per cent would seem to be more realistic, which would enable the target to be met between 1992 and 1994.

9.2.3 Boreholes

The proportion of the rural population that will be served by boreholes may lie between 25 and 35 per cent. By the end of 1980, 0.9 million people will already have been served and the rate of implementation should be 90000 people per year (300 boreholes per year). No growth at all is needed to serve 25 per cent of the population by 1990. If 35 per cent are to be served, the programme would have to expand at the modest rate of 8 per cent. Assuming that enough drilling rigs and trained drilling teams are employed, the programme should be able to grow at the rate of at least 10 per cent, which would enable the target to be reached between 1986 and 1989.

9.2.4 Rural Water Sector Target

In summary, it would appear feasible for the rural sector to achieve 100 per cent coverage by the mid-1990s, providing sufficient resources are available. Assuming per capita costs will average K10, K1, K10 at present prices for piped water, shallow wells and boreholes respectively the total cost will be between K40 and K50 million.

9.3 FUTURE TECHNICAL DEVELOPMENTS

The introduction of impounding reservoirs, pumped schemes and simple treatment has been mentioned briefly in Chapter 7. They will be introduced during the course of the Decade as the need for these technologies arises.

9.3.1 Washing Facilities

At the village level, the social and health benefits of the water supply would be greatly increased by the introduction of washing facilities. These could be introduced either during the construction of the project itself, or as a supplementary phase after the supply has been completed.

As far as community motivation is concerned, it would be preferable to construct such facilities during the course of the project itself, as one of the standard routines to be carried out before the village tap is connected. Previous experience with tap aprons showed that a supplementary phase after water has been connected requires a huge effort on the part of field staff to motivate the people again.

However, the construction of washing facilities during the project would place a significant extra burden on field staff and the community, and would lead to a slower rate of implementation. In view of the urgency imparted by the Decade, the extra work-load must be kept to a minimum so that the present rate of progress is not unduly affected. This rules out the possibility of elaborate ablution blocks and plumbed-in wash-tubs and leads to the conclusion that a simple brick and concrete washing slab with its own apron and soakaway is the only feasible improvement at this stage. To reduce the work-load and water consumption,water for washing should be drawn from the village tap nearby. The construction of personal washing facilities is not feasible during the project itself, but assistance may be given to those villages who subsequently decide to build them.

9.3.2 House Connections

The Government is opposed to private house connections in the foreseeable future. There are three main reasons for this. First, the primary goal is to provide all rural communities with free water within as short a time as possible. The Government has therefore chosen a higher rate of implementation with a modest level of service (public standpipes) rather than a lower rate with a higher level of service (house connections).

Secondly, the improved social and health benefits associated with house connections would only be available to the very few people who could afford to pay. Thus, there would be little widespread community benefit in proportion to the extra cost and effort expended. The implications for design, consumption figures and revenue collection are also out of proportion to the real benefits for the majority.

Thirdly, if house connections were permitted, the water supply would become a dividing rather than a uniting influence on the community. These divisions would adversely affect the community spirit and self-help commitment on which the programme depends, and could ultimately lead to the break-down of the programme itself.

9.4 MONITORING AND EVALUATION

In view of the current rate of completion of water projects, there is an urgent need to establish an internal monitoring and evaluation system. This system would have five main functions:

1. To record the technical details of each supply, including the locations of village taps and tanks and the rate of flow at each tap on completion of the supply.

2. To record the maintenance history of the supply.

3. To monitor the performance of the supply.

4. To monitor demand by periodic surveys.

5. To evaluate design criteria and standards of installation in the light of the performance of completed supplies.

With the new organization of WPS, a post has been created for an engineer whose responsibilities will include monitoring and evaluation. There is also a case for an evaluation of the overall management of the programme on a national level as part of the preliminary work for the Water Master Plan.

9.5 HEALTH BENEFITS

It should be stressed that improved health is not the primary goal of the rural water supply programme. As far as the community is concerned, the principal motivating influence is the social benefit perceived in the improved availability and accessibility of water. The Government, for its part, sees water supply as just one component in the broad spectrum of rural development.

Nevertheless, it is generally acknowledged that an improved water supply will have some impact on health. The purpose of measuring health benefits is therefore not to justify the programme itself (which would imply that the programme had failed if no benefit could be measured), but to indicate how the maximum beneficial health impact can be achieved by the water supply within the resources available.

Unfortunately it is extremely difficult to measure the impact of an improved water supply on the general level of health. In Mulanje District, for example, where a high proportion of the population has received an improved supply within the last ten years, the medical officers cannot report any significant improvement in health due to the water supply, although no detailed study has been made. It is possible that an improvement could be identified by analyzing all the out-patient records of clinics in the district for the last ten years to plot the incidence of water-related disease, but such a method would be extremely tedious, and would depend heavily on the accuracy of the diagnoses and the recording system.

An alternative[1] and much simpler method could be to compare the nutritional status of children, on the premise that exposure to water-related disease will affect a child's nutritional status. Comparisons could be made between an area with a water supply and an area without, but which is similar in all other respects. The advantage of this method is that Malawi already has a well-developed system of Under-Five Clinics which monitors the nutritional status of children. The system has a wide coverage, with 60 per cent of all children under five being seen at least once a year, and probably 80 per cent of children less than two (Family Health Care Inc. 1978). It should therefore be relatively easy to get a large volume of data covering a high proportion of the child population. If this method could show a significant correlation between water supply and child nutrition, it could possibly be developed to indicate the comparative health impacts of different levels of service.

In addition to the general level of community health, public water supply can have a major impact on epidemic situations. In 1973-4 a serious epidemic of cholera affected Malawi and Figure 9.1 shows the incidence of cholera in Mulanje District for this period. The water supplies shown are the combined areas of Mulanje West and Chambe, and the small Migowi supply to the north of the mountain. Phalombe supply was not yet completed. Population density is uniform in the western half of the map, the south-eastern quarter being Mulanje Mountain. It can be seen that isolated cholera cases within the water supply area do not appear to spread within the community in comparison with cases outside the area. The outbreak occurred in the wet season when surface water becomes heavily polluted. The villages outside the water supply area were using the streams shown on the map, as well as unprotected shallow wells.

9.6 RURAL SANITATION

No figures are available to indicate what proportion of the rural population of Malawi own and use pit latrines. A quick survey in Mulanje District would probably show that the proportion is fairly small. The Ministry of Health encourages the use of pit latrines as part of its health education programme, but there is no specific programme for rural sanitation.

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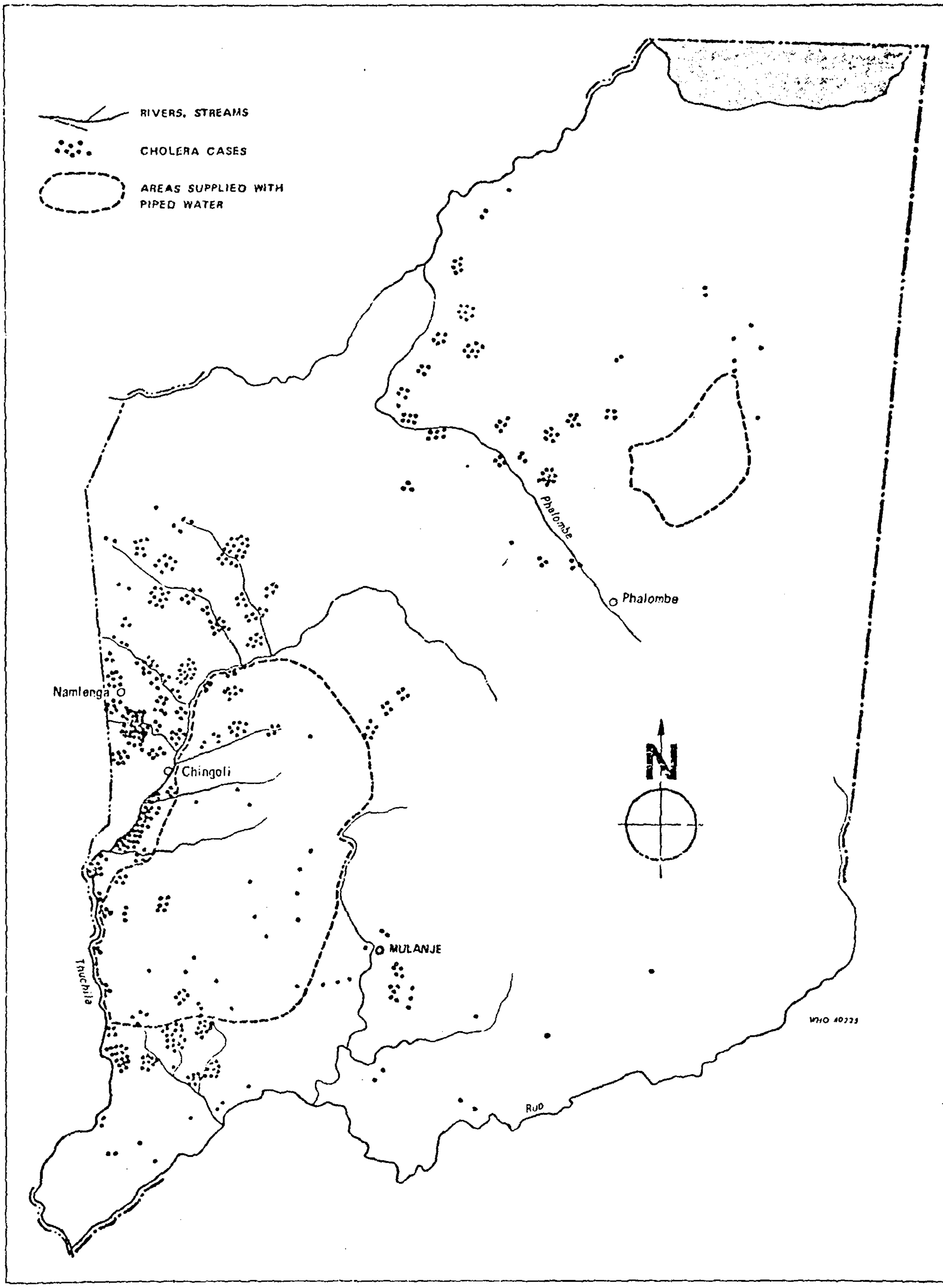
1. Personal communication, Dr. S. Cole-King, Institute of Development Studies, Sussex.

FIGURE 9.1 INCIDENCE OF CHOLERA CASES IN RELATION TO PIPED WATER SUPPLY MULANJE DISTRICT, MALAWI, MARCH 1974

Compiled by Dr C. Pauli and Mr L. Robertson



Source: Pineo and Subrahmanyam (1975).

It was noticeable that during the cholera outbreak of 1973-4 there was a dramatic increase in the construction of pit latrines, which appears to indicate that many people understand the relationship between sanitation and disease. It seems, therefore, that the scarcity of pit latrines is due to lack of motivation, rather than lack of understanding.

It is theoretically possible for the motivation that is generated by the rural water programme to be used for the construction of pit latrines. The routine procedures before the installation of the village tap could include the construction of, say, a certain number of pit latrines. This would, of course, slow down the rate of implementation of the water programme, but that may be justified if real benefits are obtained.

One of the difficulties is to decide what form the sanitation input should take. Communal latrines are simpler to construct, but may not be used very much. They would also need an efficient system to keep them clean. Private latrines would probably be used more, but pose a major logistic and organizational problem. An alternative may be to build, say, five demonstration latrines in each village, and make available a supply of squatting plates, which may be issued by the Maintenance Assistant of the water supply once a latrine has been dug and the superstructure built to an acceptable standard. In this way, only those who genuinely want a latrine will build one, and this is likely to be more effective in the long term than forcing communities to build latrines as part of a "package deal" in exchange for the issue of a village tap.

The emphasis of the Decade stresses the inter-relationship of water supply and sanitation, and if the rural water programme does not realize the potential for introducing sanitation a great opportunity will have been lost. However, the idea should be introduced with caution, beginning with a pilot phase to determine the best approach and test the suitability of the squatting plates. If the pilot phase is successful it should lead to an increase in popular demand and the sanitation element can then gradually be introduced through the water supply programme. Although the Decade target for sanitation is unlikely to be reached, at least a good start will have been made.

CHAPTER 10

IMPLICATIONS OF THE MALAWI EXPERIENCE

10.1 INTRODUCTION

It is not suggested here that the details of the Malawi programme are necessarily transferable to other countries. Each country has its own approach to rural development; most rural water programmes operate within different institutional frameworks and have already developed their own significant characteristics. Nevertheless there are certain broad themes that emerge from the experience of Malawi which may be of use to other countries and which are of particular relevance to the Decade. In this final chapter two of the most important themes with the widest implications are drawn out and summarised. These concern the process of programme development and the significance of field management.

10.2 OVERVIEW OF THE PROGRAMME

The programme originated with a simple request from a community for Government assistance in solving their water supply problem. This request led to a small water supply project which proved so successful that the Government decided to initiate another, much larger project in an area of high potential for gravity supplies. Significant lessons were learnt from the experience of this second project, particularly relating to the size of pilot projects and the need for suitably trained field staff. Nevertheless the project was successful and Government initiated two major projects to meet the popular demand in the two neighbouring areas. The principal characteristics of the programme emerged during the course of these two projects, particularly those concerning the management of self-help labour and field staff, and the raising of technical standards. These major projects also served as a training for field staff who were later posted to smaller pilot projects in selected areas of the country. The success of these smaller projects triggered off genuine popular demand locally, and led to the further expension of the programme.

The current strength of the programme lies in its highly motivated team of field staff, in its well developed procedural systems for community participation and technical operations, and in the fact that it is responding to genuine popular demand. The programme's record of achievement encourages continued confidence on the part of rural communities, Government and donor agencies.

10.3 THE PROCESS OF PROGRAMME DEVELOPMENT

The first major implication of the Malawi experience is that a programme should develop gradually within the limits of its own competence. Any attempt to establish an "instant" programme on a large scale is unlikely to succeed. There are two necessary phases in the development of a programme, the pilot phase and the consolidation phase.

10.3.1 Pilot Phase

This is undoubtedly the most important phase of any programme. If it is omitted, the programme will start beyond the limits of its competence and will undoubtedly run into serious problems. There is a danger that the sense of urgency generated by the Decade will cause this fundamental fact to be ignored.

10.3.1.1 Objectives of a Pilot Project

The principal objectives of a pilot project can be summarised as follows:

1. To Establish the Confidence of Government and Potential Donors
If the Government is to continue its support it must be satisfied that the programme can be successful and fulfil a genuine need. Similarly, potential donors will be encouraged to support a programme which has already proved itself with a successful pilot phase.

2. To Stimulate Demand in Target Communities
The strength of a programme depends on the intensity of public demand.

Target communities who are able to see the results of a pilot project, and who can talk to the beneficiaries will be far more impressed than they could ever be by listening to Government propaganda or the exhortations of their leaders.

3. To Test Practical Aspects of the Proposed Programme

The experience gained in the pilot phase may show up technical and organizational shortcomings of the proposed programme. It is better that these come to light during the pilot phase, when it is still relatively easy to rectify the situation. If problems arise during a major project they could lead to a breakdwon of confidence in the whole programme.

4. To Provide Experience and Training for Field Staff

It is unwise to launch straight away into a major programme relying on staff who have no previous experience of the particular technical and organizational requirements. The pilot phase is therefore a period when field staff can become familiar with the programme itself and gain some experience in preparation for the next stage.

10.3.1.2 Desirable Features of a Pilot Project

The programme cannot develop until the above objectives have been achieved. It is therefore imperative that the pilot project is successful. To facilitate this it is logical to choose a project with as many favourable features as possible. The most important features are listed below:

1. Accessibility of Project Area

The project itself depends on the guaranteed supply of all materials and on the regular supervision and support of the controlling ministry. If the project is situated in a remote area, communications will be difficult, supplies will be jeopardised and the project may receive inadequate supervision and support. Furthermore, the first two objectives listed above depend upon the project being reasonably accessible to Government officials, politicians and donor officials as well as being adjacent to target communities. If this is not possible, it will be necessary to execute two pilot projects consecutively, one to achieve the first objective and the other to achieve the second.

2. Project Size

The success of a pilot project is dependent upon the maximum possible supervision of all project activities. Bearing in mind that the numerical strength and experience of field staff is likely to be limited it is important that the project is kept as small as possible.

3. Suitability of the Chosen Community

It is important that the community selected for a pilot project is known to be responsive and willing to co-operate with Government. It should have strong local leadership and be as free as possible from factions and animosities within the community. It should also have a real need for the services offered by the programme.

4. Technical Simplicity

If a complicated and arduous project is undertaken the community's enthusiasm is likely to fall away and the project will run into difficulties. Ideally, the people should be able to see the results of their labour within a relatively short time. More difficult projects can be undertaken once the pilot phase has been successfully completed.

5. The Quality and Experience of Field Staff

A pilot project is a particularly testing time for field staff who will have to cope with unfamiliar situations. They should therefore be experienced enough to foresee and avoid difficulties, particularly of a community nature, and be persevering enough to guide the project through the problems that arise.

10.3.2 Consolidation Phase

The consolidation phase begins once the pilot phase has been successfully completed. It is a period when the lessons of the pilot phase are acted upon, procedures and techniques developed and improved, when field staff are trained and experience and self-confidence accumulated. The process of consolidation continues for the life of the programme, although the bulk of the consolidation may be achieved within about five years. Although the details of this period will be defined by the nature of the programme and the policies adopted, planners and engineers should acknowledge the existence of this process of consolidation when any programme is being undertaken.

10.4 FIELD MANAGEMENT

The second major implication concerns the field management of projects. Government agencies sometimes expect too much of field staff and self-help labour and fail to give them adequate support. This may be one reason why the experience of community participation in some countries has not always been successful. Although the subject of field management has been fully discussed in Chapter 5 and recurs in most other chapters, the main points are summarised here in general form:

1. Selection and Training of Field Staff
Any programme is utterly dependent on the quality of its field staff. It is therefore essential that the appropriate type of person is selected. A short field selection course is a very much more effective selection procedure than an interview. Field staff should be given a minimum of formal training, as the most effective training process lies in the accumulation of experience on the job.

2. Supervision and Procedural Framework
Newly appointed field staff can only fulfil their responsibilities if they are supported within a framework of adequate supervision and standard procedures. This framework also encourages the maintenance of technical standards and adherence to the project schedule.

3. Community Organization
The authority of the community organization set up for a self-help project must originate from the acknowledged leaders of the community. A programme must therefore engage community support in such a way that this authority is brought into play. The role of the programme is to assist the formation of the community organization without usurping this authority. In this way the committees have both the authority and the duty to act.

4. Self-help Labour Management
Many problems often associated with self-help labour can be avoided by adequate organization and management at the point of work. Efficient utilization of labour will ensure that technical standards are upheld

and that the project maintains momentum. If the self-help labour is left to carry out its tasks without this support, technical standards will fall and the project may come to a halt.

10.5 IMPLICATIONS FOR THE DECADE

The United Nations Water Conference in March 1977, reflecting the concern of the world community for the lack of water supply and sanitation facilities available to the urban and rural poor, adopted the target of clean water and sanitation for all by 1990. The decision to announce this target must be seen as a successful political and public relations exercise designed to attract international attention and to call for resources on a scale commensurate with the magnitude of the problem.

Now that this preliminary objective has been achieved, engineers and planners in developing countries and funding agencies are addressing themselves with renewed vigour to the solution of these problems. However, there is a danger that continued adherence to the Decade targets will force many national programmes to undertake more work than they have the ability to carry out satisfactorily. This may result in the proliferation of poorly constructed and badly maintained water and sanitation facilities, and in the disillusionment rather than the satisfaction of target communities.

It is significant to note that the Malawi programme has taken ten years to develop from the beginning of its pilot phase to its present stage. It is now in a reasonably strong position to serve the rural population of Malawi within the next fifteen years. This suggests that, while a few countries may indeed be able to achieve Decade targets, the Decade will have made its most effective contribution if by 1990 every country has developed strong national water and sanitation programmes, with realistic and proven development policies, operating within well organized institutional frameworks, with cadres of well trained and experienced staff and enjoying the confidence of the communities to be served. If this situation can be reached the programmes will be able to sustain adequate growth rates to serve the remainder of the population within the following decade.

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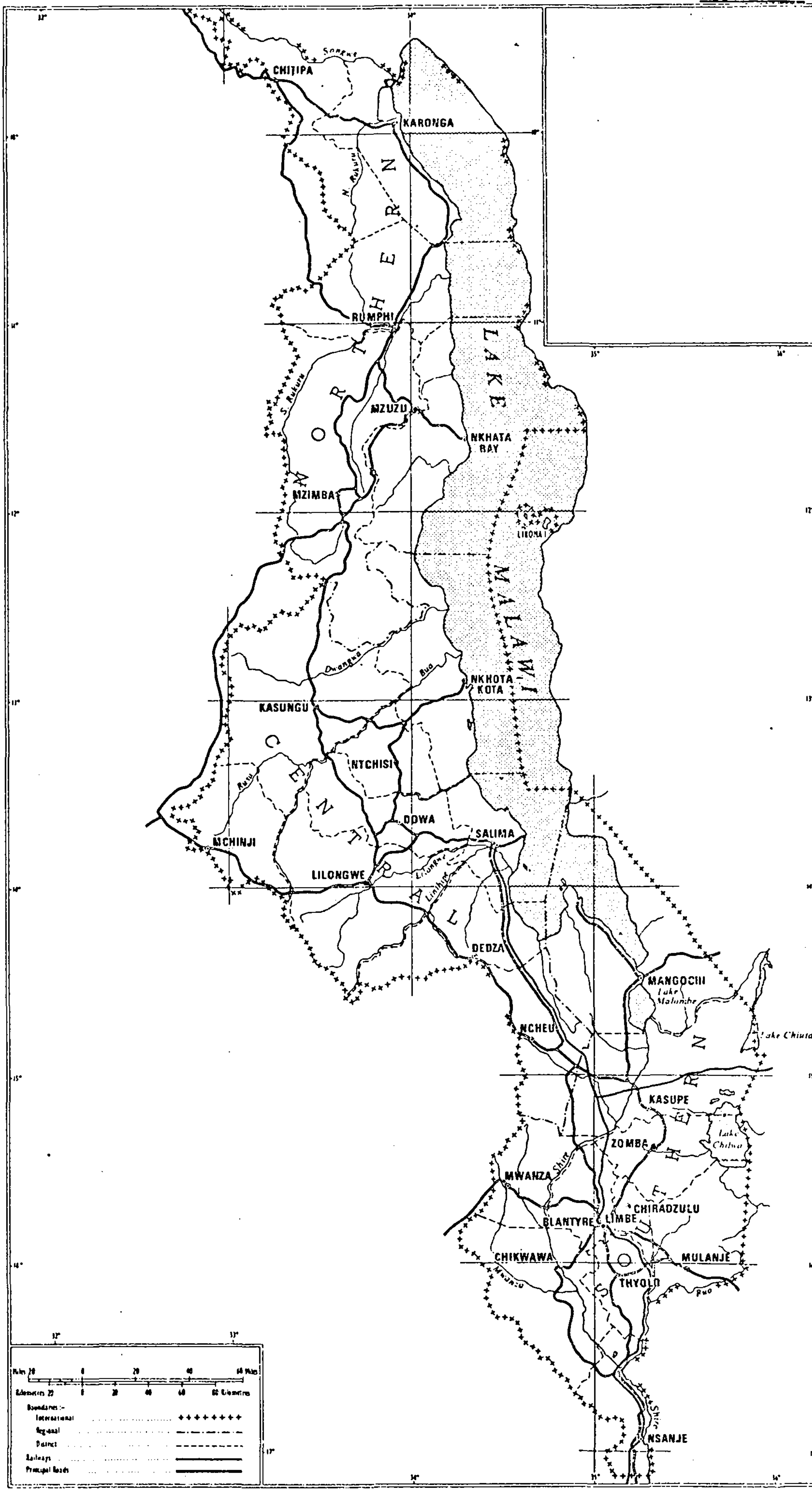
REPUBLIC OF MALAWI

Appendix 1



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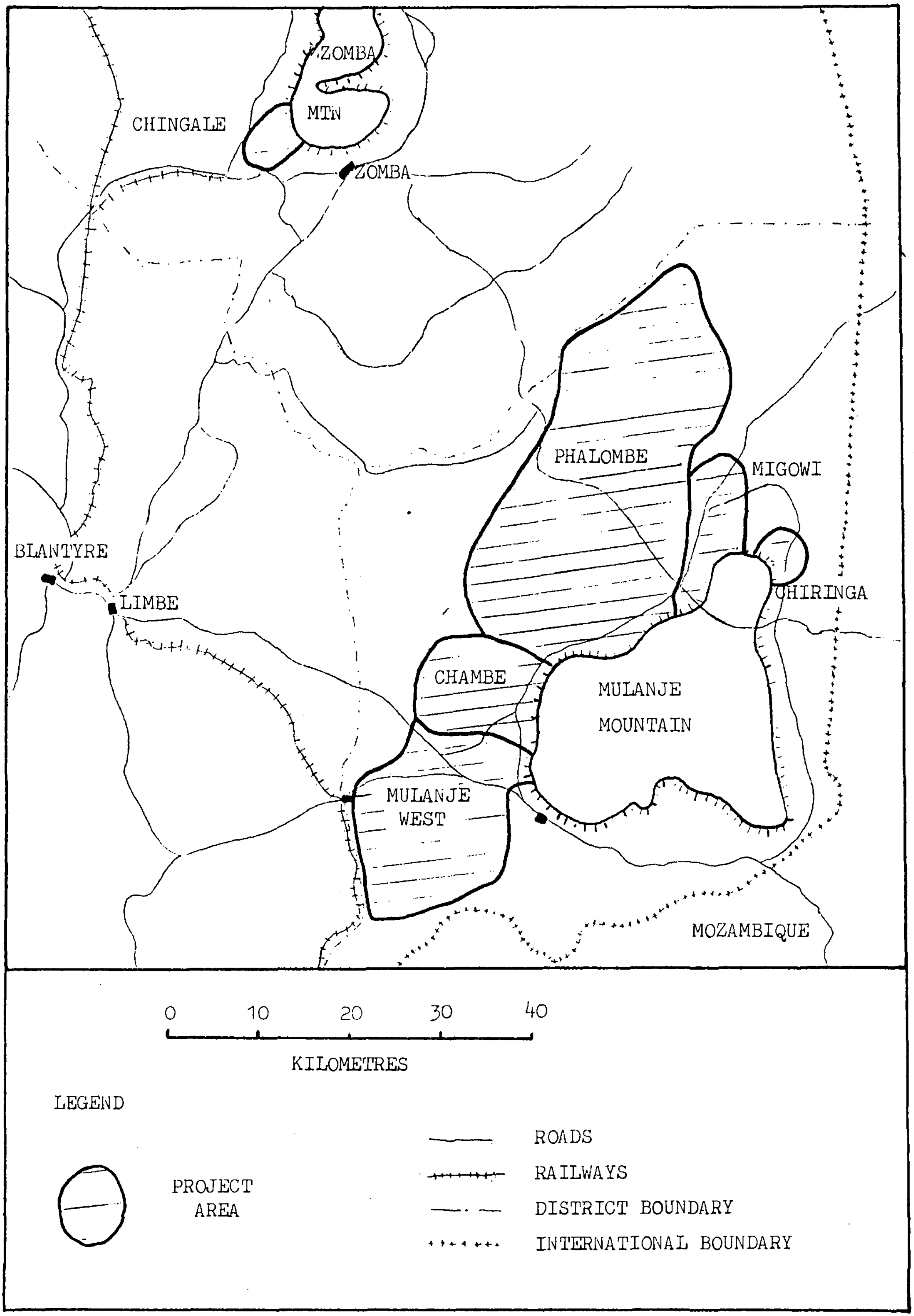
Drawn and Printed by the Department of Surveys, Blantyre, Malawi. 1973

MAP LOCATING CHINGALE AND EARLY PROJECTS IN MULANJE DISTRICT



SUMMARISED DESCRIPTION OF THE RURAL PIPED WATER PROGRAMME

1. Objectives

1. To supply domestic water to the rural population of Malawi
2. To encourage maximum benefit and use by active community participation

2. Executing Agency

The Water Projects Section within the Ministry of Community Development and Social Welfare (until 1980)

3. Methodology

1. The people are invited to participate in the construction of the supply by contributing their labour
2. In return, the Government provides the materials and technical supervision

4. Initiative for Projects

The Government selects the projects from:

1. Requests from communities, channelled through District Development Committees
2. Proposals from ministries engaged in rural development (principally Agriculture)
3. Proposals from planning activity within the Water Projects Section

5. Selection Guidelines

1. Projects are considered on an area basis to maximise the potential from available water resources (i.e. not on an individual village basis)
2. The programme is concentrated on focal points in the three regions of Malawi, and projects near these foci will in general be favoured for reasons of efficiency and to build up local confidence.
3. In a new area, a smaller scheme will be selected as a pilot project
4. Areas where the absence of domestic water is a constraint to settlement and agricultural development will be favourably considered
5. The Government generally favours those projects with a low per capita cost

6. The above guidelines are not mutually exclusive and the final selection will represent a mixture

7. In view of the immense potential for gravity systems in Malawi and their great advantages of costs and maintenance, the programme concentrates initially on those projects suitable for gravity supply

8. In view of the number of unpolluted upland surface water sources, the programme concentrates initially on those projects utilising these sources, replacing the need for treatment by the need for catchment protection

9. Proposals that do not conform to any of guidelines 1-5 may be favoured to counteract the excessively imbalanced geographical distribution that would otherwise result

6. Stages of Programme Development

Pilot Phase

1968-69	Chingale - a small pilot project serving 3000 people
1969-70	Chambe - a larger pilot project for 30000 people in a heavily populated area with high potential for gravity schemes. Mulanje District becomes the focus for the Southern Region
1971-72	Small pilot projects in Northern Region Pilot projects raise demand in neighbouring areas Lessons learnt and confidence gained in pilot phase results in: 1. Recruitment and training of 20 Project Assistants to supervise self-help labour 2. Selection of 2 major projects in Mulanje District in the areas either side of Chambe

Main Construction Phase

1972-74	Construction commences on the 2 major projects Development of techniques, procedures and standards, acquisition of experience at all levels
1974 -	New projects undertaken annually in all three Regions Further recruitment and in-service training of field staff as required for programme expansion

	Programme expansion steady, public demand increases rapidly
1978	In first ten years of programme over 300000 people served; 200000 more engaged in projects under construction Total programme staff 70 people

7. Level of Service

1. 27 litres per capita per day
2. 160 persons per public standpipe
3. No private connections
4. The water is free

8. Project Procedure

1. The Chief announces the project at a public meeting for all villages concerned. Project staff commit the Government to the supply of materials and technical supervision. In return the meeting must commit itself publicly to the project by agreeing to supply all the labour required

Committees are formed under the Chief's authority to organise the work programme. The task is explained by project staff

2. Project staff and village labour mark the proposed pipe-line
3. Local builder builds headworks (intakes, screens, tanks) under contract
4. The people dig the trenches under supervision of project staff
5. The people provide the labour for pipe-laying; joints made by project staff
6. The people backfill, mark and protect the line from erosion
7. Each village prepares its tap aprons, drains and soakaways under guidance of project staff
8. All work inspected prior to installation of tap
9. Public village meeting called by headman for installation of tap

Maintenance responsibilities explained

10. Maintenance procedures introduced
11. Project completion

9. Field Staff Organization

Major Projects (approx 30000 to 100000 population)[1]

1. Project Manager - a professional engineer. He will usually run more than one major project in his area. Provided with a pick-up vehicle

2. Supervisors - one or two as required, each supervising about 10-15 Project Assistants. Promoted from experienced Project Assistants. Provided with a motorcycle

3. Project Assistants - ten to twenty as required, some still under training. Grouped in small teams of two or three for main line digging and laying, then each allocated to a branch line. Own bicycles with monthly allowance

4. Training Posts for Technical Officers - one or two. Provided with motorcycles

5. Project Vehicles - one or two four-wheel-drive pick-ups, part share in a 7-ton lorry, drivers

6. Project Headquarters/Store with storeman

7. Construction Team - under contract to build tanks, supervised and all materials supplied by Project Manager

Minor Projects

1. Technical Officer (TO) - technical graduate with some training on a major project. He supervises a number of projects within his focal area. Provided with a motorcycle

2. Experienced Project Assistants - with at least two years' experience on a major project. One or two per 10000 project population[1]

3. Project Vehicles - one four-wheel-drive pick-up based at the centre for the area under the TO, and a share in a 7-ton lorry as required

10. Maintenance of Completed Projects

1. Overall responsibility for maintenance and running costs is retained by the programme

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1. These figures are given as a general indication of range and are not criteria.

2. Maintenance is minimal with gravity systems. Most pipe failures are rectified during testing. The major maintenance activities are:
(i) The cleaning of intake screens and sedimentation tanks (chiefly during the rains)
(ii) Keeping pipelines marked and free from erosion hazards
3. Village taps and tap sites are the direct responsibility of the village who must carry out and pay for their own repairs
4. Farmers with pipelines crossing their land are responsible for maintaining the marking ridge and preventing erosion. They also report any damage that they cannot rectify
5. So far, minor projects have been maintained by the self-help committee formed for construction. They have depended on technical and material support from the programme.
6. For major projects, a Project Assistant is left behind after project completion for maintenance duties. He receives an allowance for his bicycle and is able to request a programme vehicle for transport of stores when required. His duties are:
(i) To inspect all tanks, lines and tap sites as per maintenance schedule
(ii) To carry out preventive and repair work as identified during inspection or by reports from villagers
(iii) To carry out routine procedures such as checking air valves, flushing scour points, cleaning storage tanks etc.
In addition a watchman is employed at the headworks to clean the intake, screens and sedimentation tank. The Forestry Department patrols the catchment area to prevent encroachment
7. All labour required for maintenance and repair duties is supplied by self-help

11. State of the Programme at January 1979

1. Completed Projects
   22 completed projects serving 308300 people
   Mean completed project size 14000 people, range 700 to 90000
   Total length of piping laid 1541km, range 1.6 to 491m
   Total number of taps installed 2087, range 7 to 578
   Total financial construction cost K1.154 million, range K1000 to K500000[1]

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[1] [illegible] for inflation.

2. Projects under construction
   8 projects under construction to serve 310000 people
   Mean project size 38750 population, range 8000 to 100000
   Total financial construction cost (1979) K1.944 million
   Mean per capita cost K6.27, range K3.33 to K9.93

3. Planned Projects
   20 projects to serve 469500 people
   Estimated total financial construction cost K4.125 million

COMPLETED RURAL PIPED WATER PROJECTS IN MALAWI AT JANUARY 1979

	PROJECT	DISTRICT/REGION		DESIGN POPULATION	LENGTH OF PIPING(KM)	NUMBER OF TAPS	CONSTRUCTION PERIOD	COST OF CONSTRUCTION	FUNDING AGENCY
1.	CHINGALE	Zomba	S	5000	40	35	1968-9	K 6000	USAID
2.	CHAMBE	Mulanje	S	30000	97	180	1969-70	64000	OXFAM
3.	MIGOWI	Mulanje	S	6000	24	45	1969-71	12000	USAID
4.	CHILINGA	Mulanje	S	2000	10	14	1971-2	4000	CSC
5.	NG'ONGA	Rumphi	N	2000	18	20	1971-2	6000	CSC
6.	MUHUJU	Rumphi	N	1000	19	21	1972-3	7000	USAID
7.	CHINKWEZULE	Kasupe	S	700	2	7	1973-4	1000	CSC
8.	IGHEMBE	Karonga	N	4000	18	36	1973-4	7000	CSC
9.	MULANJE WEST	Mulanje	S	75000	238	460	1972-5	170000	UNICEF
10.	LUZI	Mzimba/Rumphi	N	8000	60	42	1974-5	24000	CSC/UNICEF
11.	CHINUNKHA	Chitipa	N	4000	26	51	1974-5	12000	"
12.	CHILUMBA	Karonga	N	4000	18	29	1974-5	8000	"
13.	CHILOBWE	Ntcheu	C	1200	6	12	1974-5	2000	"
14.	PHALOMBE	Mulanje	S	90000	491	578	1973-7	500000	DANIDA
15.	DEDZA	Dedza	C	1400	8	10	1975-6	5000	CSC/UNICEF
16.	MCHINJI	Mchinji	C	20000	137	116	1974-6	52000	"
17.	CHAGWA	Kasupe	S	7000	80	95	1975-6	15000	"
18.	KALITSIRO	Ntcheu	C	1000	6	9	1976-7	3000	"
19.	LIFANI	Zomba/Kasupe	S	20000	101	140	1975-7	72000	"
20.	HEWE	Rumphi	N	8000	42	42	1975-7	30000	"
21.	NKHAMANGA	Rumphi	N	12000	76	120	1976-8	134000	CSC
22.	LIZULU	Ntcheu	C	6000	24	25	1976-8	20000	CSC/UNICEF
		TOTALS		308300	1541	2087		K1154600	

CURRENT RURAL PIPED WATER PROJECTS IN MALAWI AT JANUARY 1979

	PROJECT	DISTRICT/REGION		DESIGN POPULATION	LENGTH OF PIPING (KM)	NUMBER OF TAPS	CONSTRUCTION PERIOD	COST OF CONSTRUCTION	FUNDING AGENCY
23.	NTONDA	Ntcheu	C	25000	121	140	1977-9	K 106000	CSC/UNICEF
24.	LINGAMASA	Mangochi	S	12000	43	48	1977-9	40000	"
25.	NAMITAMBO	Chiradzulu/ Mulanje	S	50000	257	350	1976-80	480000	DANIDA
26.	SOMBANI	Mulanje	S	40000	185	300	1977-80	240000	ICCO
27.	ZOMBA (DOMASI)	Zomba	S	100000	451	700	1977-80	520000	CEBEMO
28.	LUWAZI	Mzimba	N	8000	80	54	1978-9	79400	CIDA
29.	MULANJE SOUTH	Mulanje	S	45000	293	394	1979-81	150000	"
30.	KARONGA	Karonga	N	30000	196	250	1979-81	180000	"
			TOTALS	310000	1626	2236		K1944400	

NEW RURAL PIPED WATER PROJECTS COMMENCING 1979

	PROJECT	DISTRICT/REGION		DESIGN POPULATION	CONSTRUCTION PERIOD	ESTIMATED COST OF CONSTRUCTION	FUNDING AGENCY
31.	KAWINGA	Machinga	S	60000	1979-82	K 711300	DANIDA
32.	NTHALIRE	Chitipa	N	3000	1979-80	50000	CIDA
33.	DOMBOLE	Ntcheu	C	16000	1979-81	85000	"
34.	MWANZA VALLEY	Chikwawa	S	20000	1979-81	120000	"
35.	LIVULEZI	Ntcheu	C	10000	1979-81	75000	"
			TOTALS	109000		K 1041300	

JOB DESCRIPTIONS

1. Senior Water Engineer

1. The Senior Water Engineer is responsible to the Chief Community Development Officer[1] for the overall management of the programme.
2. He is based in Ministry Headquarters.
3. He is responsible for the long term planning of the orderly development of water resources to supply rural communities, in co-operation with other government agencies involved in the sector.
4. He conducts an annual feasibility survey of all project requests received in the year, and submits recommendations of suitable projects to be included in the programme.
5. He liaises closely with Development Division and the Ministry of Finance in negotiations with aid donors.
6. He liaises with civil servants at the appropriate level of related Ministries.
7. He is responsible for the overall manpower, recruitment and training policy, to ensure adequate staff are available for the execution and expansion of the programme.
8. He is responsible for procurement of all supplies,[2] including quotations, orders, shipping instructions and payment.
9. He is responsible for the overall transport programme.
10. He is responsible for the detailed design, material and staff requirements for all projects.[3]
11. He monitors the progress of all projects, making regular visits and maintaining a close relationship with field staff.

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1. With the formation of the new ministry for the water sector (1980), the Senior Water Engineer will be designated Chief Water Engineer, responsible to the Chief Water Controller. Some of the duties listed will be taken over by a new post of Senior Projects Engineer.
2. The procurement of locally available supplies is delegated to field officers.
3. Design is delegated as much as possible to Project Managers and Technical Officers.

12. He is responsible for the establishment and execution of an adequate maintenance policy for completed supplies.
13. He is responsible for the establishment and review of design criteria.
14. He ensures that Technical Officers receive appropriate training in design and fieldwork.
15. He is responsible for all expenditure and accounts.[1]
16. He conducts the development and adaptation of appropriate water supply technologies to expand the scope of the programme.[2]

2. Project Manager[3]

1. The Project Manager is responsible to the Senior Water Engineer for the overall management of the project.
2. He carries out the detailed design and draws up the material and staff requirements for the whole project.
3. He makes a schedule of project work for each year.
4. He surveys and sites the intake, all tanks, river crossings and the alignment of all main pipelines.
5. He is responsible for the ordering, procurement and distribution of all local supplies within the funds allocated, and for the receipt and distribution of all specially imported supplies.
6. He is responsible, through the Supervisors and Project Assistants, for the motivation, organization and supervision of self-help labour.
7. He is responsible for overall supervision of field staff, ensuring efficient staff utilization, maintenance of technical standards, in-service training and staff morale.
8. He conducts regular staff meetings to monitor progress and problems.
9. He supervises the work of the building contractor.
10. He has control of all project vehicles and their maintenance.

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1. In liaison with the accounts office of the Ministry.
2. For example, SWE has developed a handpump for the Shallow Wells Programme.
3. This job description is similar for Technical Officers in charge of smaller projects

11. He is responsible for the final inspection of the project, to ensure the desired standard has been attained and to resolve any problems before project completion date.
12. He sets up the maintenance organization and ensures that it is functioning correctly before project completion.
13. He submits simple quarterly progress reports.
14. He liaises with the District Officers of all Ministries or Departments working in the project area.

3. Supervisor[1]

1. The Supervisor is responsible to the Project Manager.[2]
2. He liaises closely with all committees and community leaders to explain the work to be done and to assist committees with the organization of the self-help work programme.
3. He is responsible for the day-to-day supervision of Project Assistants, monitoring their work programmes and progress reports.
4. He pays particular attention to the support and advice for trainees.
5. He is responsible for the day-to-day utilization of project vehicles.
6. He is responsible that the project stores system is maintained efficiently and that all stores drawn are utilized correctly. He is assisted in this by a storeman.
7. He is responsible for the efficient distribution and use of project tools.
8. He is particularly responsible that all jobs listed on the Village Tap Check Sheet are completed before a tap is issued.

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1. Under the new organization (1980) these may be called Water Foremen to bring them into line with other staff in the water sector. They will continue to have specialist skills and experience in community organization.
2. There may be one or two Supervisors in a major project.

4. Project Assistant[1]

1. He is responsible for a branch line or a section of a main line on a major project, either alone or as part of a small team of two or three.

2. He is responsible for the day-to-day supervision and efficient utilization of self-help labour in close liaison with village headmen, committees and leaders, and ensuring the labour achieves the standards required.

3. He is responsible for marking the route of pipelines from aerial photographs.

4. He is responsible for the operations of digging, laying, backfilling, protecting, and marking his pipelines.

5. He is responsible for the technical operations involved in joining Asbestos Cement, PVC and steel pipes and fittings, and the construction and installation of village standpipes and aprons.

6. He is responsible for the procurement of all pipes and fittings from the project stores in accordance with information interpreted from his aerial photograph.

7. He submits a fortnightly work programme and a weekly report to his Supervisor.

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1. Under the new organization (1980) these will be called Pipelayers to bring them into line with other staff in the water sector. There will be three grades of Pipelayer according to experience and proficiency.

Zomba East (Domasi) Rural Piped Water Project

1977/78 DEVELOPMENT ESTIMATES PROJECT SUBMISSION

PROJECT TITLE : ZOMBA EAST (DOMASI) RURAL PIPED WATER PROJECT

RESPONSIBLE MINISTRY/DEPARTMENT : COMMUNITY DEVELOPMENT AND SOCIAL WELFARE

MALAWI DEVELOPMENT ESTIMATES 1976/77 : HEAD 086 ITEM 024

RELATED PROJECTS : MULANJE WEST RURAL WATER PROJECT, PHALOMBE RURAL PIPED WATER PROJECT

1. FINANCIAL SUMMARY

(a) Funds Requested

Category		1977/78	Kwacha 1978/79	1979/80	Total 3 Years
(03)	Water Supplies	207,300	214,600	2,600	424,500
(06)	Plant & Vehicles	22,700	-	-	22,700
(08)	Personal Emoluments	12,240	12,910	13,460	38,610
(09)	Running Expenses	8,000	8,000	8,000	24,000
(10)	Special Expenditure	5,000	2,000	2,000	9,000
	TOTAL	255,240	237,510	26,060	518,810

(b) Previous Expenditure: Nil

(c) Source of Finance

The Christian Service Committee of the Churches in Malaŵi.

2. PROJECT TARGET

The project will supply by gravity system clean mountain water to 100,000 people in villages at 620 water points covering an area of 400 square kilometres on the dry but fertile plain to the east of Zomba Mountain.

Expected Completion Date:

March, 1980.

3. BACKGROUND INFORMATION

This project is situated in Zomba District between Zomba Mountain and Lake Chilwa in the area of Chiefs Kuntumanji, Mwambo and Chikowi. The land is fertile and densely populated, but domestic water is a problem.

The people near the mountain get water streams, which dry up during the dry season and at other times are polluted. The people further out on the plain have to carry water many miles from the dry river beds in which they dig. The few boreholes in the area give only saline water.

Zomba Mountain which rises 2,000 metres from the plain has a good perenial supply in the main rivers which flow to the North East. This project will tap water from the Domasi Valley and carry it in pipes to the South East in a Main Asbestos Cement Pipe Line to nine reticulation system serving 100,000 people from 620 water points.

The Malaŵi Government and the people of Mulanje District have already installed two water projects of this type. The Mulanje West Project which serves 75,000 people and the Phalombe Project which serves 80,000 people. These projects have proved highly successful.

A feature of these projects is the large self-help element. All the work of digging the trenches and burying the pipes is done by the people themselves. For this work to be organised, local committees are formed. The work helps to develop the leadership and engenders a spirit of self-help and achievement. When the project is finished, the people will have a good clean safe supply to water in every village. It is free because there will be no running costs.

Having organised themselves to install the water scheme the people are encouraged to achieve an increased standard of living, improved health and nutrition and increased production from the area.

4. SUCCESS SO FAR ACHIEVED

The people and leaders of this area have seen other successful projects near by and are eager to have a project of their own.

5. PROPOSED WORK

It is intended to construct the intake; lay the main pipe; construct the storage tanks and provide the necessary reticulation systems.

1977/78	Construct Intake Works Construct 3 x 50,000 gallon tanks Construct 2 x 15,000 gallon tanks Lay Main Line Pipe A - D Lay Reticulation Systems 1 - 3
1978/79	Construct: 1 x 50,000 gallon tank 2 x 20,000 gallon tanks 2 x 15,000 " " 2 x 8,000 " " Lay main line pipe D - H Lay Reticulation System 4 - 7
1979/80	Lay Reticulation Systems 8 and 9 And complete all tap sites.

Funds will be required only for the cost of pipes, tanks, fittings and transport, since the local people will carry out all the labour of digging trenches and laying of pipes as they have done in previous similar projects. Technical control and supervision will be provided by the staff of the Ministry of Community Development and Social Welfare.

6. JUSTIFICATION FOR PROPOSED WORK

(i) This project will provide clean domestic water to 100,000 people, who depend on unhealthy and unreliable supplies for which in the dry season of the year they sometimes have to walk as far as five miles.

(ii) Experience with previous projects has shown that the necessity for local communities to organise themselves to carry out the work of laying pipes engenders a spirit of self-help which can be used for further development.

7. EXECUTION AND SUPERVISION

The project will be executed by the Ministry of Community Development and Social Welfare.

The people of the area will contribute free labour for digging trenches and laying pipes. Maintenance will also be carried out by the local people organised by their local committees as is being done successfully in other similar schemes.

1977/78 DEVELOPMENT ESTIMATES
APPENDIX TO PROJECT SUBMISSION

PROJECT TITLE : ZOMBA EAST (DOMASI) RURAL PIPED WATER PROJECT

RESPONSIBLE MINISTRY/DEPARTMENT : COMMUNITY DEVELOPMENT AND SOCIAL WELFARE

MALAWI DEVELOPMENT ESTIMATES : 1977/78
: 1978/79
: 1979/80

1. PROJECT OFFICER : The Community Development Officer Water Projects

2. FINANCIAL DETAILS:

(a) Details of Expenditure	Notes	1977/78	Kwacha 1978/79	1979/80	Total 3 Years
(03) Water Supplies					
Main Pipe Line	(1)	49,200	75,000	-	124,200
Reticulation	(2)	132,000	125,000	-	257,000
Tanks & Fittings	(3)	26,100	14,600	2,600	43,300
		207,300	214,600	2,600	424,500
(06) Plant & Vehicles					
1-5 Ton lorry		10,000	-	-	10,000
2 LWB Pick-Up Land Rover		8,000	-	-	8,000
3 Motor Cycles		2,400	-	-	2,400
1 Cement Mixer		1,500	-	-	1,500
1 Vibrator		800	-	-	800
		22,700	-	-	22,700
(08) Personal Emoluments					
1 P.O.		2,000	2,150	2,200	6,410
1 T.O.		1,200	1,270	1,310	3,780
2 STA		2,080	2,170	2,260	6,510
15 Dev. Assistants		4,770	5,130	5,440	15,340
1 Driver Grade I		850	850	850	2,550
2 Drivers Grade III		830	830	830	2,490
2 Carpenter/Handyman		350	350	350	1,050
2 Caretakers		160	160	160	480
		12,240	12,910	13,460	38,610

	Kwacha 1977/78	1978/79	1979/80	Total 3 Years
(09) Running Expenses				
1 Lorry	2,400	2,400	2,400	7,200
2 Landrovers	4,000	4,000	4,000	12,000
3 Motor-Cycles	700	700	700	2,100
Transport and Travelling	600	600	600	1,800
Telephone Expenses	300	300	300	900
	8,000	8,000	8,000	24,000
(10) Special Expend.				
Tools & Materials	800	800	800	2,400
Contingencies	4,200	2,000	2,000	6,600
	5,000	2,000	2,000	9,000

(b) Notes on Expenditure

(1) Asbestos Cement Pipes Class 18

Size	Price per Metre Kwacha	Quantity Metres	Cost Kwacha	Quantity Metres	Cost Kwacha
150mm	4.20	9,000	37,800	9,000	37,800
125mm	3.26	3,500	11,400	4,200	13,700
100mm	2.13	-	-	11,000	23,500
			K49,200		K75,000

These prices are calculated according to prices quoted by Lusalite in 1975 to which has been added 10% for railage and 10% for further price increase.

(2) P.V.C. Pipes

Pipe requirements and cost

PVC piping for drinking water at 10 kp/cm^2 supplied in 6 metre lengths. 90 mm, 75 mm., 63 mm. to have rubber joints.

Size	Price per Metre	Quantity Metres	Cost Kwacha
90	1.97	10,300	20,300
75	1.37	38,500	52,800
63	.97	40,400	39,100
50	.795	41,800	33,300
40	.608	54,800	33,100
32	.437	63,700	27,800
25	.348	59,400	20,600
20	.289	96,300	27,900
16	.210	10,000	2,100
			K257,000

These prices are calculated from quotations of REHAU dated October 1974 to which has been added 40% for freight and fittings.

Note These prices could be supplied as one order or split as shown in the financial estimates.

(3) Tanks and Fittings:

	Kwacha		
	1977/78	1978/79	1979/80
Intake	4,500	-	-
50,000 gallon tanks	12,000 (3)	4,000 (1)	-
20,000 gallon tanks	-	4,200 (2)	-
15,000 gallon tanks	3,200 (2)	1,600 (1)	-
8,000 gallon tanks	-	2,400 (2)	-
Tap Units at K12, each	2,400(200)	2,400(200)	2,620(220)
Valves and Fittings	4,000	-	-
	K26,100	K16,600	K2,620

3. LOCATION OF CONSTRUCTION

The project is located in the areas of Chiefs Kuntumanji, Mwambo and Chikowi in Zomba East.

Appendix 7

LIST OF CONTENTS OF FIELD HANDBOOK FOR PROJECT ASSISTANTS

FORMS

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1. Letter form for the use of Committee Secretaries calling Village Headmen for work.
2. Letter concerning maintenance read out and distributed to leaders at the tap installation ceremony.

TIMETABLE FOR PROGRAMME SELECTION COURSE AT KAMBENJE 1979

ARRIVAL ON SATURDAY PRECEDING THE BEGINNING OF COURSE FOR PREPARATION OF CAMP SITE

WEEK 1	6.00-9,00	9.30-12.00	13.00-15.00	EVENING	WEEK 2	6.00-9.00	9.30-12.00	13.00-15.00	EVENING
MONDAY	TRENCH DIGGING AC	PROCEDURE FOR AC PIPES	READING MAPS AND MARKING	FILM	MONDAY	PROTECTION OF PIPELINES	PROCEDURE FOR PVC	ORGANIZATION AND COMMITTEES	ROLE GAMES
TUESDAY	TRENCH DIGGING AC	LAYING AC PIPES	AERIAL PHOTOGRAPHS ORGANIZATION		TUESDAY	PREPARING TAP SITES	FORMING PVC HEADS	GULLY CROSSINGS AND CHECKDAMS	
WEDNESDAY	TRENCH DIGGING AC	LAYING AC PIPES	CAST IRON FITTINGS	ROLE GAMES	WEDNESDAY	PREPARING TAP SITES	STEEL PIPES	TANKS	
THURSDAY	TRENCH DIGGING PVC	VISIT TO PHALOMBE AND SOMBANI PROJECTS	VISIT	ROLE GAMES	THURSDAY	PREPARING TAP SITES	VISIT TO MULANJE WEST AND NAMITAMBO PROJECTS	VISIT	
FRIDAY	TRENCH	LAYING AC PIPES	CAST IRON FITTINGS		FRIDAY	TESTS	TESTS	TESTS	
SATURDAY	REMOVAL OF OBSTACLES	STORES	FOOTBALL		SATURDAY	DEPARTURE			

Appendix 8

DESIGN PROCEDURE FOR GRAVITY PIPED WATER SYSTEMS

1. Basic Design Criteria

1. Consumption 27 litres per capita per day
2. Flow per tap 0.75 litres per second (originally 1 gallon per minute) assuming all taps in use at the same time
3. 160 persons per tap
4. Night storage period 8 hours, day service period 16 hours.

2. Materials Required for Design

Aerial Photographs
Survey Maps
Census Maps
Census Tables
Graph Paper
Dividers
Coloured Chinagraph Pencils
Coloured Felt Tip Pens

3. List of villages and populations

This is drawn up using the census maps and tables.

4. Design Population

1. Present Population: This is calculated from the most recent census data applying a 2.6% increase per year.
2. Potential Population: This will partly depend on the population that can be supported by the traditional agriculture of the area. The productivity of the soil is assessed in conunction with the Ministry of Agriculture. The potential population will vary from about 100 to 300 persons per sq. km. It should be remembered that provision of domestic water will encourage settlement in uncultivated areas, thus increasing the population.

3. Project Design Population: By interpreting the existing and potential populations, a project design population figure is chosen. This will determine the total quantity of water required from the source.
4. Design Populations of Villages: The ratio of the design population to the project's present population will give a factor. The present population of each village is multiplied by this factor to give the design population of each village.

5. Marking the Aerial Photographs

Using the census maps and design population figures, the villages and populations are marked on the aerial photographs in blue chinagraph.

6. Tap Locations

Provisional tap locations are marked on the aerial photographs in red chinagraph. This is a technique that improves with practice and it is useful to study photographs of previous projects. Some important points are:
1. When plotting tap locations reasonably definable areas of, say, 5 to 10 villages are considered at a time and the number of taps plotted according to the total design population of those villages. Villages are not considered individually at this stage.
2. The initial allocation of taps is 1 per 180 persons. This means that approximately 10 per cent of the total number of taps possible are reserved to allow for omissions that may subsequently come to light. The final allocation is 1 tap per 160 persons, averaged over the whole project area.
3. Taps are plotted at population centres for large communities and at mid-points between smaller communities. In sparsely populated areas of potential development, growth points are identified, e.g. at the intersection of paths. As long as the tap is near at least one or two houses, the rest of that village will help to dig the trench.
4. In general, taps are kept away from the banks of rivers and streams.
5. Every school and health centre is allocated a public tap.

6. The final siting of the tap on the ground is left in the hands of the communities themselves, but intelligent siting at the design stage will minimise the changes necessary later.

7. Transferring Tap Locations onto Map

The tap locations are now transferred accurately from the photographs to the map.

8. Alignment of Pipelines

The taps are now joined up on the map by a network of pipes, involving sub-branches, branches and main lines, like the trunk and branches of a tree. The basic principles are:
1. To maintain a steady gradient
2. To site the main lines and branch mains on a ridge to reduce soil erosion hazards
3. To keep the length of piping to a minimum by following the shortest route (unless this conflicts with 1 and 2 above).
The network is extended right back to the header tank. Several possible alignments are drawn to obtain the best. At this stage the alignment is drawn in pencil on the map.

9. Selection of Storage Tank Sites

This is done in conjunction with the alignment of pipelines. Tank sites are selected according to the following principles:
1. A tank must be sited at such an elevation as to give an adequate gradient to the area it serves.
2. As a tank marks the beginning and end of a pressure stage it must be situated so that the pipelines operate within the maximum working pressure of the class of piping used.
3. Tanks divide the supply into manageable areas, both for installation and operation. A large project may have a number of large area storage tanks, and ideally every branch line should have its own storage tank.

10. Storage Factor

The rate of inflow to a storage tank should be two-thirds of the outflow.
1. Under design conditions, the outflow from a tank occurs for 16 hours per day, so the continuous inflow rate need be only two-thirds of the service time outflow requirement.
2. For tanks in series, the storage factor is only applied for those taps served directly from the tank, not to taps served through a subsequent tank for which the storage factor has already been applied.
3. The storage factor is never applied to a sedimentation tank which must be full all the time.

11. Flows Required

Once the tap locations, pipe alignments and the tank sites have been plotted on the map, each section of pipeline is marked with the flow required in that section:
1. Starting from the end tap on every branch, the flow in each section of pipe (i.e. between two connections) is marked on the map on the basis of 0.075 l/s per tap.
2. At each tank the storage factor is applied where appropriate as described above.

12. Design of Main Line to Area or Branch Storage Tanks

1. The lowest point of the main line is determined. This may be a tank at the end of the line if gradient is steady, or it may be at a river crossing anywhere along the line. The lowest point is determined (approximately) by checking the contours of the map.
2. A suitable header tank elevation is determined by:
   (i) The need for an adequate overall gradient from header tank to the storage tanks
   (ii) The need for the maximum static pressure at the lowest point to be within the limit of the class of pipe chosen.
3. A ground profile is plotted on graph paper of the main line from header tank downwards. This can be done from the map at this stage,

prior to a full survey. The crossing of each contour should be plotted although some interpolation is possible using spot heights and streams.

4. A horizontal static head line is drawn from the elevation of the header tank.

5. The desired hydraulic gradient is lightly drawn in pencil. This is always above the ground profile and will either be a straight line from end to end, or a series of straight lines changing at high points in the ground profile.

6. Knowing the flow required in the first section of main line (from 11 above) the pipe size is calculated that will give the required flow for a head loss nearest to the desired hydraulic gradient. The actual head loss in that section is then plotte.

7. This is repeated for every section of the main line, plotting successive head losses, keeping the hydraulic gradient as close as possible to the desired hydraulic gradient.

8. If the main line splits the flows are kept in the right proportion by adjusting the elevations of the tanks at the end of each arm relative to each other. The hydraulic gradient of the two arms is kept approximately the same as that of the main line.

9. It may be found that the maximum static pressure at the lowest point in the project is above the maximum working pressure of the class of pipe chosen. In this case three courses are open:

(i) If the maximum static pressure is not greater than 110 per cent of the maximum working pressure of the pipe, the excess is acceptable (pipes are always tested to double their maximum working pressure).

(ii) If it is greater than 110 per cent, the next class of pipe should be used for the high pressure section. However, for AC pipes this causes complications with fittings and is only considered if the high pressure section is a small proportion of the main line, say less than 25 per cent. If it is longer than this, the whole main line of that particular size should be of the next class of pipe.

(iii) An alternative is to keep the end of the main line open the whole time (i.e. flowing into a tank) so that it can never reach static pressure, and the maximum pressure is then the normal running pressure. This means there must be no sluice valves in the line.

10. Maximum pipe weight for man-handling is 120kg. The design must not call for a pipe size which is impossible to handle by self-help manpower. This should normally be considered a limiting factor on the size of a project.

13. Design of Branch Lines from Storage Tanks

1. A ground profile of the branch line is plotted from the storage tank, showing every pipeline and every tap. This is done from the map and drawn on graph paper.
2. The flow is written against each section of pipe between two connections.
3. The pipe size is calculated for each section of the branch main, and the head loss plotted. Ideally the hydraulic gradient is kept roughly 10m above ground level, to allow for contour errors on the map and to ensure every tap has a positive pressure. Calculations are made using nomograms or water flow slide rule calculator.
4. The pipe sizes are calculated for all minor branches down to each tap. The normal size for a single tap connection is 20mm (except high pressure taps - see 9 below).
5. The hydraulic gradient for every section of pipe is plotted in pencil on the profile so that the design running pressure at any point is known. This is important for solving flow problems that may be experienced after laying.
6. When every pipe size has been calculated, the pipe lines are coloured in on the profile using the colour code.
7. Normal PVC pressure class used is class 10 (maximum working pressure 100m head). For large pipe sizes, 110mm and over, class 6 is sometimes chosen for reasons of economy.
8. If pressures over 100m are involved, a break-pressure tank is installed.
9. All taps on a branch main of size 50mm and larger, and all taps at which there is a plotted pressure of over 10m are marked on the profile with a red chinagraph circle. Sizes 16mm and 12mm are usually used to connect these high pressure taps to ensure they do not take excessive flow.

14. Storage Tank Capacities

Under design conditions, the night storage period is 8 hours. The size of the tank must therefore be sufficient to store all the water supplied at the design flow rate in a period of 8 hours. The next highest standard size is chosen. Standard tank sizes at present used are 14, 27, 46, 68, 91, 137 and 228m^3.[1]

15. Plotting Design onto Map and Aerial Photographs

1. Once the design of pipe sizes has been completed, the pipelines in pencil on the map can now be overdrawn using the colour code for different pipe sizes.
2. The pipe sizes are marked in red figures alongside every section of pipe on the aerial photographs.
3. Tanks, with sizes and elevations, are also marked on the map and photographs.
4. High pressure taps are transferred from the profile on to the map and photographs.

16. Siting of Air Valves

1. Single and double air valves are designed to release air that is trapped in the water in the form of tiny bubbles, which accumulate at high points and can cause an airlock. Double air valves have the additional property of allowing air to exhaust rapidly from the line during filling, or preventing the build up of a vacuum after a burst.
2. The profile of the main line plotted after survey shows the approximate position of high spots. On a large main (size 100mm and above) double air valves are situated approximately every 3km at high spots and changes in gradient. Single air valves are fitted at other high spots. Approximate positions are marked on the profile, map and photographs, the exact position being fixed later by surveying each spot in detail.

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1. Equivalent to 3, 6, 10, 15, 20, 30 and 50 thousand gallons.

17. Siting of Flush Points

1. The purpose of a flush point is to empty the main and to clean out any sediment that may collect at the low points. It consists of a tee-piece with 80mm branch controlled by a sluice valve.
2. The main line profile shows the position of low spots, usually at stream crossings or swamps. A flush point is fitted about every 3km and at every significant low spot.

18. Siting of Sluice Valves and Gate Valves

Sluice valves are used for sizes 80mm and above, gate valves for sizes 100mm and below. Valves are sited as follows:
1. At the inlet and outlet of every tank, except at the outlet of the main header tank (to prevent surge pressures caused by sudden closing or opening the valve. The main line can be closed by emptying the tank).
2. In main lines at every branch and every change of pipe size.
3. In branch lines:
   (i) At the beginning of every branch where the major line is 40mm or larger
   (ii) At every reduction of pipe size involving 40mm or larger
   (iii) Below 40mm at every size reduction or every mile, whichever is the less.

Valves are marked on maps and photographs with the appropriate symbol.

19. Design of Pipelines at Headworks

1. Having decided on sites for intake and screening tank, the pipe alignment from intake through the screening tank to the sedimentation tank is selected, surveyed and plotted on the profile.
2. The inflow to the sedimentation tank is designed to equal the outflow, plus about 10 per cent to ensure a continuous overflow.
3. Knowing the flows and the head available, the pipe sizes can be calculated.

20. Calculation of Material Requirements

Once the design is completed and plotted on both map and aerial photographs a list is drawn up of pipes, fittings and construction materials. This is used for estimating costs and ordering materials.

1. AC Pipes: The lengths are measured from the map and 3 per cent is added for errors and breakages.
2. Cast Iron Fittings for AC Pipe: A schedule of fittings is made out showing the figures derived from "actual count" plus an allowance for spares. The most common spares needed are short collar joints and a few extra saddle pieces. One or two extra hydrant tee pieces are included for unforeseen air valves or flush points.
3. Major Flow Control Fittings: Sluice valves, air valves (double and single), and equilibrium float valves are counted and an allowance made for spares.
4. PVC Pipes: The lengths required of each pipe size are added accurately from the map design. 3 per cent is added for sizes 40mm and larger, 5 per cent for 32mm, 10 per cent for 25mm, 20per cent for 20mm and 10 per cent for 16mm.
5. PVC Pipe Connection Fittings: The fittings required on each line are counted and a sensible allowance is added for spares.
6. Gate Valves, Float Valves, Taps: These are counted from the plan and a sensible allowance added for spares.
7. Steel Pipes: Intake pipe requirements are calculated in detail and estimates are made from the map design of the sizes and quantities needed for river, stream and gully crossings.
8. Construction Materials: At this stage a list is made of the number and sizes of tanks and all other works (intake, river crossings) and the number of tap sites.

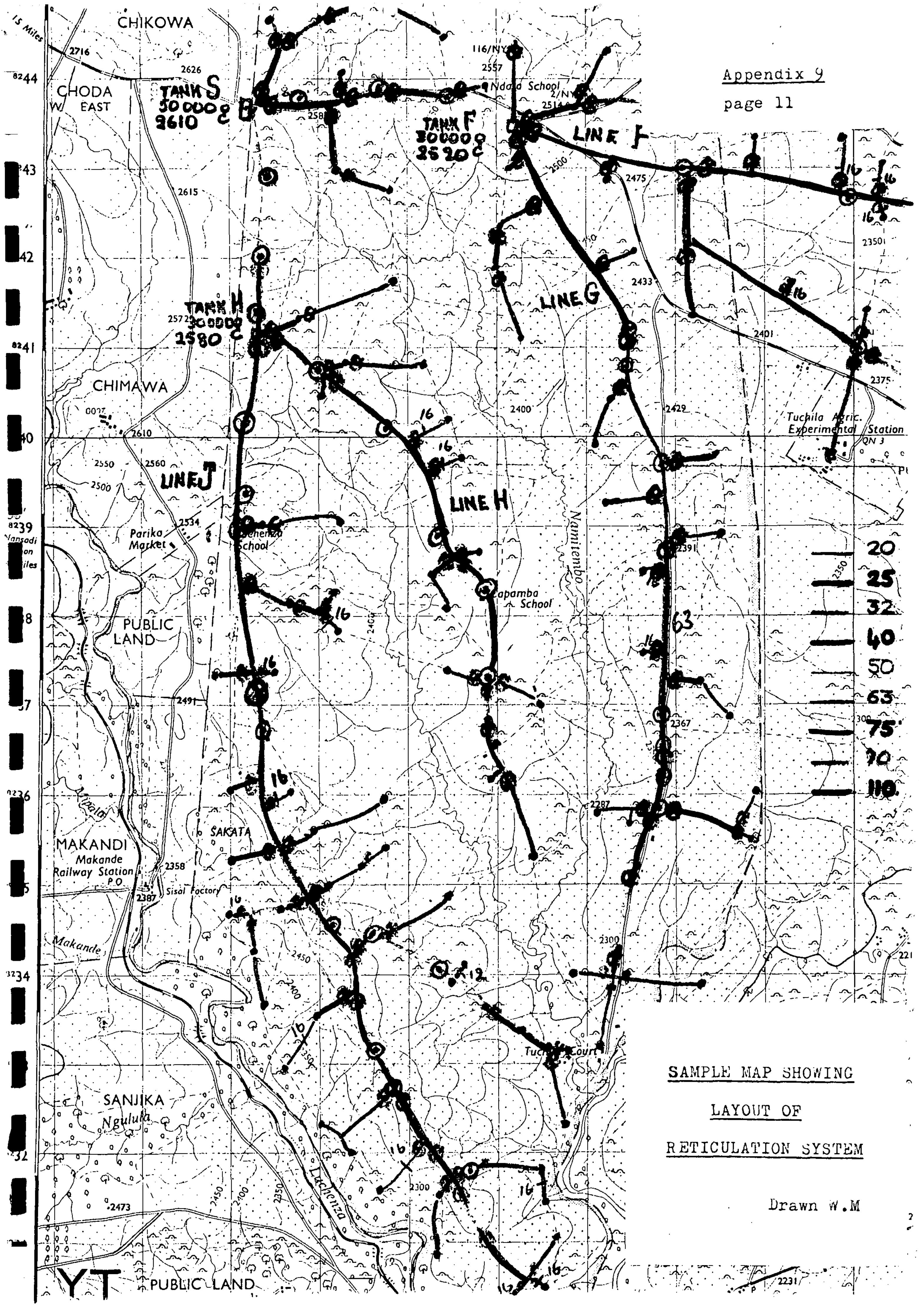
21. Presentation of Completed Design

The completed design consists of:

1. A sheet showing:
   - (i) Actual population
   - (ii) Design population

(iii) Number of villages
(iv) Total land area
(v) Estimated arable land
(vi) Total design daily consumption
(vii) Per capita daily consumption
(viii) Number of taps
(ix) Ratio of persons per tap
(x) Total storage capacity

2. A list of material requirements.
3. A diagram, not necessarily to scale, of the layout of main lines to area and branch storage tanks, showing pipe sizes, length, flow and head loss in each section and the size and elevation of tanks.
4. Profile of main lines.
5. Profiles of branch lines.
6. Map showing design.
7. Aerial photographs showing design.
8. List of villages and populations.
9. All sheets used for calculations (useful if design changes have to be made).

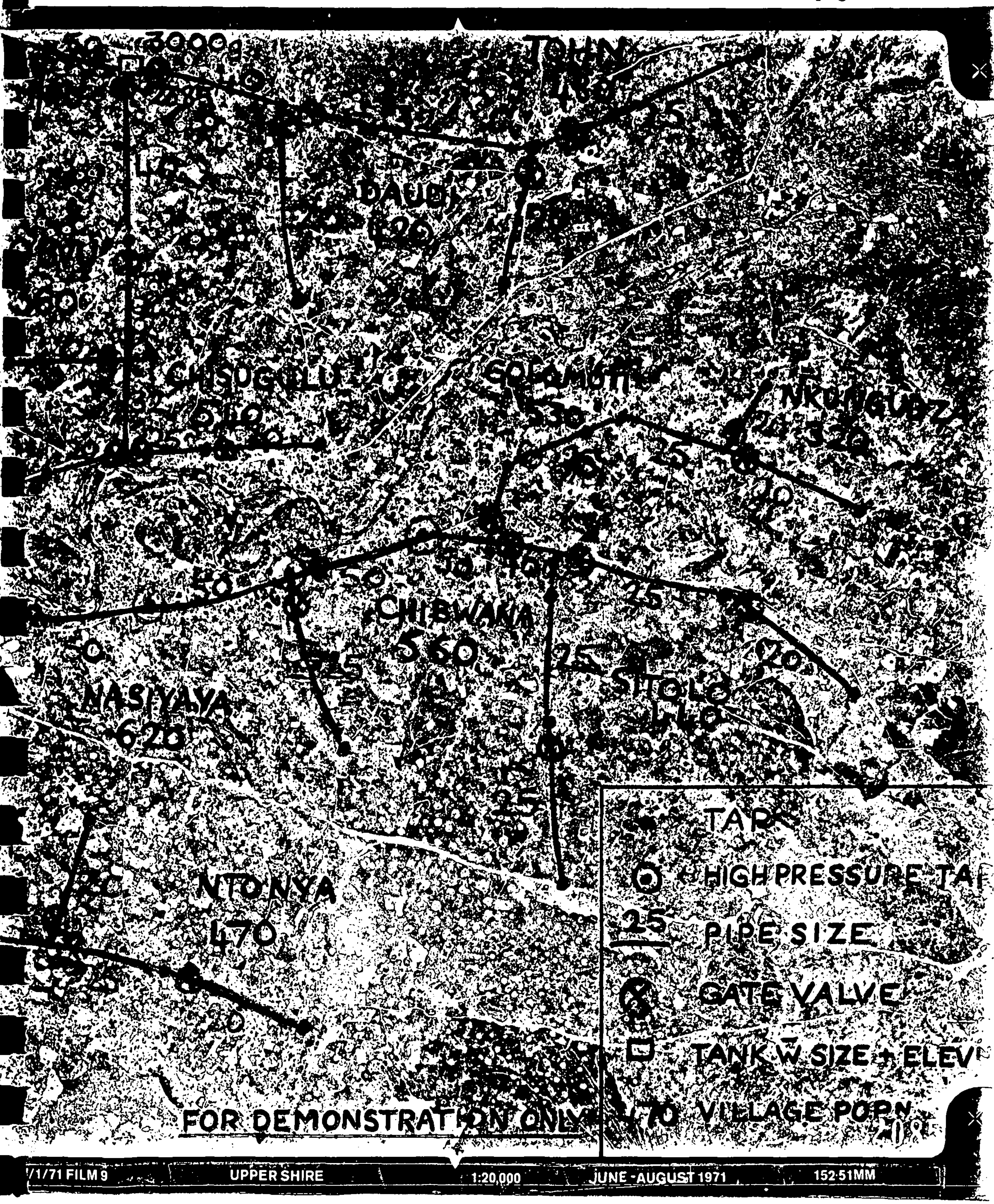


SAMPLE MAP SHOWING

LAYOUT OF

RETICULATION SYSTEM

Drawn W.M



SAMPLE AERIAL PHOTOGRAPH SHOWING LAYOUT OF RETICULATION SYSTEM