JAMHUURIYADDA DIMOQRAADIGA SOMAALIYA
WASAARADDA BEERAHA
SOMALI DEMOCRATIC REPUBLIC
MINISTRY OF AGRICULTURE

DARA SALAAM BUSLEY AGRICULTURAL DEVELOPMENT PROJECT

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October 1988

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ACKNOWLEDGEMENTS

Sir M. MacDonald & Partners Limited wish to thank the many officials of government departments and agencies, and outside aid agencies, for their help and assistance in the collection of data and information needed in the preparation of this report.

The villagers in the project area and in the surrounding area were most helpful and our thanks to them is also recorded.

We would like to say that the preparation of this report would not have been possible without the special help of the Ministry of Agriculture and its staff. The Vice-Minister and Director of Land and Water Resources gave valuable assistance and guidance to the team at all times.

Our thanks are also due to the staff of the EEC Delegation in Mogadishu who gave much of their time and knowledge to help in the formulation of the final project.

ABBREVIATIONS FREQUENTLY USED IN THE REPORTS

AFMET	Agriculture, Farm Management Extension and Training Project
API	Aerial photographic interpretation
CARS	Central Agricultural Research Station - Afgoi
CIF	Carriage, insurance and freight
CSB	Commercial and Savings Bank
DLF	Development Loan Fund
EAA	Euro Action Acord
EC	Electrical conductivity
ECU	European Currency Unit
EDF	European Development Fund
ENB	National Banana Board or Ente Banane
FAO	Food and Agriculture Organization, United Nations
FOB	Free on board
HASA	Hides and Skins Agency
HTS	Hunting Technical Services Limited
GOS	Government of Somalia
GTZ	German Technical Aid
id	Internal diameter
IRAS	Inter-Riverine Agricultural Study
IRR	Internal rate of return
JSP	Juba Sugar Project
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association (of the IBRD)
ILCA	International Livestock Centre for Africa
IMF	International Monetary Fund
ITCS	Inter-Tropical Convergence Zone
MLFR	Ministry of Livestock, Forestry and Range
MMP	Sir M. MacDonald & Partners
MOA	Ministry of Agriculture
NCA	Net cultivated area
NFMAS	National Farm Machinery and Agricultural Service
NTTCP	National Tsetse and Trypanosomiasis Control Project
ODA	Overseas Development Administration, British Government
ONAT	Former name of NFMAS
SACA	Societa Azionari Concessionari Agricoli de Genale
SAR	Sodium adsorption ratio
SC	Specific capacity
SDB	Somali Development Bank
SoSh	Somali Shilling
SY	Specific yield
TOR	Terms of Reference
UNCDF	United Nations Capital Development Fund
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture

SPELLING OF PLACE NAMES

Throughout the report Somali spellings have been used for place names with the exception of Mogadishu where the English spelling has been used. Below is a selected list of the adopted spellings.

Afgoi
Aw Dheegle
Balcad
Baraawe
Beled Weyn
Busley-Dawd
Buulo Burti
Buulo Mareerta
Dara Salaam
Duduble
Falkeerow
Gayweerow
Golweyn
Jowhar
Kismaayo
Mahaddaay Weyn
Marka
Mogadishu
Mubaarak
Sablaalle
Shalambood
Qoryooley

GLOSSARY OF SOMALI TERMS

Cambuulo	-	Traditional dish of chopped boiled maize with cowpeas or green grams
Chiko	-	Chewing tobacco
Der	-	Rainy season from October to December
Dharab	-	Five jibals or approximately 0.31 ha
Gu	-	Rainy season in April and May
Hafir	-	Large reservoir on farms for storing water for use in dry periods
Haagai	-	Climatic season June to September characterised by light scattered showers
Jibal	-	Area of land approximately 25 m by 25 m or 0.0625 ha
Jilaal	-	Dry season from January to April
Kawawa	-	Two-man implement for forming irrigation borders
Quintal		Unit of weight measurement equivalent to 100 kg
Uar	-	A stock watering pond
Yambo	-	Small short-handled hoe
Zareebas	-	Thorn stock pen

ANNEX 6

ENGINEERING

ANNEX 6 - ENGINEERING

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CHAPTER 1

EXISTING IRRIGATION SYSTEM

1.1 Background

Irrigated agriculture within the project relies mainly on supplementary flood irrigation during the gu-haagai and der seasons. Flows in the Shabeelle are divided into two distinct seasons which correspond to the two rainy seasons in the upper catchment area in the Ethiopian highlands. Between these seasons base flows are low. Gravity irrigation is only possible during the high flood flows, though the period of irrigation can be extended by pumping. During the jilaal, river flows usually cease altogether so that surface water is mainly only available from residual pools fed by sub-surface flows in the river bed or from releases from the Jowhar storage, used for drinking water supplies. The division between rainfed and irrigated agriculture is blurred since crops depend on both rainfall and flood flows. Farmers often experience water shortages.

The irrigation system has developed over at least the last 150 years. Flood irrigation started either as self-help schemes such as those in Mubaraak (from 1828) or as commercial enterprises such as those found near Tugaarrey which date back to around 1850. Originally canals were short and the area under flood irrigation limited. The irrigated area was expanded by the Italian settlers; it is still being expanded and canals lengthened though the scope for future development is limited. The dates of establishment of each canal surveyed are recorded in Table 1.3.

1.2 The Irrigated Area

A land use map (Annex 1, Drawing Nr 1a) has been prepared from an uncontrolled mosaic of the March 1983 aerial photography. The date of the photography is towards the end of the dry season and so the boundaries of different cultivation patterns are indistinct. The total irrigated area is estimated to be 9 465 ha gross. The net irrigable area is 8 500 ha or approximately 90% of the gross area. This is subdivided into 4 450 ha cultivated land and 3 760 ha fallow. This fallow includes both seasonal fallow and land not recently cultivated. A large proportion of the fallow is either affected by a land dispute or has now been developed under large private farms. The breakdown of the different areas is given in Table 1.1.

1.3 The Canal System

The project is bounded by Malable to the north-east and the boundary of land commanded by the Gure canal to the south-west corresponding to river chainages 39.4 km and 8.4 km upstream of Janaale barrage. Within this stretch, using the 1 : 30 000 aerial photography taken in 1983/4, 56 flood or inundation canals were initially identified offtaking directly from the river. When the topographic survey was carried out on the ground in February 1988 three of these canals were no longer identified on the ground. These were canals Nr 28 (Aw Nuur), 37 and 38 with an aggregate length of 1.1 km or about 1% of the total length of canals in the area. All the canals are unlined and run roughly at right angles to the river. The canals vary in length between 0.1 km and 7.5 km, have bed widths of 1 m to 2 m and bed slopes in the range 10 to 60 cm/km. The canals are listed in Table 1.2 and shown in Figure 1.1. Only eight of the canals

TABLE 1.1

Land Use and Project Areas in March 1983

Land use	Irrigation development area	Rainfed development area	Swamp development zone	Total
1. Cultivated	4 450	425	-	4 875
- banana	100	-	-	100
- grapefruit	15	-	-	15
- seasonal crops	4 335	425	-	4 755
2. Fallow	3 760	3 950	-	7 705
3. Grassland	-	-	1 785	1 785
4. Uncultivated	845	1 260	-	2 105
5. Dense bush	60	235	605	900
6. Uncultivable	295	1 955	-	2 250
7. Permanent swamp	-	-	1 310	1 310
8. Villages	55	55	-	110
9. Main road	-	155	-	155
Total Project Area	9 465	8 030	3 700	21 190
Danida/UNSO/Fuelwood Plantation Project	-	5 430	-	5 430
Total Area				26 620

Figure 1.1

Project Flood Canals

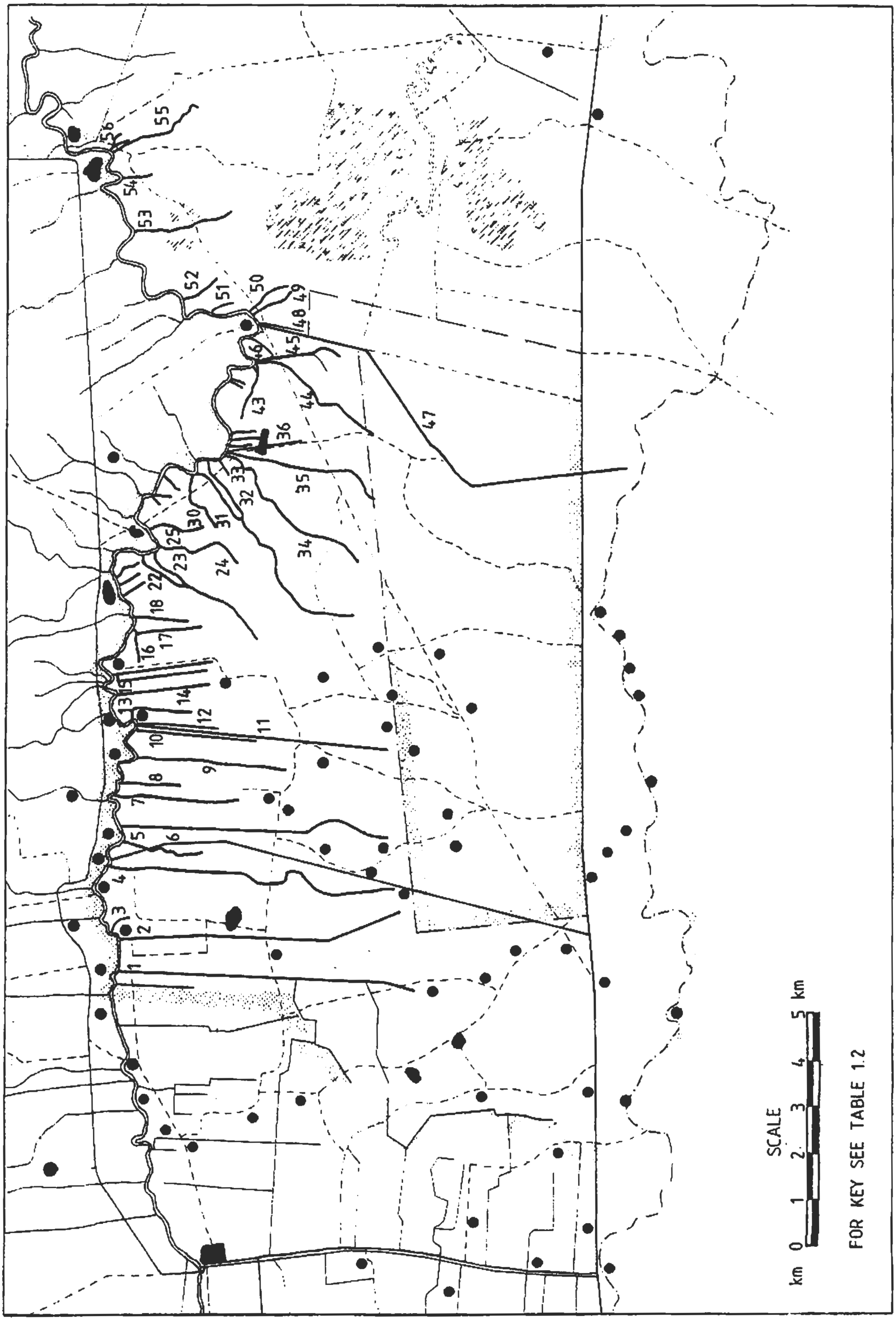


TABLE 1.2

Project Canals

Number	Canal name	Chainage[2] (km)	Length[3] (km) (5)	(6)	Area commanded[3]	Headworks	Pumping Capacity
1	Gure	8.6	6.3	6.3	970	Rehabilitation required	Mobile pump
2	Minow	9.3	6.7	6.7	735	Rehabilitation required	Mobile pump
3	Itolo	-	-	0.6	100	No information	None
4	Gududu	11.5	6.9	7.2	855	Rehabilitation required	Pumping station
5	Matawani	12.2	1.8	0.45	20	Rehabilitation required	None
6	Baroieri/Bundo Cadde	12.6	6.2	6.2	490	New structure	None
7	Xassan Youssef[1]	13.7	2.5	2.6	135	No structure	None
8	Abliko-Khalif[1]	13.8	1.4	1.4	45	No structure	None
9	Eboien	15.0	2.3	2.3	200	Structure only - no gate	None
10	Deeq	15.8	3.2	2.6	60	No structure	Pumping station
11	Dhere	15.8	6.1	6.1	565	No structure	None
12	Suuu	15.8	2.0	2.0	165	No structure	Mobile pump
13	Cuhaad	16.1	4.0	4.0	250	No structure	None
14	Domaay	17.2	2.4	2.4	75	No structure	None
15	Suliman	17.7	2.6	(2.5& 1.1)	110	No structure	Pumping station None
16	Saddick	19.0	-	0.8	50	No structure	Pumping station
17	-	19.1	0.8	0.8	70	Pumped intake only	None
18	Garilan[1]	19.7	1.4	1.4	80	No structure	None
19	Dhequere[1]	20.6	0.4	0.4	40	No structure	None
20	Sheik Dhere[1]	20.9	0.4	0.4	10	No structure	None
21	Aw Gaboow[1]	21.0	0.2	0.4	10	No structure	None
22	Dhurey	22.2	1.2	1.2	500	No structure	None
23	Ungunji	22.3	3.8	3.8	-	No strucure	None
24	Barwaaqo	22.6	2.4	2.4	69	No structure	None
25	Baiemoaley	23.0	0.9	0.9	60	No structure	None
26	Abdulle Bube[1]	24.0	0.2	0.2	10	No structure	None
27	Mohammed Ekow[1]	24.2	0.2	0.2	10	No structure	None
28	Aw Nuur[1][4]	24.3	(0.2)	-	..	No structure	None
29	Caaysiney[1]	24.5	0.7	0.3	10	No structure	None
30	Aw Madae	25.5	1.7	1.7	35	No structure	None
31	Aw Barre	25.6	1.5	1.5	435	No structure	Mobile pump
32	Xanole	26.1	3.4	3.4	-	Rehabilitation required	Mobile pump
33	Muuno	26.3	0.4	0.4	15	No structure	Mobile pump
34	Dhuufe	26.5	4.3	4.3	400	No structure	Mobile pump
35	Dhere	26.5	1.4	1.4	335	No structure	Mobile pump
36	Hahre	26.6	1.7	1.7	80	No structure	Mobile pump
37	-[4]	-	(0.1)	-	-	No structure	Mobile pump
38	-[4]	-	(0.8)	-	-	No structure	Mobile pump
39	Baar	26.9	0.6	0.8	20	No structure	Mobile pump
40	Gaabo Yerro	27.1	1.6	1.6	50	No structure	Mobile pump
41	-	28.5	0.5	0.2	10	No structure	None
42	-	28.6	0.2	0.45	10	Rehabilitation required	None
43	Salhan	29.5	1.1	1.1	95	Rehabilitation required	Pumping station
44	Gaaoo	29.5	3.6	3.6	150	No structure	None
45	Bolay (new offtake)	29.5	2.8	2.8	230	No structure	None
46	Bolay (old offtake)	30.7	(0.8)	(0.8)	Disused	No structure	None
47	Caafimaad	30.7	(9.5)	(9.5)	Outside project		Pumping station
48	Abdi Nasin	30.8	2.6	1.6	30	Structure to be constructed	None
49	Camoon	31.1	1.8	1.8	35	No structure	Pumping station
50	Raxoole	31.3	1.0	1.0	40	No structure	None
51	Duuf	-	0.6	0.55	67	No structure	None
52	Modkadeyo[1]	33.2	0.8	1.05	85	No structure	None
53	Jilaal Moogi	35.9	2.7	2.7	150	No structure	None
54	Xasan Nuur[1]	37.7	0.3	0.3	10	No structure	Mobile pump
55	Siad Berry[1]	38.2	0.7	0.7	275	New headworks	None
56	Tugaarrey	38.4	0.5	0.5	10	No structure	Mobile pump
Totals excluding ( )			102.9	102.6			

Notes:
(1) The name of the canal is uncertain
(2) The chainage is measured upstream of Janaale barrage.
(3) The length and area commanded by each canal has been estimated from the 1 : 30 000 aerial photography.
(4) Canals no longer operative and now not identifiable on ground.
(5) Measured on 1983/4 aerial photography.
(6) From ground survey 1988.

TABLE 1.3

Analysis of Land Holding by Canal

Number	Canal name	When built	Recognised(2) ownership	Distribution(2) management	User farm(3) pattern	Type and number of farms(4) AZ	L	TL	T	M	S	Known villages using canal(5)
1	Gure	1973	Government	Government	Mixed	-	-	-	-	26	70	Busley, Cambanani, Siliqsale
2	Minnow	1930s		Separated	Mixed	2	3	30		7	-	Busley, Bardiid, Sagaaroole, Ceel Warregow
3	-	na	na	na	na			na				na
4	Gududu	1930	Communal	Co-operative	Mixed	-	11	-		21	200	Busley, Sagaaroole, Dune villages
5	Matawani	1930s	Private	Private	Large	-		-	na	-	-	na
6	Barbieri/Bundo Cadde	1969	Communal	Co-operative	Mixed	-	2			22	200	Khaliif, Sagaaroole, Barrow, Siidow, Taras Weyn
7	Xassan Yusuf	na	Private	Private	Large	-		na	na	-	-	na
8	Abiiko-Khaliif	na	Communal	Co-operative	Smallholder	-	-	-	-	-	-	Abiiko, Khaliif, Sagaaroole
9	Eboleh	na	Private	Private	Large	-				-	-	na
10	Deeq	na	Private	Private	Large	-				-	-	na
11	Dhere	1850	Disputed	Separated	Abandoned	New canal adopted (13)						-
12	-	na	Private	Private	Medium	-	-	-	-	1	-	-
13	Gulmad	1850	Communal	Co-operative	Smallholder	-	-	-	-	-	600	Tugaarrey, Siidow, Yerrow, Mude, Dune villages
14	Oomaay	na	Military	Government	Large	-			-	-	-	Tugaarrey
15	Suliman	na	Military	Government	Large	-		-	-	-	-	-
16	-	na	Military	Government	Large	-			-	-	-	-
17	-	na	Military	Government	Large	-			-	-	-	Sediiq
18	Garilam(1)	na	na	na	na			na				na
19	Dheqere(1)	1800s	Communal	Co-operative	Mixed			na				Mubaarak
20	Sheik Dhere(1)	1800s	Communal	Co-operative	Mixed			na				Mubaarak
21	Aw Gaboow(1)	1800s	Communal	Co-operative	Mixed			na				Mubaarak
22	Dhurey	1828	Communal	Co-operative	Mixed	-	-	-	-	20	660	Mubaarak, Dara Salaam, Siidow, Yarrow
23	Unounji	1828	Communal	Co-operative	Mixed							Garas Weyn, Dune villages
24	Barawwin	1955	Communal	Co-operative	Smallholder	-	1	-	-	-	60	Dara Salaam, Mubaarak
25	Balamboley	1955	Communal	Co-operative	Smallholder	-	-	-	-	-	20	Dara Salaam
26	Abdulle Bure(1)	1955	Private	Private	Medium	-	-	-	-	9	-	Dara Salaam
27	Moxamed Ekow(1)	1955	Private	Private	Medium							Dara Salaam
28	Aw Nuur(1)	1955	Private	Private	Medium							Dara Salaam
29	Caaysiney(1)	1955	Private	Private	Medium							Dara Salaam
30	Aw Hadae	1955	Communal	Co-operative	Mixed	-	-	-	-	3	40	Dara Salaam
31	Aw Barre	1955	Private	Private	Medium	-	-	-	-	3	-	Dara Salaam
32	Xanole	1955	Communal	Co-operative	Smallholder	-	-	-	-	3	200	Dara Salaam, Mude, Dune villages
33	Maano	na	Private	Private	na			na				na
34	Dhuufe	1955	Communal	Co-operative	Mixed	-	20	-	-	50	100	Aybuuteey, Mude, Dune villages
35	Dhere	1955	Communal	Co-operative	Mixed	-	-	-	-	6	74	Aybuuteey, Dune villages
36	Hohre	na	na	na	na			na				Aybuuteey
37	-	na	na	na	na			na				Aybuuteey
38	-	na	na	na	na			na				Aybuuteey
39	Barr	na	na	na	na			na				Aybuuteey
40	Gaabo Yerro	na	na	na	na			na				Aybuuteey
41	-	na	na	na	na			na				Aybuuteey
42	-	na	na	na	na			na				Aybuuteey
43	Salhan	na	Private	Private	Large	-	1		-	-	-	Aybuuteey, Salhan
44	Ganho	1960	Communal	Co-operative	Mixed	-	-	-	-	50	150	Aybuuteey, Mude, Jawhar, Salhan
45	Bolay (New)	na	Private	Private	Large	-	2	30	-	-	-	Jaane Adhere
46	Bolay (Old)	na	Abandoned	-	-							-
47	Caafimaad	na	Government	Government	-							-
48	Abdi Nasin	1907	Private	Private	Large	-	1	-	-	-	-	na
49	Camoon	na	Private	Private	Large	-	1	-	-	-	-	Jawhar
50	Raxonle	na	Communal	Co-operative	Medium	-	-	-	-	10	-	Jawhar, Aw Dheegle
51	Duuf(1)	1850	Communal	Co-operative	Mixed	-	2	-	-	4	25	Jawhar, Aw Dheegle
52	Madkadeyo(1)	na	na	na	na			na				na
53	Jilaal Moori	1983	Government	-	-			na				-
54	Xassan Nuur(1)	1800s	na	na	na			na				Aw Dheegle
55	Siad Derry(1)	na	na	na	na			na				na
56	Tugaarrey	na	Communal	Co-operative	Smallholder	-	-	-	-	-	100	Aw Dheegle

Notes:
(1) Name of canal is unclear.
(2) While under nationalisation all land is owned by Government, traditional rights of tenure are still recognised. In practice the canal users regard the main off-take and canal structures as being owned or the responsibility of the following categories:

- (a) Ministry of Agriculture or other government institution, e.g. military farms;
- (b) Privately owned when built or controlled by an individual farmer;
- (c) Communally owned when operated by a canal committee on behalf of many villagers;
- (d) Top section of the canal and off-take appropriated by large farmers or Azende owners.

(3) Indicates the pattern of farm sizes supplied from the canal, i.e. individual private farms, mixed farms of small, medium and/or large farms and those dominated by smallholders.

(4)
- Az = Azenda, i.e. present banana plantations
- L = Large farms (100 ha)
- TL = Azenda or large farm employing full-time local labourers and providing their families with tenant holdings on the main farm
- T = Large farms with land rented out to tenant farmers from outside villages
- M = Medium farms (10 ha to 100 ha)
- S = Smallholders (10 ha)

(5) Villages having families using land commanded by the canal. The list may be incomplete.

All information has been obtained in interviews with farmers and canal committees and should not be taken as definitive or accurate in all cases. Canals Nr 28, 37 and 38 not identified on the ground February 1988.

have any form of head regulator or gated structure at the river offtake. The larger 'main' canals feed a system of distributary canals at 100 to 200 m intervals on either side. The smaller main canals supply water to the farmers directly. Downstream of the river offtake there are no water control structures except on one or two of the larger farms that use a concrete pipe as a canal turnout into the secondary canals. Fields are usually irrigated by breaching canal banks.

As there are no topographic maps of the project area, it is difficult to assess whether the canal system is aligned in an optimum direction for irrigation. Canals appear to have been developed on an ad hoc basis, especially the more recent extensions. This was confirmed in discussions with farmers, and during the topographic survey of the canals.

1.4 Pumping Capacity

The majority of the large private farms have the facility to augment gravity irrigation by pumping, thereby increasing the reliability of the irrigation supply. The river pumping stations are of similar design, comprising a diesel engine driven 350 mm diameter low head centrifugal pump. The pumps are manufactured by VEB Pumpenwerke, East Germany and were supplied in the mid-seventies. They are mostly well maintained. The pumps have a nominal capacity of 200 l/s against an 18.5 m head increasing to 340 l/s against a 12 m head. They are housed on a simple concrete slab with, at some locations, corrugated iron roofing. There are no proper intake structures and the suction pipework is poorly supported. There is also a problem with silting of the non-return valve at the end of the suction pipe. Due to the arrangement of the delivery pipe the static head is unnecessarily increased by 2 m to 3 m. This could easily be avoided by extending the delivery pipe to ground level to achieve siphonic discharge. The delivery pipe discharges into a masonry outlet box. In most cases the floor is badly eroded. There is no facility for water measurement and due to a further drop in level between the outlet box and downstream bed there is often erosion of the downstream channel.

In addition to the pumping stations, some canals have mobile pumps stationed at the river. Formerly, the Italian farmers used locally manufactured submersible, centrifugal pumps which were belt driven by a tractor. The pumps have twin parallel discharge pipes and for a 7 m head have a discharge of 280 l/s with 250 mm diameter pipes and 210 l/s with 200 mm diameter pipes. Though still available, these pumps are no longer manufactured at Shalambood but due to their simplicity are easily repaired. A number of more modern Italian pumps are also available, typically 100 to 200 mm diameter.

1.5 Groundwater Development

There are a few tubewells in the project area used for irrigating perennial crops during low river flows. The majority are located on large farms fed by the Gure, Minnow and Gududu canals. During the Consultants field visit further wells were being drilled in this area.

The wells are drilled, using the rotary method with a bentonite drilling fluid, to a depth of 60 to 70 m and lined with 250 mm inside diameter casing. It is not known what type of well screens are used or whether a gravel pack has been installed. The wells are equipped with deep well turbine pumps driven by a surface diesel engine and are capable of delivering 30 to 40 l/s.

1.6 Method of Irrigation

Irrigation within the project area is predominantly seasonal for maize and sesame, though other crops are grown. Perennial irrigation is confined to the larger farms which can afford pumping, either surface or groundwater.

Three types of irrigation methods are practised within the project area:

(i) Large Rectangular Basins

Large basins varying in size between 1 and 6 ha are formed by bulldozers pushing up earth banks of 0.5 to 1.0 m high. The basins are filled with water to a depth of 0.3 to 0.45 m at the start of the der flood. After the water has infiltrated the traditional sesame crop is planted and relies on residual moisture in the soil, and the der rains. Water melons and tomatoes are also grown using this system.

(ii) Small Rectangular Basins

This is the most common method of irrigation within the project area. Bunds are constructed around small plots, roughly one jibal in area (25 m x 25 m) or smaller depending on the topography. The bunds are about 150 mm high and retain irrigation or rainwater within the plot. The low soil intake rate allows a good water application efficiency and the problem of the lack of land levelling is overcome partly by decreasing the size of the basin.

(iii) Furrows

Furrow irrigation is used for the first few months after the planting of bananas. This is later adapted to a form of basin irrigation with water passing down the old furrow from one basin to the next.

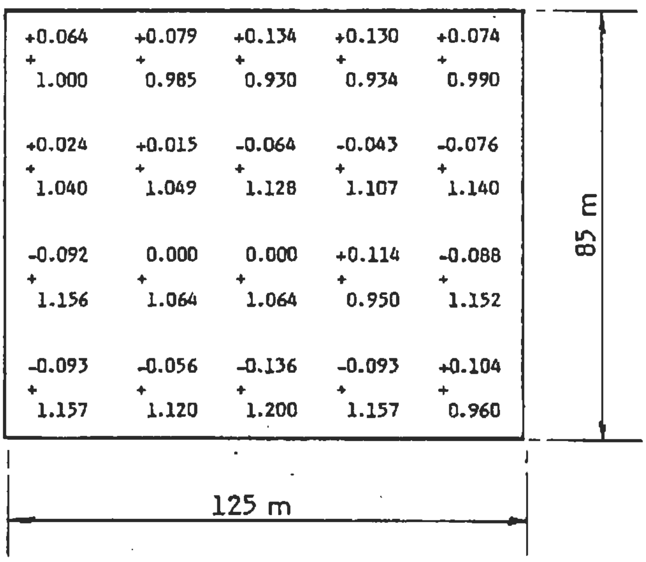
1.7 Land Levelling

To allow the efficient distribution of irrigation water over the field, accurate land forming or land levelling is required. Minor irregularities influence moisture infiltration patterns and reduce the effectiveness of fertilisers applied. Water will inevitably collect in low lying areas resulting in water-logging, poor aeration and inhibited root development. Conversely high spots will be inadequately wetted causing water stress. To ensure dry areas are kept moist farmers tend to over-irrigate and/or irrigate too frequently. This results in wastage of water, poor yields and greater risk of drainage and salinity problems.

Two sample areas were surveyed within the project. The first area was typical of smallholder cultivation, the land being divided into 25 m x 25 m jibals and rough land levelling achieved through years of cultivation. The second area of approximately 1 ha was bounded by large bunds to form a basin for flood irrigation. Rough land levelling had been achieved using a bulldozer. The survey showed the two areas required 106 m^3/ha and 236 m^3/ha further land levelling (see Figure 1.2).

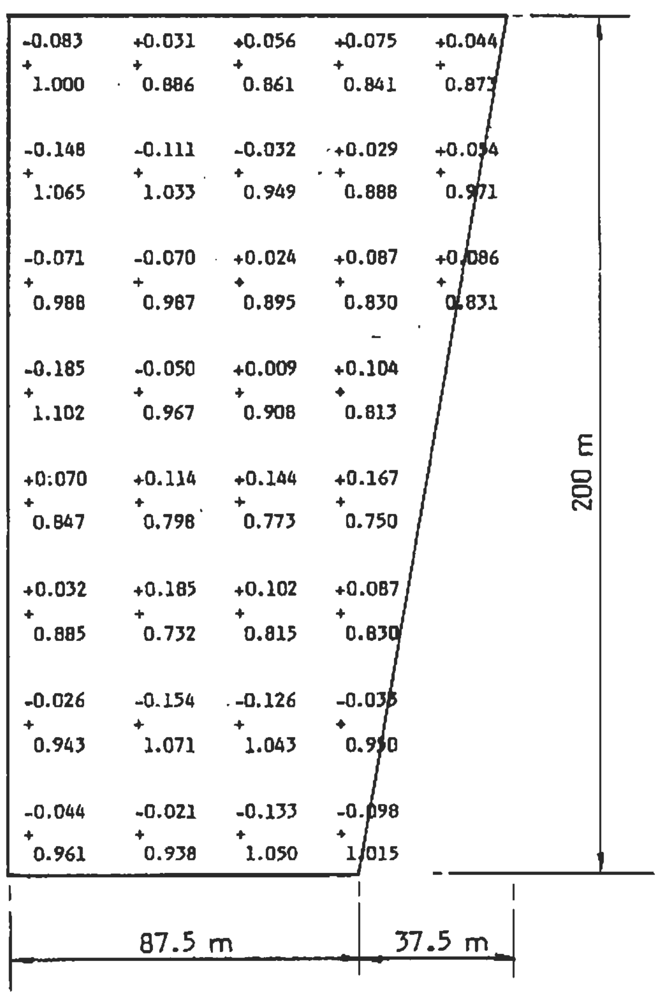
Figure 1.2

Sample Grid Surveys for Landlevelling



FIELD 1 (1.06 ha)

Σ A/4 $C^2/(C+f) = 106\ m^3/ha$



FIELD 2 (2.13 ha)

Σ A/4 $C^2/(C+f) = 236\ m^3/ha$

A = plan area of grid square

C = sum of cut depths at each grid corner

f = sum of fill depths at each grid corner

± 0.167 (cut/fill)

\+ grid point

0.750 (level)

1.8 Drainage

The aim of drainage is to avoid or remove excess water from the root zone. Plant roots must be aerated so that waste carbon dioxide produced by the plants can be dispelled and replaced by oxygen. When waterlogging stops this process, uptake of moisture and nutrients is retarded and the plant will wilt and die if the condition is prolonged.

Drainage is divided into two types, surface drainage and sub-surface or groundwater drainage. Surface drainage provides for the disposal of excess irrigation or storm runoff from rainfall. Only in the areas of perennial irrigation was any form of surface drainage observed. Ditches have been dug at the perimeter of banana and pawpaw plantations to draw off excess water. However, there is no provision for disposal of the drainage water so that these ditches become semi-permanent ponds of stagnant water and represent a health risk. During the rainy season farmers may delay vital irrigation if heavy rains appear likely so as to avoid the risk of waterlogging. However, if the rains do not materialise crops may suffer from water stress.

Sub-surface drainage is required to maintain a groundwater table below the root zone and at sufficient depth to avoid secondary salinisation by capillary rise from a saline watertable. Salinisation is especially a risk due to the high proportion of fallow land. For a heavy clay the watertable should be not less than 1.5 m below ground level. Although high water levels have been observed in the neighbouring Janaale-Bulo Marerta project, soil surveys gave no indication of waterlogging (gley features, mottling, etc.) or build-up of salinity. It is therefore assumed that the soils are sufficiently permeable for drainage not to be a problem.

1.9 Canal Operation and Maintenance

Within the project area the size of farms and nature of ownership varies considerably, see Table 1.3. Land is either privately owned or belongs to a government institution, e.g. the military. Private farms vary in size from smallholders having a land holding of 0.5 ha to 2 ha to a few large farms of over 500 ha. The variation in land ownership is reflected in the differences in the ways the main canals are operated. Each canal forms a separate irrigation unit, independent of the others. While under legislation all canals are owned by the government, in practice only two canals are operated or managed by the local office of the Department of Land and Water Resources - Keli Gure and Keli Caafimaad. Apart from those canals feeding an individual farm, each canal is run by a canal or water committee. The committee consists of: the Aw or Aabe who is the father or chairman of the canal; the yersin who fills the position of canal foreman, waterguard and deputy chairman; and the Sagallo who are the canal administrators and are responsible for controlling water in the distribution system. In addition, other individuals (Maamulayaal) deal with local judicial proceedings in arbitrating or resolving complaints and disputes amongst canal and water users.

The committee members are exempt from manual labour for canal maintenance and irrigation and payments in lieu of their work. They receive payments each season from every user and the Aw is responsible for maintaining and distributing these funds in accordance with the agreed needs of the systems.

The committee members are often the traditional leaders and elders in the villages; but not always. The leaders of one village may not always represent village interests on canals where one might expect them. The members of the canal committee are elected by the canal users only once but can be replaced and dismissed at any time if the canal users deem this necessary.

The operation of each canal varies depending on the strategy adopted by the committee for the allocation of water and the size and nature of the farms supplied by the canal. However, some general principles are common to all. When there is no water shortage, water is allocated on a first-come, first-served basis. A farmer applies to the Aw for water and his name is added to a list of those requiring water. Water is then allocated according to the time and date of the request. In periods of water shortage, different strategies are adopted. These vary between a fixed rotation starting at the head or tail of the canal, a system of picking straws and a first-come first-served system with a reduced irrigation duration to the farmer. Irrigation takes place day and night with nightime flows being monitored as for day.

Due to the heavy silt load in the Shabeelle, the canal system requires annual maintenance. This is usually carried out during the jilaal. The canal committee is responsible for the cleaning operation. Each farmer is required to clean a portion of the main canal in proportion to the size of his holding. In some cases the length of time a farmer received irrigation water is determined by the number of man-days spent on the cleaning operation. The majority of canals supplying smallholders are cleaned by hand either by the farmer or using hired labour. When available some of the larger farms hire machinery for the task.

1.10 Constraints of the Existing Irrigation System

The main constraints of the irrigation infrastructure and irrigation practices are as follows:

(a) River water levels are not sufficiently high to allow adequate irrigation in years of poor rainfall without pumping. Flood flows in the gu season are relatively short and unreliable but rainfall is more reliable than in the der season.

(b) The majority of the flood canals have no intake structure at the river and are either open to flood flows or are temporarily blocked using earth bunds, stakes and grass. Water control is therefore difficult if not impossible, leading to low irrigation efficiencies and the risk of downstream flooding. The structures that do exist are often in a poor state, gate and gate guides need replacing and in some cases there is considerable scour downstream. There are no water measurement facilities.

(c) Downstream of the canal offtake there are no control or regulating structures. Water is diverted down secondary canals and ponded to levels sufficient for irrigation using earth bunds. Farmers breach the canal banks to irrigate their fields as there are no farm turnouts. This practice leads to overtopping of canal banks and flooding where the breaches are inadequately repaired, and poor water control at farm level.

(d) Due to the heavy silt load in the Shabeelle, the canal system requires annual desilting. This is inevitable due to topographic restraints leading to canal slopes of 10 to 20 cm/km and no desilting basins at the river offtake.

(e) Canals are in some cases poorly aligned in relation to the topography. This is caused by the lack of any topographic maps or surveys, lack of trained personnel during the planning and construction of the canal and in some cases problems with farm boundaries.

(f) Canals are poorly dimensioned or shaped with uneven canal banks. Side slopes are too steep resulting in bank erosion and a low hydraulic efficiency. During maintenance silt is deposited on the canal banks with no attempt to reform its section or to compact the canal embankment. Some excavated material is washed back into the canal with the onset of the rains.

(g) No land levelling is carried out by the smallholders leading to low field application efficiencies and waterlogging. Where bulldozers have been used for land levelling on the larger farms the results are poor with levels across a field varying by $\pm$150 mm.

(h) There is no field drainage provision to remove excess water from either irrigation or rainfall resulting in waterlogging and yield reduction. Natural drainage is limited to water draining into natural depressions along the course of the old river.

(i) The pumping stations within the project area are poorly constructed with no proper intake structure and a badly designed delivery arrangement resulting in an unnecessary static lift. Pump discharge basins are usually poorly designed.

CHAPTER 2

PROPOSED IRRIGATION DEVELOPMENT

2.1 Objectives

Any rehabilitation or remodelling of the irrigation system must take account of the successfully operated and managed canal system which has developed under the canal committees. A well organised structure already exists for dealing with shortages of water and it must therefore be the approach of the project to develop the existing amenities and to minimise disruption to the farming communities.

The purpose of the proposed engineering development is to increase agricultural production through the more efficient use of water during the flood season and the extension of the reliably irrigated area. At present it is estimated that approximately 4 000 ha or 90% of the 1983 cultivated area can be irrigated with 75% reliability. In the Memorandum of Understanding GOS's decision that the amount of water available to the project during low river stages should not exceed present abstraction was duly noted. The extension of the irrigation season by pumping has therefore not been considered, except in special cases, and typically between the gu and der flood peaks, when river levels are only slightly below canal invert levels. The present overall efficiency is estimated to be as low as 20%, consisting of a canal conveyance efficiency of 50% and a field application efficiency of 40%. It is hoped that under the remodelled scheme the conveyance efficiency will increase to 75% and the field application efficiency to 60%. The proposed engineering measures to achieve these efficiencies are:

(i) Provision of canal head regulators.

(ii) Provision of canal structures in the distribution system.

(iii) Canal remodelling.

(iv) Land levelling.

(v) Mechanised canal maintenance.

In the development, priority is given to canals serving areas farmed by small-holders (see Table 1.3).

2.2 Main Canal Head Regulators

At present regulation of canal flows during periods of high river stage is extremely difficult. Once breached, canals will tend to flow continuously throughout the irrigation season. Adjustment of flows for day and night time irrigation or after heavy rainfall is difficult. This results in wastage of water at the canal tail-end, over-irrigation causing waterlogging and accidental breaching of canal banks. It is proposed that head regulators be provided for all canals that do not have functioning regulators at present - a total of about 47 structures including rehabilitation of existing structures and replacement of gates and gate-guides. The proposed head regulator types are shown in Figure 2.1. It consists of a gated concrete culvert with a reinforced concrete baffled outlet box (USBR - Type 4). The vertical lift gate is mounted on a mass concrete retaining wall on the upstream side of the culvert. The culvert has been limited to 0.75 m diameter so that gate lifting mechanism can be a simple screw and nut arrangement suitable for local manufacture. Larger gate sizes require a bevel gear to overcome friction. The Type 4 outlet box is provided to dissipate excess energy when there is a high head loss across the structure. The culvert length is such that future vehicle crossing is possible.

Table 2.1 shows the action required at each canal head: some new structures require no action, some older ones rehabilitation and canals will need the provision of head regulators of a size capable of passing the water requirement for the area served.

2.3 Canal Resectioning

In conjunction with the installation of canal head regulators it is proposed that canals will be remodelled by the project with the exception that those canals less than 300 m in length will be remodelled by the beneficiaries. For these short canals, the project staff will arrange for control sections to be excavated free of charge as a guide for the work.

Topographical surveys were carried out on all the 53 canals off taking from the river within the project area. The longitudinal sections for all the canals (except for Nr 53 - Jilaal Moogi which is the subject of Annex 7) are shown on Drawings Nr 159201/24 to 159201/29, album accompanying this report.

It is not proposed to alter the basic layout and operation of the canal system. Canal alignments, though possibly not ideal, are based on cadastral boundaries as well as topographic considerations. Remodelling will therefore be restricted to regrading the canal side slopes to 1 vertical to 1½ horizontal, removing silt and weeds, reforming canal banks where required and regrading the canal bed. This will provide a more stable section and increase the canal capacity alleviating problems of low canal flow during periods of low river flows. Figure 2.2 shows an idealised canal cross-section based on Manning's equation. Canals should have a minimum water surface slope of 10 cm/km and a maximum slope such that the tractive force does not exceed 4 N/m^2. The maintenance of distributary canals is considered an agricultural operation under the control of the farmers.

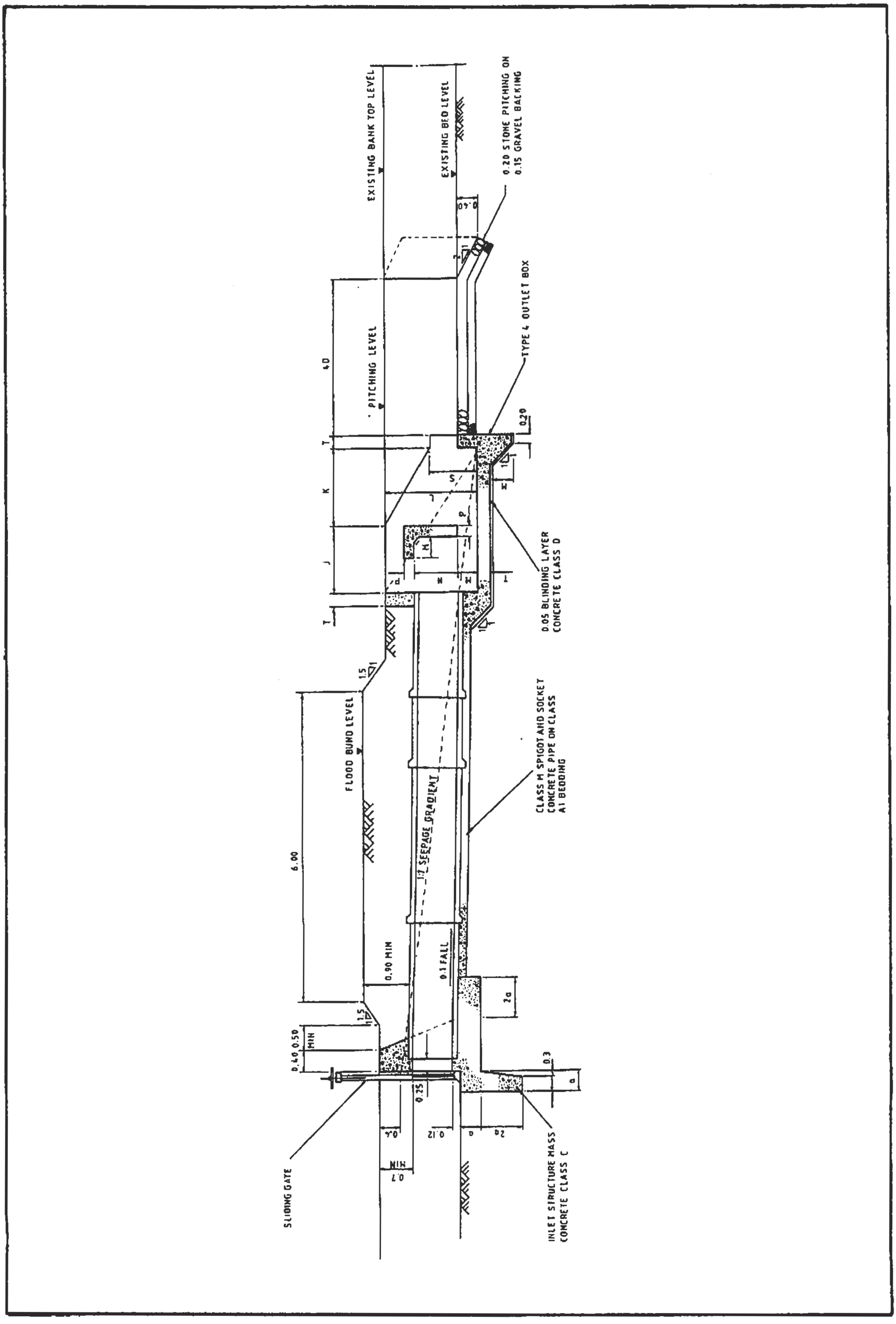
The earthwork quantities based on a canal section to meet a water requirement of 1.2 l/s per hectare gross at the river and an allowable headloss across the structure of 0.3 m were found to be as follows:

Total volume of cut	24 000 m^3	(approximately 230 m^3/km)
Total volume of fill	371 500 m^3	(approximately 3 680 m^3/km)

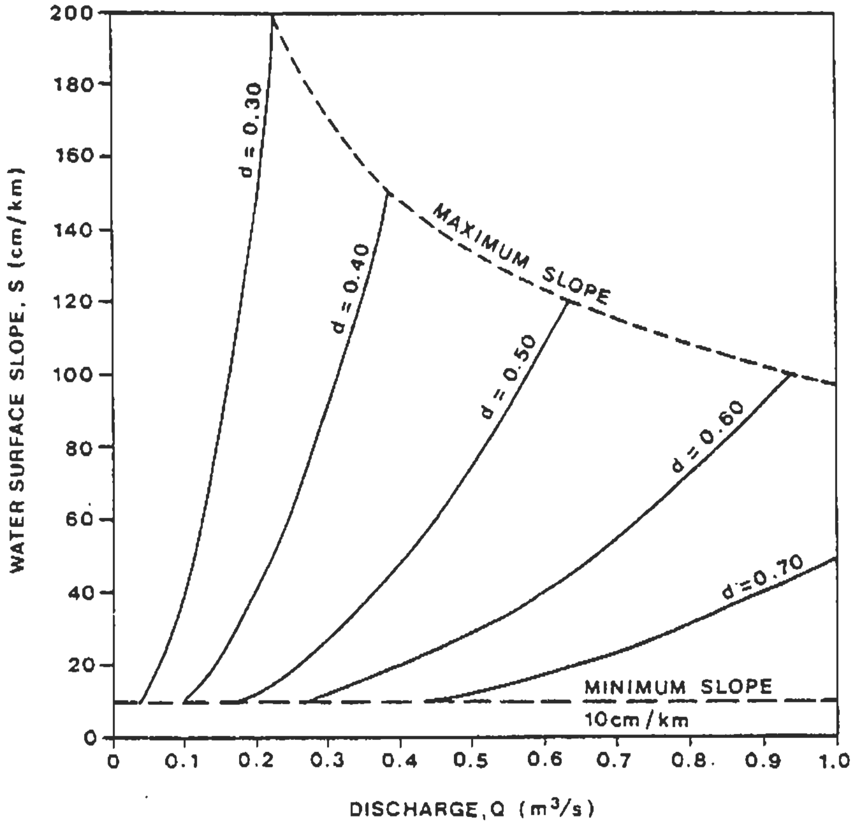
The above quantities are those for 47 canals, that is the 56 less Jilaal Moogi (Nr 53) the three Nr 28, 37 and 38 which are no longer identifiable, Nr 46 which is disused and five canals which are less than 300 m long and will be excavated by the beneficiaries as already described. The total length of the 48 canals is 102.6 km and the cut/fill per kilometre have been given above. The quantities for the three small canal control sections will be very small compared with those for the other canals and can be considered to be covered by the contingency allowance in the cost estimates and implementation programme in Tables 2.2 and 2.3 respectively.

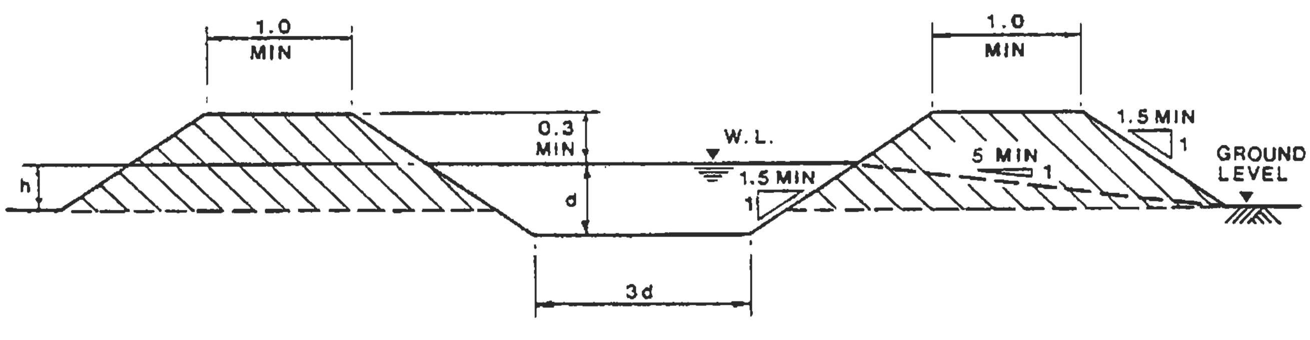
Figure 2.1

Proposed Canal Headregulator



Typical Canal Cross – Section





NOTE : COMMAND h TO BE 0.3M MIN WITHIN IRRIGATED AREA

TABLE 2.1

Proposed Canal Head Regulators

Number	Canal name	Size of proposed head regulator (m diameter)
--		
1	Gure	Rehabilitation of existing h/r
2	Minow	Rehabilitation of existing h/r
3	Itolc	0.45
4	Gududu	Rehabilitation of existing h/r
5	Matawani	0.45
6	Barbieri/Bunds Cadde	New structure (no action)
7	Xassan Youssif	0.45
8	Ablika-Khalif	0.45
9	Eboleh	Rehabilitation (provide 0.45 gate)
10	Deeq	0.45
11	Dheere	0.75
12	Suuu	0.45
13	Guhaad	0.60
14	Oomaay	0.45
15	Suliman 1	0.45
16	Suliman 2/Saddik	0.45
17	-	0.45
18	Garilan	0.45
19	Dheqere	0.45
20	Sheik Dhere	0.45
21	Aw Gabbow	0.45
22	Dhurrey	0.75
23	Unqunji	0.75
24	Barwaaqo	0.45
25	Balambaley	0.45
26	Abdulle Bube	0.45
27	Mohammed Ekow	0.45
29	Caaysurey	0.45
30	Aw Madal	0.45
31	Aw Barre	0.75
32	Xanoole	Rehabilitation of existing h/r
33	Muuna	0.45
34	Dhuufe	0.60
35	Dhere	0.60
36	Hahre	0.45
39	Duuf/Baar	0.45
40	Gaabo Yerro	0.45
41	-	0.45
42	-	Rehabilitation of existing h/r
43	Salhan	0.45
44	Gaabo	0.45
45	New Bolay	0.60
48	Abdu Nasir	New structure (no action)
49	Camoon	0.45
50	Xaxoule	0.45
51	Duuf	0.45
52	Modkadeyo	0.45
54	Xassan Nur	0.45
55	Siad Barre Berry	New structure (no action)
56	Tugaarey	0.45

Summary: 6 Nr Rehabilitation
33 Nr 0.45 m diameter head regulator
4 Nr 0.60 m diameter head regulator
4 Nr 0.75 m diameter head regulator
3 Nr No action

TABLE 2.2

Cost Estimate for Head Regulators/Canal Reforming

Item Nr	Decription	Quan-tity	Unit	Unit rate (US$)	FE %	Amount (US$)
1	0.45 m dia. head regulator	33	Nr	6 500	55	214 500
2	0.60 m dia. head regulator	4	Nr	10 500	55	42 000
3	0.75 m dia. head regulator	4	Nr	11 500	55	46 000
4	2 x 0.75 m dia. head regulator	-	Nr	22 500	55	-
5	Rehabilitation of existing structure	6	Nr	10 000	40	60 000
6	0.45 m dia. gate	33	Nr	1 600	75	52 800
7	0.60 m dia. gate	4	Nr	1 800	75	7 200
8	0.75 m dia. gate	4	Nr	2 000	75	8 000
9	Replacement of existing gate and gate guides	6	Nr	2 000	75	12 000
10	Canal earthworks - Cut	24 000	m^3	2.5	55	60 000
	- Fill	368 000	m^3	2.5	55	920 000
	- Small canals(1)	1.2	km	3 000	55	3 600
Sub-total						1 426 100
Contingencies (10%)						142 610
Total						1 568 710

Maintenance of structures (4%) US$ 60 007.

TABLE 2.3

Canal Head Regulators - Implementation Programme

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Head Regulators:						
0.45 m	16	17	-	-	-	33
0.60 m	2	2	-	-	-	4
0.75 m	2	2	-	-	-	4
0.75 x 2 Nr	-	-	-	-	-	-
Rehabilitation	3	3	-	-	-	6
Canal Remodelling Length (km)	30	36.4	35	-	-	101.4
Small canal length(1)	1.2	-	-	-	-	1.2

Note: (1) Small canals are 300 m or less in length.

2.4 Canal Distribution Structures

Structures are required in the canal distribution system to improve water regulation and distribution. However there is no experience of operating canal distribution structures in the project area and no evidence of how successful they would be. It is therefore recommended that a pilot study is set-up to construct canal structures in three smallholder canals and to monitor and evaluate their success in terms of saving water/increasing conveyance efficiencies. This will necessarily be a subjective exercise based on the reaction of farmers to the new structures. If the pilot study proves successful a full programme of construction would be implemented to build distribution structures in all the smallholder canals and 50% of the mixed/communal canals, see Table 2.4. The number of canals able to be redeveloped is limited to the number that could be successfully developed in the first 3.5 years of the project.

Two types of structures are envisaged - canal checks and field outlet pipes. The latter is shown in Figures 2.3 and 2.4. It is recommended that Keli Barwaaqo (see Figure 2.5) be used as one of the pilot canals; the other two should be identified during the early stages of the project. They should all be smallholder canals of medium size and length operated by a highly developed canal committee. Canal checks would be installed downstream of every secondary canal offtake. These would be used to raise or maintain upstream water levels in periods of low flows.

Field outlet pipes would be installed at all distributary canal and field offtakes from the main canal to avoid the necessity to breach canal banks. The field outlet pipe is a simple orifice offtake with a rod operated gate. The rod is drilled to suit the number of opening settings required. The structure cannot be used for accurate flow measurement but has the advantage of being cheap and robust. Unfortunately in the present system a large number of fields are irrigated directly from the main canal. For Keli Barwaaqo it is estimated that 69 field outlet pipes and seven main canal checks are required. However some reduction may be accomplished at implementation stage by combining two or more farmers on one outlet.

Installation of canal structures must be done in liaison with the smallholder farmers, the village elders and the canal committees. The required work prior to construction would be:

(i) Check survey of canal bed and bank top levels after resectioning of the canal. This survey is required to finalise the measurement of quantities so that the Contractor can be paid for work done.

(ii) Check required location of field outlet pipes and canal checks. This should be done in liaison with the AW and canal committee. At this juncture any combining of outlets should be discussed and finalised.

Due to the small size of farm holdings (0.5 to 2 ha) it is the Consultant's view that the provision of field outlet pipes for all field offtakes from the main canal may be uneconomic and that these structures may only be worthwhile for the larger distributary canals. The cost of canal checks and field outlet pipes is estimated at US$ 1 000 each making the combining of outlets even more attractive. The costs and proposed implementation rates are given in Tables 2.5 and 2.6 respectively.

TABLE 2.4

Proposed Canal Distribution Structures

A. PILOT STUDY*

Barwaaqo

B. FULL IMPLEMENTATION

Smallholder canals:

Abliiko - Khaliif
Barbieri
Balamboley
Garilan
Guhaad
Hahre
Tugaarrey
Xanoole

Mixed/Communal Canals**

Aw Madae
Dheere
Dhurey
Dhuufe
Gabbow
Gududu
Gure
Minow
Raxoole
Ugunji

Notes:

* Implementation of construction programme for canal check structures and field outlet pipes will depend on the success of the study on the Barwaaqo canal.

** Any installation of canal structures will be limited to five canals from this list chosen by the project authorities after consultation with the canal committees and further field investigations during the Pilot Study period.

Figure 2.3
Field Outlet Pipe

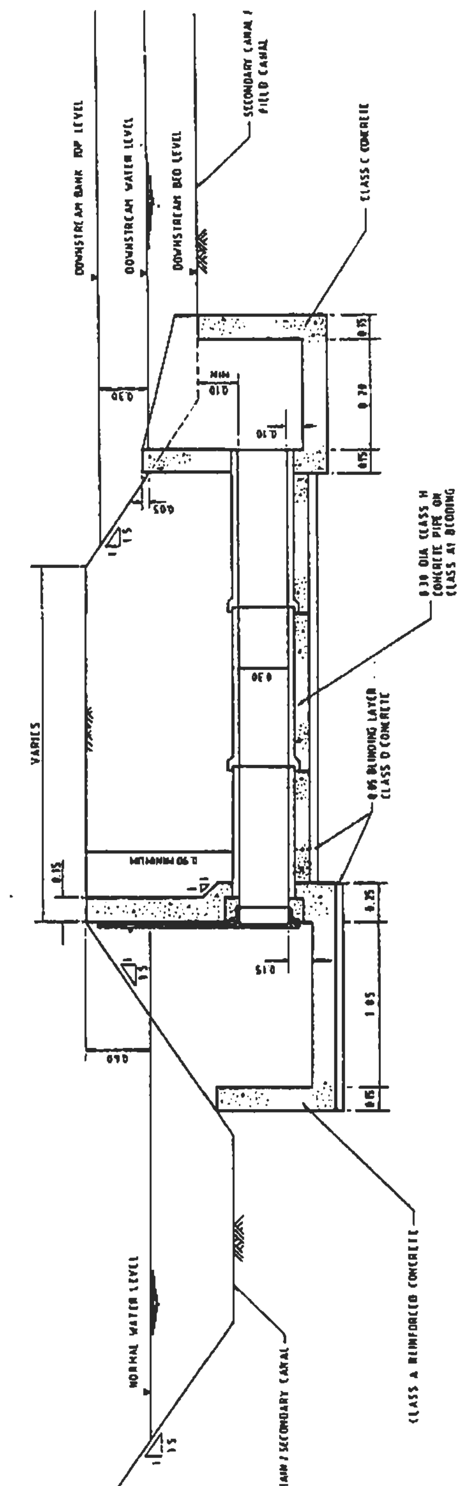


Figure 2.4

Field Outlet Pipe Gate

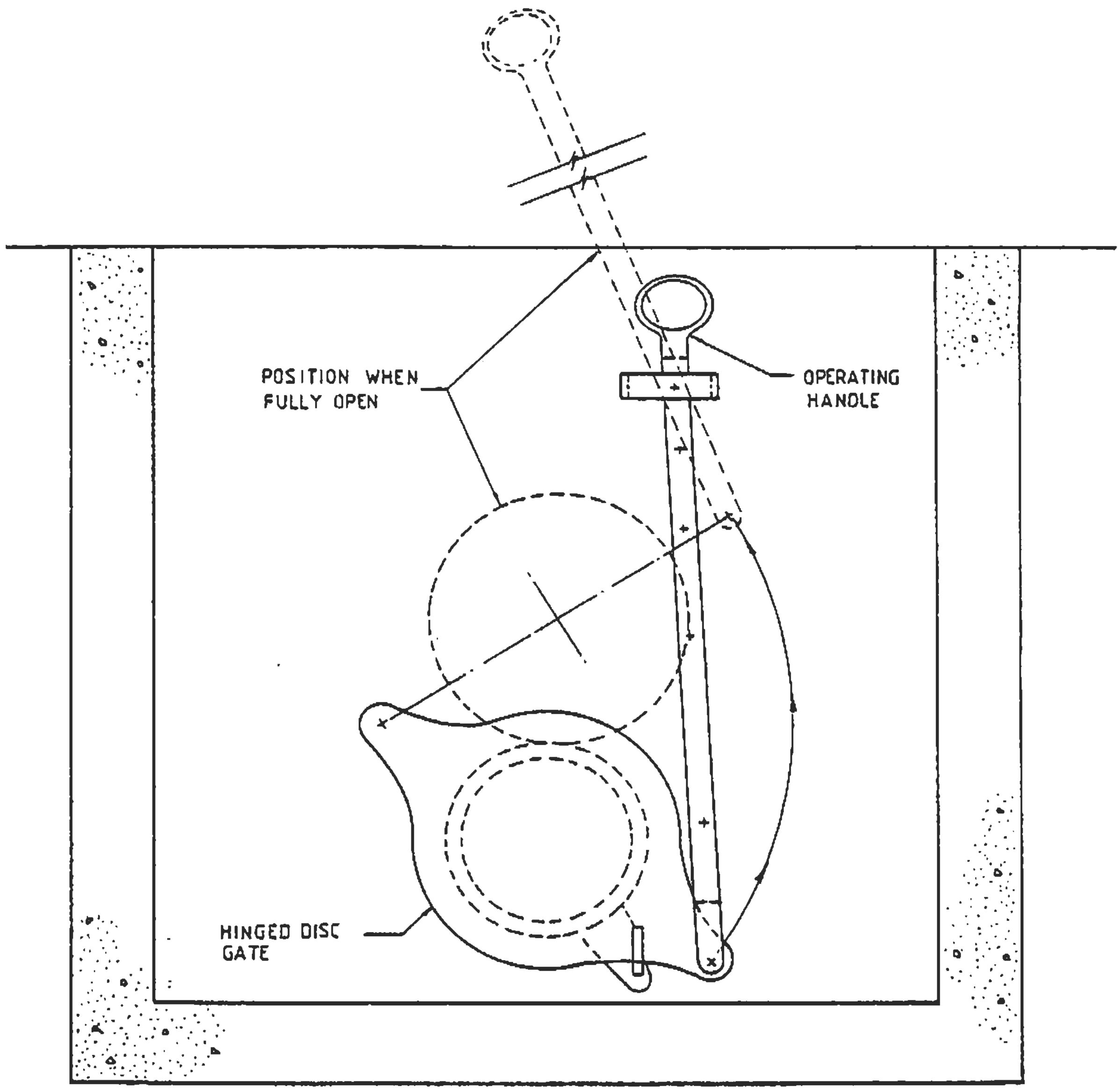


Figure 2.5
Keli Barwaaqo

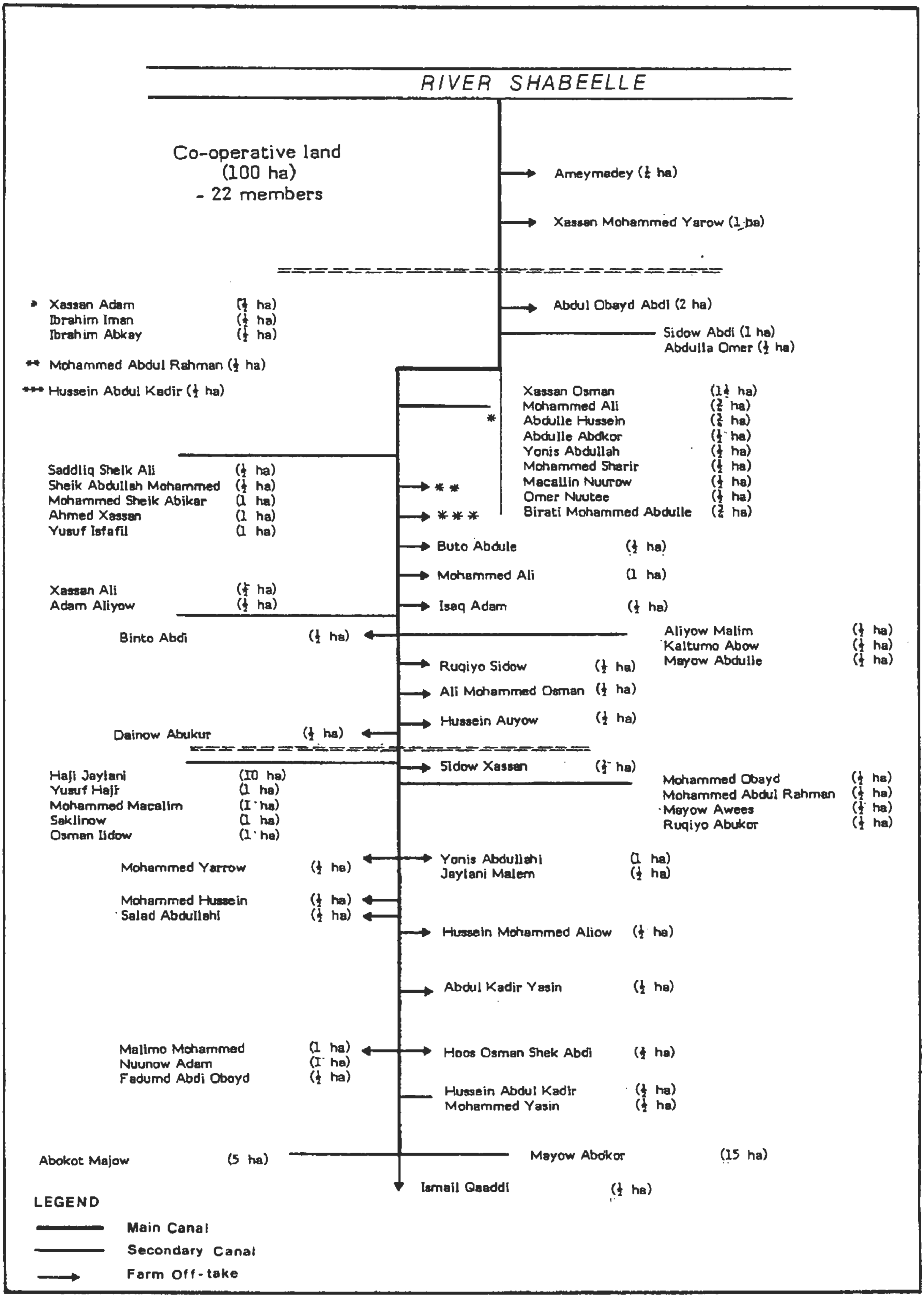


TABLE 2.5

Cost Estimate for Canal Distribution Structures

Item Nr	Description	Quantity	Unit	Unit rate (US$)	FE (%)	Amount (US$)
1	Field outlet pipe - trial	63	Nr	1 000	55	63 000
2	Canal check - trial	7	Nr	1 000	55	7 000
3	Field outlet pipe	1 000	Nr	1 000	55	1 000 000
4	Canal check	100	Nr	1 000	55	100 000
Sub-total						1 170 000
10% contingencies						117 000
TOTAL						1 287 000

Operation and maintenance costs - assume 4% = US$ 51 480

TABLE 2.6

Canal Distribution Structures - Implementation Programme

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Number of canals remodelled	1	6	5	2	-	14
Field outlet pipe	63	400	400	200	-	1 063
Check structures	7	45	40	15	-	107

2.5 Land Levelling

It is recommended that a drag scraper be used for relevelling cultivated fields where more than about 150 m^3/ha of soil has to be moved. For less extensive soil moving, the method described in Annex 4 may be found more economical and practicable. A drag scraper is similar to a land plane. It is a 4 to 5 m wide blade dragged along the ground behind a heavy tractor, preferably a crawler tractor. The blade is bucket-shaped and has a capacity of 5 to 7 m^3 so that it transports more soil than a land plane. The drag scraper can undertake cut-and-fill operations by itself and no subsequent grading or land planing is required. The average working cut of a drag scraper is 0.07 to 0.10 m, with a maximum of 0.20 m.

2.6 Canal Maintenance

At present the majority of canals are cleared either annually or seasonally by hand. As part of a supply contract funded by the project, two hydraulic excavators will be provided to project management.

The estimated CIF cost is US$ 60 000. During the first 3 years of project implementation it is envisaged that all smallholder canals and mixed/communal canals will be resectioned as part of the remodelling programme. It is therefore recommended that the provision of hydraulic excavators is staggered. The machines should be purchased at the start of Year 4. It is estimated that one excavator can clean 300 m of canal per 8 hour day. As a guide to present hire charges from private contractors and ONAT are approximately 1 500 SoSh/hour, giving a unit cost of 40 SoSh/m.

The cost of labour for canal maintenance based on a rate of 3 m/d and a wage rate of 150 SoSh/d is 50 SoSh/m.

2.7 Drainage

Since the watertable is well below the root zone of any crop likely to be grown, given a well-managed irrigation regime and proper control of the amount of water entering the fields, deep drainage is unlikely to be a problem in the foreseeable future. This is corroborated by the fact that groundwater levels are acceptable even in areas irrigated since the early 1800s. However, surface drainage, the disposal of excessive irrigation water or heavy prolonged rainfall, requires consideration.

It is concluded that with the land levelling proposed under the project, and mainly the avoidance of large, imperfectly levelled compartments within the fields, there is no need at present to consider installing a surface drainage system. Rather, as stated, the emphasis should be on land levelling, irrigation water control and the establishing of secure irrigation units within which the water can infiltrate within 3 to 4 days, which is within the tolerance limit for submergence of all the field crops likely to be grown in the project area.

CHAPTER 3

DRINKING WATER SUPPLY

3.1 Water Supply and Construction Methods

The benefits accruing from the provision of an adequate potable water supply cannot be stressed too highly. Where no such provisions are made the hazards to health, especially hazards of water-borne diseases, are great. Young children and babies are especially prone to the dangers resulting from a contaminated water source.

With clean water provided close to the centres of population the health of all the users improves and in addition the water carriers, mostly the women, are released from the long daily journeys to collect water. The time saved can be used for more productive work which can result in either more cash or more food being available to the community as a whole.

For any water supply system to be a success, it must have the wholehearted support of those who are going to use it. This means that the women must be consulted from the planning stage. The Austrian Catholic Aid Agency (CARITAS) has rehabilitated, improved or constructed over 100 shallow wells including the provision of hand pumps in the Middle Shabeelle and Middle Juba between April 1984 and December 1986. This has been accomplished with one expatriate and a small Somali staff. The second phase which covers a further 100 wells will be completed by April 1988. The success of this project which will have fitted some 200 hand pumps to rehabilitated, improved or newly constructed wells in 4 years is obvious and the villagers using them around the periphery of the project area are well pleased with the programme. Where new wells have been constructed, the labour has been provided by the villagers or they have employed and paid a well digging contractor. When a potable water source is reached the concrete well rings, 1 m in diameter, are fitted by CARITAS staff, the additional excavation is then carried out and the lower rings installed so that the well has at least 2 m of its ring depth in the water bearing strata.

Very few small villages similar to those in the area have a bored tubewell. This is because the cost of a tubewell is usually beyond their financial capability. Most of the tubewells drilled are for farm supplementary water supply, see Section 3.2.

3.2 Present Situation

At present, within the project area there is only one well used for domestic water at Busley. There are a few shallow wells located along the edge of the project where the sand dunes join the alluvial plain and one shallow well in Jilaal Moogi area located near the village of Kilometre Sixty on the main road. In addition a few tubewells have been installed but the use of these is restricted by the owners to the very dry months when no water is available for pumping from the Shabeelle river. This water is used to irrigate the perennial crops, bananas and citrus orchards. The tubewells are only used as a last resort for irrigation and likely damage by saline water to the crop must be balanced against damage due to drought. Also, since the water quality in a number of cases is poor and pumping costs from tubewells is much higher than pumping from the river. This aspect is dealt with in Section 3.3.

3.3 Well Inventory in the Janaale Area

Figure 3.1 gives the location of a number of wells located along the south-western boundary of the project area. A detailed study of these wells has already been carried out by the Consultant between 1968 and 1969 and the results of these investigations are given in Table 3.1. In addition, the World Health Organization Water Engineer stationed in Somalia has carried out a survey of existing water sources and sanitation in the project area and its environs. The results of this survey, carried out in late 1986 and early 1987, are tabulated in Table 3.2 which also includes recommendations to improve conditions and service. A number of these wells were visited by the Consultant and his additional observations have been added in the table.

In the project area two tubewells were seen near the Gure and Red canals providing water to the perennial crops. The wells could not be sounded but the operators reported that the water levels were 50 m to 60 m below ground level.

3.4 Water Quality and Depth

The quality and water depth of groundwater in the area is described in detail in Annex 2 - Water Resources, Chapter 4. Broadly the EC varies from 1 440 to 15 000 µmho/cm.

The depth to water in the shallow wells varies from 4 to 18 m and for the tubewells from 49 to 97 m. It is clear that pumping from tubewells can be expensive if diesel engines are used; this is to be avoided for small village water supplies if possible.

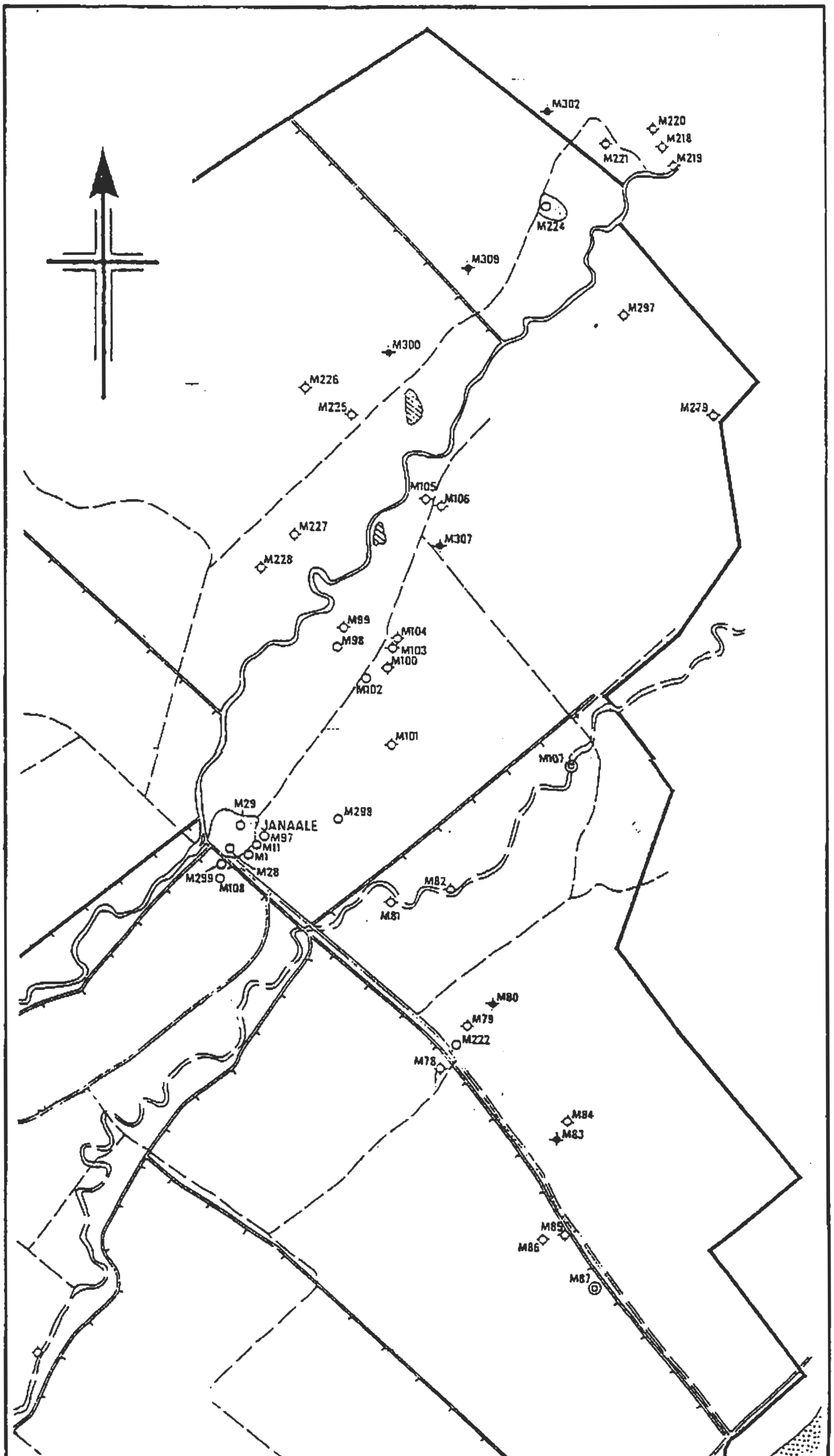
At Dara Salaam where water is pumped from the river into a settling tank, the EC value was 1 060 µmho/cm; higher than would be expected due to evaporation from the uncovered tanks. The uar at Busley Dawd is filled with water from the river, carried by a canal. When the river runs dry the supply ceases. It was observed that the uar, besides being used to provide water for human consumption, is also used to water animals. The watering arrangements leave much to be desired: animals are actually entering to drink, thus fouling the water.

The most reliable source of supply is from groundwater. If the groundwater is, say, no more than 25 m from the surface then it should be reached by digging an open well suitably lined and fitted, when completed, with a cover and a hand pump. Provision should be made in the surface slab for an inspection manhole so that entry to the well can be made to carry out repairs to the lining or to the rising main of the hand pump when required. The slab should also be provided with sufficient space under the pump delivery for the standard 20 litre earthenware pots used by the women to be filled and, most important, to allow for drainage from the immediate vicinity of the installation of any spilt water. CARITAS reported that it had found that of 26 wells recently checked for signs of pollution 10 were in fact affected. In most cases the pollution was suspected as having been caused by contaminated water/liquid having seeped in from the immediate area of the well head. To avoid this it is proposed to place concrete around the top four concrete rings to seal them, and to construct a concrete apron which will channel water from the well to a soakaway located at least 20 m away.

Where the water is below 25 m it is proposed that a borehole be drilled, and a hand pump provided for lifting the water.

Figure 3.1

Location of Wells



Source: Genale-Bulo Mererta Project - Annex II - Map 1D.

TABLE 3.1

Well Inventory

Well Nr	Location	Type of well	Use of well	Depth of well (m)	Dia. of well (mm)	Geol-ogical log	Pump type	Pump test	Yield (m^3/h)	Draw-down (m)	SC (m^3/h per metre)	Water analysis	EC (mmho/cm)	Water level (Jan 1978)	Comments
M1	Janaale	H	X	11.0	1 000	-	-	-	-	-	-	MMP (P)	2.895	2.95	-
M11	Janaale	H	D	17.7	800	-	B	-	-	-	-	MMP (P)	4.600	4.95	-
M28	Janaale	H	U	13.0	800	-	B	-	-	-	-	MMP (P)	5.978	3.25	-
M29	Janaale	H	U	8.0	800	-	B	-	-	-	-	MMP (P)	8.280	4.29	-
M78	Janaale	T	Bp	60.0	191	-	S	-	-	-	-	HTS(F)	4.200	15.50	-
M79	Janaale	T	I	60.0	254	-	Tu	-	-	-	-	-	-	15.69	-
M80	Janaale	T	X	74.6	254	F	-	F	120.0	9.5	12.6	-	-	-	Infilled
M81	Janaale	–	I	84.7	254	F	Tu	F	120.0	9.0	13.3	-	-	3.61	-
M82	Janaale	T	I	60.0	254	-	Tu	-	-	-	-	-	-	6.37	-
M83	Janaale	T	X	80.0	254	-	-	-	-	-	-	-	-	-	Infilled
M84	Janaale	T	I	80.0	254	-	Tu	-	-	-	-	-	-	26.62	-
M85	Janaale	T	I	82.0	254	-	Tu	-	-	-	-	MMP (P)	3.700(+)	33.62	-
M86	Janaale	T	I	84.0	254	-	Tu	-	-	-	-	-	-	30.96	-
M87	Janaale	T	O	84.0	254	-	-	-	-	-	-	-	-	39.49	-
M97	Janaale	H	X	4.0	800	-	-	-	-	-	-	-	-	2.97	Infilled
M98	Janaale	H	D	6.0	800	-	B	-	-	-	-	-	-	1.45	-
M99	Janaale	T	I	71.0	254	F	Tu	F	140.0	13.5	10.3	-	-	2.13	-
M100	Janaale	T	I	80.0	254	F	Tu	F	120.0	9.5	12.7	-	-	2.10	-
M101	Janaale	T	I	85.0	254	-	Tu	-	-	-	-	-	-	1.46	-
M102	Janaale	H	X	6.0	800	-	-	-	-	-	-	-	-	2.12	-
M103	Janaale	T	Bp	60.0	150	-	S	M	-	-	-	-	-	1.39	-
M104	Janaale	T	I	98.0	254	F	Tu	M	202.0	7.6	26.5	MMP (F)	2.350	-	-
M105	Malable	T	I	60.0	254	-	Tu	-	-	-	-	-	-	3.09	-
M106	Malable	T	I	60.0	254	-	Tu	-	-	-	-	-	-	2.82	-
M107	Malable	T	O	97.3	254	F	-	F	120.0	7.8	15.4	F (P)	6.000	7.39	-
M108	Janaale	T	D	60.0	150	-	S	-	-	-	-	-	-	2.90	-
M116	Janaale	T	I	70.0	254	-	Tu	-	-	-	-	-	-	3.55	-
M218	Ugunji	T	Bp	59.0	150	-	S	-	-	-	-	HTS (F)	3.540	4.19	-
M219	Ugunji	T	I	90.0	254	-	Tu	-	-	-	-	-	-	5.98	-
M220	Ugunji	T	I	60.0	254	F	Tu	F	100.0	11.0	9.0	F(P)	1.600	1.00	-
M221	Ugunji	T	I	93.8	254	F	Tu	F	110.0	8.5	14.6	-	-	13.43	-
M222	Janaale	H	D	12.5	1 000	-	B	-	-	-	-	MMP (P)	2.802	1.47	-
M224	Ugunji	H	X	14.0	800	-	-	-	-	-	-	MMP (P)	8.740	12.63	-
M225	Siiqaale	T	I	60.0	254	-	Tu	-	-	-	-	-	-	7.06	-
M226	Siiqaale	T	I	88.0	254	F	Tu	F	100.0	11.5	8.6	F (P)	6.000	9.38	-
M227	Siiqaale	T	I	60.0	254	-	Tu	-	-	-	-	-	-	4.07	-
M228	Siiqaale	T	I	49.0	254	-	Tu	-	-	-	-	-	-	3.86	-
M271	Qoryooley	H	X	5.8	1 000	-	-	-	-	-	-	MMP (P)	19.167	-	-
M279	Jeerow	H	X	10.0	1 200	-	-	-	-	-	-	-	-	-	Infilled
M297	Siiqaale	T	I	70.0	254	-	Tu	-	-	-	-	-	-	13.00	-
M298	Janaale	H	D	8.7	800	-	B	-	-	-	-	MMP (P)	2.503	1.05	-
M299	Janaale	H	X	9.0	1 000	-	-	-	-	-	-	MMP (P)	2.713	2.89	-
M300	Siiqaale	T	X	97.0	254	F	-	F	100.0	10.0	10.0	-	-	-	-
M302	Ugunji	T	X	86.4	254	F	-	F	100.0	11.0	9.0	-	-	-	Not found
M307	Malable	T	X	93.9	254	F	-	F	120.0	10.5	10.4	-	-	-	Not found
M309	Ugunji	T	X	78.0	254	F	-	F	110.0	12.5	8.8	-	-	-	Not found

Notes to Table 3.1:

Well Nr:
Unique number given to wells upon visiting site

Location:
Nearest town or village

Type of well:
H = Hand dug; T = Tubewell; P = Piezometer

Use of well:
X = Not used; D = Drinking water; O = Proposed observation well;
I = Irrigation; U = Washing only

Depth of well:
In metres, either measured, or from written or verbal information

Diameter of well:
In millimetres as measured

Geological log:
F = Information from Faillace (1964b); A = Agrotec (1978)

Pump type:
B = Bucket; Tu = Deep well turbine pump; S = Submersible

Pump test:
F = Faillace (1964b); C = Citaco (1974); A = Agrotec (1978);
M = MMP 1977/8 Survey

Yield: Stated quantity of test, m^3/h

Drawdown:
Maximum observed (m)

Specific capacity:
Calculated from available data (m^3/h per metre)

Water analysis:
F = Faillace (1964b); HTS = Hunting Technical Services (1969);
UN = UNDP; Af = CARS (1973); MMP = 1977/8 survey; C = Citaco (1974);
(F) = Full analysis; (P) = Partial or Ec only.

Electrical conductivity:
Most recent value, mmho/cm

TABLE 3.2

Existing Water Source Survey by WHO (1986/7)

Village name (population)	Existing water sources	Sanitation existing	Recommendation
1. Siiqaale (1 472 plus nomads)	2 wells on west side (at mosques) 1 well on east (at mosques) 1. 4 850 μmho/cm 7.10 - 60 m 2. 10 890 μmho/cm 7.50 - 80 m 3. 2 930 μmho/cm 5.90 River water used.	Some latrines	Provide pump for east side well Nr 3. Dig another well on east side tubewell hand pump (HP) Demonstration housing project recommended.
2. Ceel Wareegow (69 families)	No well. Trucked water/ private berkeds. No chance hitting water at reasonable depth	No latrines	No action, WDA responsibility
3. Kilometre Sixty Village	15 year old well west of road approximately 200 m 1 740 μmho/cm at 28.5°C	No latrines	Improve well - apron, slab plus HP
4. Mareeray (4 000 people)	Well with WDA 'Duplechin' pump. No water in the well - 18 m WDA to deepen well.	50 lateral slabs provided by unit of the M.Med School, more expected.	No action, wait and see.
5. Jawhar (700 people)	Only one salty well, 15 000 μmho/cm at 4 m	No latrines, garbage buried every Friday	Villagers willing to dig well. Propose to dig within well to lower level if pumping equipment provided. Believe sweeter water below.

TABLE 3.2 (cont.)

Village name (population)	Existing water sources	Sanitation existing	Recommendation
6. Dara Salaam (1 425)	Water pumped from river to tanks 1 060 μmho/cm well tried far from river unsuccessful	Most people have latrines	Try small sandfilter. Suggest to UNDP for demonstration
7. Mareere (7 households)	Canal or river. Well supply not tried	No latrines	Try to dig well
8. Mubarak (1 700 families)	River used. Tried well sand reached at 25 m and stopped well at Mosque near river 1 440 μmho/cm at 28.8°C	Most people have latrines	Willing to dig it given sections
9. Malable Opposite side of river	3 mosques with 3 wells, all salty 1. 6 900 μmho/cm at 3.90 m 2. 16 000 μmho/cm 3. 5.80 m 3 250 μmho/cm	No latrines	Try well close to river
10. Aw Dheegle	1. Abandoned well 4.70-0.80 m. 2. Well filled with dead animals, etc.	Some latrines	Remove old wind mill. Clean well. Install hand pump. *Well Nr 1 now operative with water being used by Finnish project. *Well Nr 2 being cleaned by CARITAS 31st March.
11. Buulo Khalif (180 families)	Austrian pump on well, functioning 5.80 - 0.8 m 2 400 μmho/cm at 29°C	Some latrines	Wants another well at Mosque

TABLE 3.2 (cont.)

Village name (population)	Existing water sources	Sanitation existing	Recommendation
12. Ugunji (360 families)	1 well 4 110 µmho/cm 30.3°C 12 sections deep CARITAS pump 2 in village centre at mosque 12-0.5 m deep 4 m water 214 µmho/cm 28.2°C CARITAS Pump	50/50 use latrines or go out. Latrines builts by villages	Additional well required. Latrine slab required *Note:1. Pump locked by CARITAS and not usable until villagers rectify drainage problem near well.* 2. Within mosque compound with supply point outside. Needs drainage provision and overflow from trough.*
13. Shuffeeri (23 families)	River	No latrines	Ready to dig well if given sections.
14. Degwariirow (770 families)	One well plus river; 12 m deep CARITAS pump 2 810 µmho/cm 29.7°C	Some have latrines	Village ready to dig two more wells - given sections plus HP
15. Buulo Jameco (36 families)	River farmer's drilled well	No latrines, latrines only for washing and urine	Ready to try well if given sections.
16. Gabadka (15 families)	1 well - Austrian CARITAS pump water worse than Dogwaariirow but used.		No action on water. Latrine slabs.

Note: * Hems added by the Project Consultant after field inspection.

HP Hand pump
TW Tubewell

Since the exact locations of suitable aquifers of potable groundwater across the project are not known it is planned to execute an investigatory drilling programme of three wells with an aggregate depth of 200 m to improve the knowledge of the availability of water for human consumption from this source. The suggested locations are shown on Figure 3.2. If successful these boreholes would be used as production wells. The results obtained from them will provide the data in locating an additional seven tubewells by the project.

3.5 Abstraction Method

The choice of abstraction method depends on several factors including cost, ease of operation and maintenance and reliability of the well discharge. For hand dug wells the discharge is likely to be lower and less reliable than for the tubewells and subject to seasonal variation as the watertable rises and falls. Consequently an expensive abstraction method, such as a diesel or wind powered pump is not justified. Nevertheless to prevent contamination of the well water the well must be properly sealed and supplied with a handpump. For the boreholes powered pumps are a possibility due to the reliability of good supply and the Consultant considered the possibility of diesel and wind powered pumps as well as handpumps. Diesel powered pumps were rejected because of the difficulties and cost of providing fuel and maintaining equipment. Wind powered pumps are feasible as recorded average wind speeds are high for most of the year. However after careful consideration the Consultant recommends that handpumps are installed for the reasons listed below:

- the cost of a suitable handpump is much lower than for a wind powered pump, (approximately US$ 1 250 against US$ 10 000 for the wind powered pumps;

- to ensure supply when there is insufficient wind a large tank must be constructed, or an alternative power source also supplied. This will substantially add to the cost per borehole;

- experience in Somalia where there was a large windmill pump programme in the mid-1960s has not proven a success. The windmill in the project area near Caal Wareego ceased to function two years after it was installed;

- maintenance of wind powered pumps is more difficult than for hand-pumps.

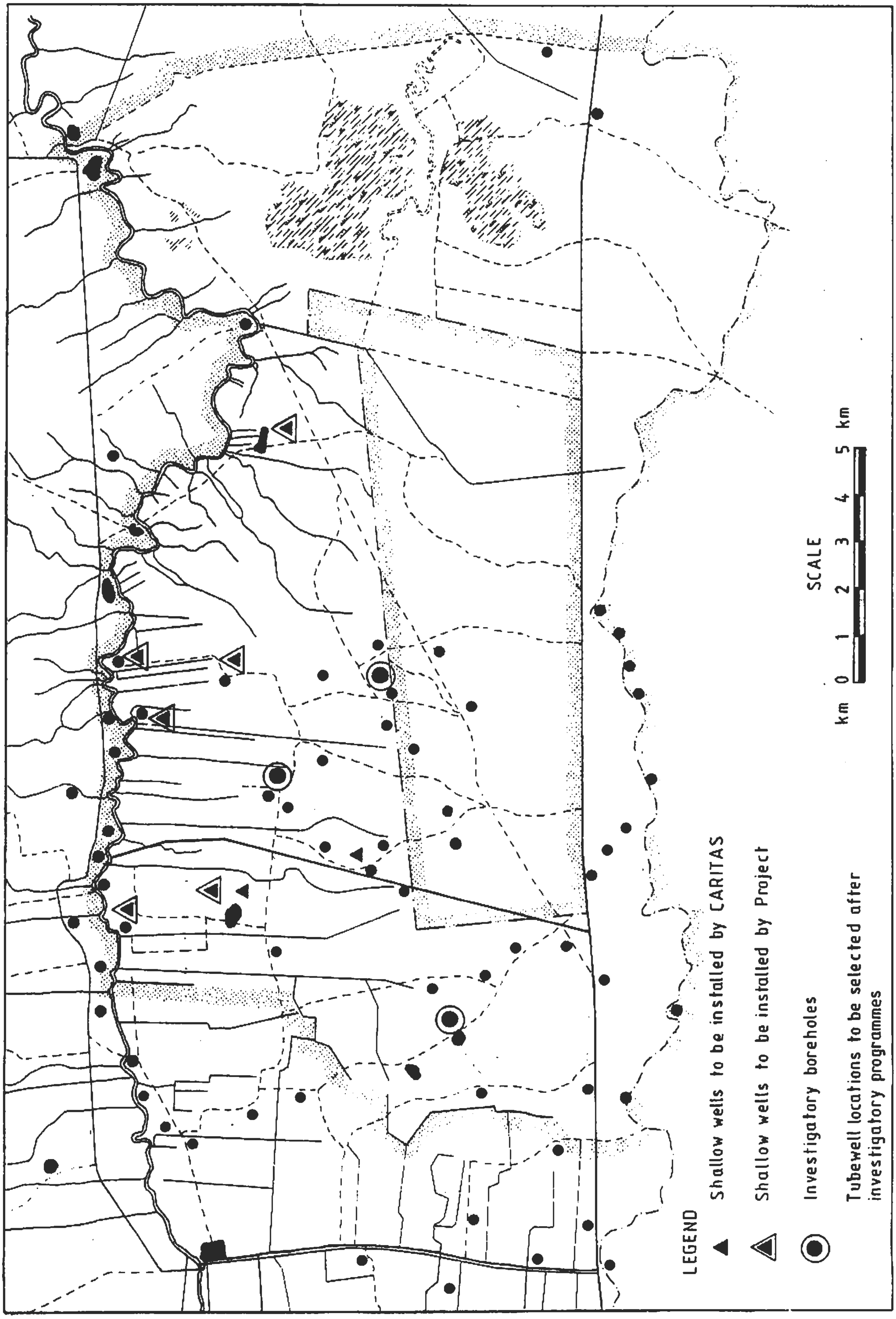
In addition the Consultant recommends that the same type of handpump be installed on the hand dug and borehole wells as are being installed under the successful CARITAS project. This will increase the likelihood of them being well maintained after installation.

3.6 Type of Supply

One of the first considerations in planning a programme is the last stage of implementation - operation and maintenance. How this is to be carried out will effect not only the pattern of implementation but the design and selection of plant to be installed.

Figure 3.2

Shallow Well and Borehole Programme



In most cases assistance in the maintenance that can be expected from central government will be minimal, therefore it is essential that effective operation and maintenance be possible at village level, with a committee responsible for ensuring that the water supply continues to serve its most important function in the community. To do this the installation must work satisfactorily and regular maintenance and necessary repairs must be carried out.

The choice of supply is dependent upon reliability, safety and cost, in that order. The reason why reliability takes priority is that unless the water is available for 365 days a year the user is forced to look for other supplies. In most cases this alternative source is unsafe so that the whole objective of supplying a safe supply is negated: a safe supply is most important. A good groundwater supply is to be preferred to one that requires treatment because there is the risk that any treatment can cease due to malfunction of equipment or the non-availability of chemicals. Cost cannot be given preference to reliability and safety, and careful consideration must be given to ensure any system can be maintained and the funds found to ensure this.

The type or system to supply will, in most cases, be dependent upon the depth at which a reliable water supply can be found. The use of the river Shabeelle as a source is restricted to the communities located within say 1 to 2 km from it and is not satisfactory for two reasons - at a number of periods the water would be unsafe unless treated and, most important, the river can run dry for up to 4 months in any year. Therefore the direct use from the river is not considered a feasible solution for any of the project area.

3.7 Implementation

No shallow wells will be installed at a village without the village making a direct request for assistance to provide a water supply. To speed up the installation the villages would not be asked to carry out the excavation as is the case with the CARITAS programme but the project would retain a contractor to do the digging, ring, cover slab and pump installation and to hand over to the village a complete operating well producing potable water.

Figure 3.2 shows the probable location of the six new shallow wells subject to the villagers affected making the necessary approach for a well and giving a guarantee they will ensure it will be maintained, etc. Three wells have been shown in the villages along the river, one at Busley Dawd, one at Tugaarrey and one at Sadiiq. One has been left to be located by the Project Co-ordinator with the engineer. From Figure 3.2 it will be seen that CARITAS has already been approached by the villagers of both Busley Dawd and Sagaaroole to provide linings and hand pumps for wells which the villagers will excavate themselves. These wells are included in the CARITAS Phase II programme and if the excavations reach a potable water stratum the well should be in operation by April 1988. It is proposed that the project construct a further well at Busley Dawd to provide for the population of 350 families.

The location of the boreholes cannot be fixed until the results of the investigatory drilling programme across the project area are available. Therefore these three exploratory boreholes must take priority and drilling should commence as soon as possible following the commencement of the project.

A schedule of the work envisaged is given in Table 3.3.

TABLE 3.3

Schedule of Work

Year	Shallow wells New	Shallow wells Rehabilitation	Tubewells Investigatory boreholes(1)	Tubewells Tubewell(2)
1	7	3	3	8

Note: (1) It is hoped that the investigatory boreholes, if successful, will be converted to production wells.
(2) Tubewell total includes 1 Nr drilled at Project HQ.

3.8 Operation and Maintenance

The operation of the well should be the responsibility of a well committee elected by the users. These committees should be elected as soon as possible following approval. Without such committees the likelihood of the continuous operation and maintenance of any well, shallow or tubewell, is very small.

These committees would have to arrange, inter alia:

(i) Time when pump could be used.

(ii) Provision of an attendant (if thought desirable).

(iii) Collection of an annual charge from users or some method of obtaining the necessary funds to pay for repairs and spares for the pump and other parts of the installation.

(iv) Ensuring that the area around the pump was kept clean and that no water was left standing in the immediate area of the well head.

(v) For the regular servicing of the pump and for the repairs when required.

A review of methods or systems to ensure that spares and a competent fitter are available within easy reach of the area was done and it is considered that the best solution is for the project to adopt the system being set up by CARITAS for its installations in the area. This is that CARITAS is arranging for a private mechanic with a workshop or store in Shalaambood to be responsible for repairing the pumps after installation. This method, which has been adopted and is working well with a similar set up based in Jelib for the Middle and Lower Juba, is as follows:

(i) CARITAS provides a supply of spares for the fast and slow moving parts of the pump to the mechanic.

(ii) When a pump breaks down, the village well committee contacts the mechanic who visits the well and carries out the repair.

(iii) The cost for the mechanics services plus the cost of the necessary parts is paid by the villagers with the exception that if the breakdown is due to a fault in pump construction or installation, the mechanic is reimbursed by CARITAS.

By the time implementation of the project elements commences the CARITAS system will be established for Shalaambood and it would seem advisable for the project to use it. It woud also seem appropriate for the project to use the same make of hand pump as that used by CARITAS. If this was agreed then the proliferation of spares would be avoided and the chances of a spare not being available reduced to a minimum. The provision of spares, especially of the fast moving type must be assured if the supply is to be maintained. In the past the lack of spares has resulted in a number of well-intentioned projects failing. One such case was the provision of windmill pumps to a number of communities. Within 2 years nearly every pump was out of action due to the lack of maintenance and spares. The method proposed for repairs and spares should reduce the risk of loss of supply to only short periods while repairs are carried out.

3.9 Cost Estimates

3.9.1 Shallow Wells

CARITAS reported that it was constructing the well rings for SoSh 5 000 (US$ 62.5), the slab cover for SoSh 10 000 (US$ 125) and the cost of excavation at approximately SoSh 1 200 per ring (US$ 15). The hand pumps were obtained for CARITAS Phase I from Austria but for Phase II are being bought in the UK at a cost of US$ 1 000 each CIF Mogadishu. Using these basic costs showed that a 10 m well would cost around US$ 1 900 and a 20 m well some US$ 2 300 excluding overheads, labour to complete installation and moving materials to site. To allow for a private contractor to bid on the installation of, say, seven new wells and to rehabilitate three existing shallow wells it is considered that a rate of US$ 4 200 per new well would not be unreasonable to allow for profit margin, etc.

3.9.2 Exploratory Wells

For the proposed exploratory programme of 200 m of drilling for three wells which if successful will be converted into production wells the WDA indicated that a rate of US$ 600 per metre would be required. To this must be added the cost of providing a suitable hand pump and ground level facilities for which US$ 4 500 per well have been allowed.

3.9.3 Boreholes

A private contractor estimated that for seven boreholes tested by a hydro-geologist, screened as required, tested and ready for the fitting of a hand pump would cost US$ 500 per metre. Assuming an average depth for each well of 50 m gives a production well cost of US$ 25 000 to which must be added cost of hand pump and ground level facilities of US$ 5 000 giving a cost for borehole well of US$ 30 000.

3.9.4 Summary of Capital Costs

Table 3.4 gives the costs of the sections of the well programme.

TABLE 3.4

Estimate of Cost for Water Supply to Villages

Description	Quantity	Unit	Unit rate (US $)	FE %	Amount (US $)
Shallow Wells					
Shallow wells including lining cover and hand pump. Average depth approximately 10 m	7	Nr	4 200	70	29 400
Rehabilitate/line existing wells and fit cover and pump	3	Nr	4 050	70	12 150
Exploratory Drilling					
Drill 3 Nr boreholes to check on groundwater levels and quality	200	m	600	50	120 000
Develop to usable wells. Assume 200 m total depth drilled. Fit suitable hand pump to wells above with cover	3	unit	4 500	90	13 500
Boreholes					
Drill up to 7 Nr boreholes average depth 50 m fit cover and hand pump	7	unit	30 000	70	210 000
Sub-total					385 050
Physical contingencies 10%					38 505
Total					422 455

3.9.5 Recurring Costs

As has been emphasised earlier it is imperative that the villagers using the water supply facilities have the ability to operate and maintain them and where necessary are able to finance the cost of spares and repairs, with minimal recourse to central government facilities.

The recurring costs for the various elements of the water supply systems are estimated to be as follows:

For shallow wells	10%
For borehole	5%
For hand pumps	10%

CHAPTER 4

FEEDER ROADS

4.1 Present Situation

The main Mogadishu - Kismaayo road traverses the project area running roughly parallel to the sand dunes - the south-eastern boundary of the project - and between 1 and 4 km from these dunes. This road, which is bitumen surfaced, is at present in need of major repair because the surface layer and, in some places, the sub-base has been broken through. Its condition has become so poor that a large proportion of the traffic which originally used the roads have rerouted their journeys so they use the new coral roads on each bank of the Shabeelle river. This road is a national highway which carries all road traffic between Kismaayo and Mogadishu and beyond, see Figure 4.1. The project boundary crosses it at Km 59 and Km 84.

There are two coral surfaced roads within the project area. The older is the coral road constructed by ONAT in the second half of 1986. This road takes off from the main road at Km 81 and crosses the area in a north-easterly direction for a distance of 12 km ending on the left bank of the river Shabeelle opposite the village of Khaliif. It is raised above the ground level and is provided with six culverts for the canals crossing the alignment.

The second coral surfaced road was also constructed by ONAT in November to December 1987. This road traverses the project area from the south-easterly boundary near Busley-Dawd/Laabaas to the north-west boundary near Aw Deegle. This road is also built elevated above normal ground level and provided with cross drainage culverts plus, where required, culverts to carry canals across the road.

These two coral roads are shown in Figure 4.2 together with the remaining unsurfaced dirt tracks in the area. During the rainy season the dirt tracks become impassable after the storms except for four-wheel drive vehicles and even these can get bogged down in the mud or at points where canals/drainage channels cross the track alignments. The construction standard of the culverts along these tracks in most cases leave a lot to be desired. Some consist of tree trunks covered with earth to span the waterway, the earth cover on the concrete pipe culverts is usually too little and the heavy lorry traffic soon breaks the pipe. The pipe diameters have in no way been selected to pass the flows required and little or no upstream or downstream protection is constructed so that the erosion from the water passing through occurs both sides of the track. At some locations, where canals cross the tracks, no structure has been provided so that even in the dry season when the canals are being used and for a period after, until the canal section dries out, an alternative route has to be found.

Any feeder roads to be constructed by the project must be provided with well designed and constructed culverts if the feeder roads are to be a useful project component.

A component of the now possibly abandoned Mogadishu fuelwood project was a road running parallel to the Caafimaad canal from the point where it offtakes from the river to where the canal crosses the main Mogadishu - Kismaayo road.

4.2 Criteria Adopted in Road Selection

The positioning of the feeder roads has been developed using the following criteria:

(a) As a general rule no major area of settlement or cultivation should be more than 3 to 4 km from a feeder road.

(b) Road alignments should pass through major areas of settlement or cultivation and link up with existing main access routes to the major markets of Mogadishu and Shalambood.

(c) Areas requiring access only in the dry season, when dirt tracks suffice, have not been considered for feeder road improvements. The Jilaal Moogi zone is an example of this.

(d) Spurs from the existing coral road through the area to connect village concentrations should be based on the shortest link and maximum catchment.

(e) Priority should be given to access to the largest population density areas.

4.3 Tracks Selected for Upgrading

Figure 4.2 shows the existing tarmacked and coral surfaced roads and the unsurfaced tracks within and in the areas adjoining the project area. Figure 4.3 shows the family population for group of villages. The average size of families within the area is 4.75, see Annex 8.

With the construction of the new coral road in late 1987 the study of the existing road network indicated that the best alignments to be followed and which would serve the largest population areas in the area were as follows:

(i) Alignment ABC. A length of 10.4 km passing through centres of population of 315 families. This road reaches the main Afgoye-Marca road at Km 69.

(ii) Alignment DEF. A length of 6.7 km joining the village of Aybuutey and a centre of population of 385 families to the main Afgoye-Marca road joining at Km 75.

(iii) Alignment GH. A short spur from the existing coral road constructed in 1986. This spur, of length 2 km will give access to a population of some 180 families centred around the village of Cambanaani.

The alignments of these feeder roads have been shown in Figure 4.3 and it will be seen that the project area with the addition of the proposed 19.1 km of roads will be provided with a network where all families will be within 2.5 km of a surfaced road except for part of the Jilaal Moogi zone between the roads where there are a few isolated settlements.

Figure 4.1
National Road Network

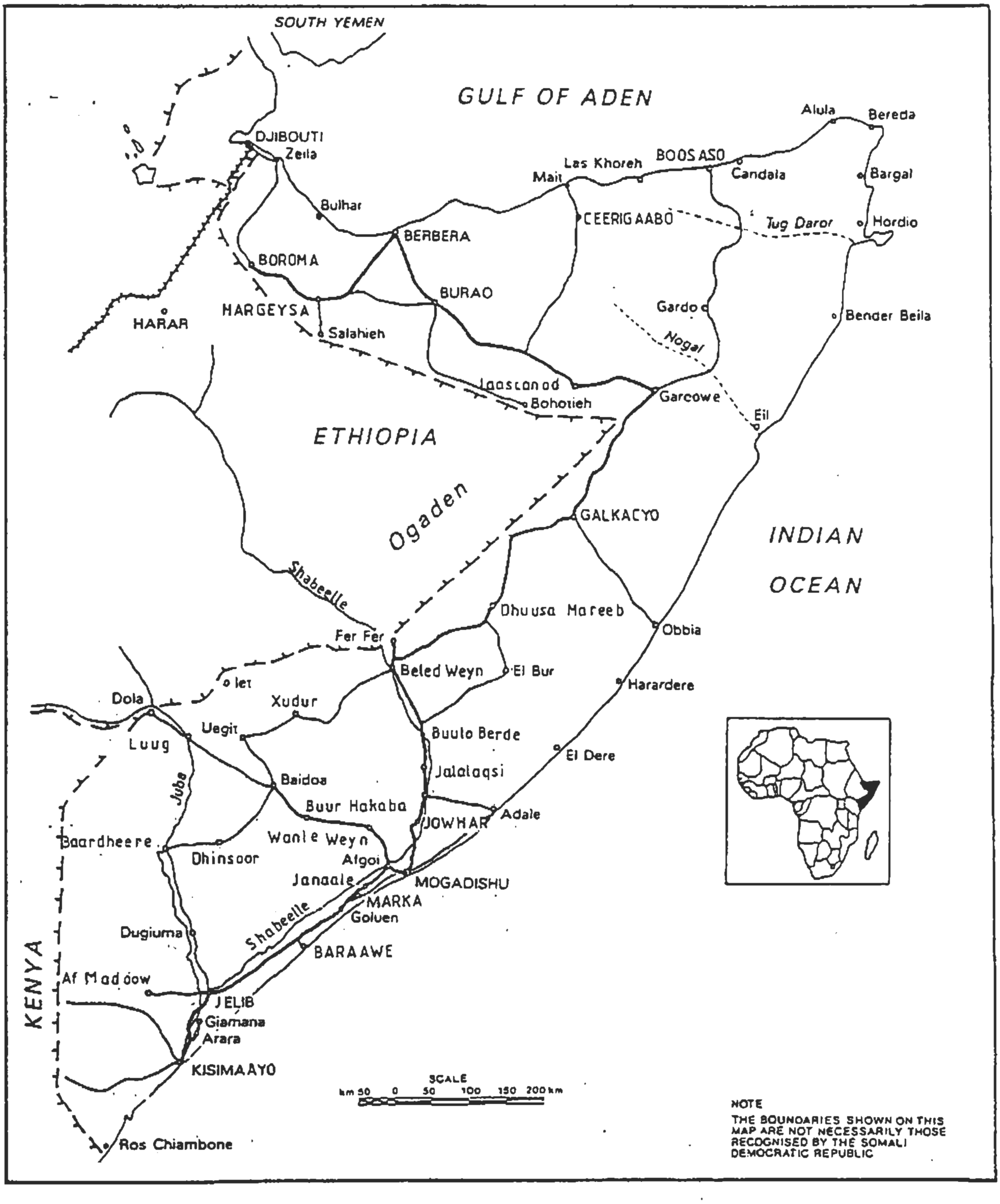


Figure 4.2

Existing Road Network

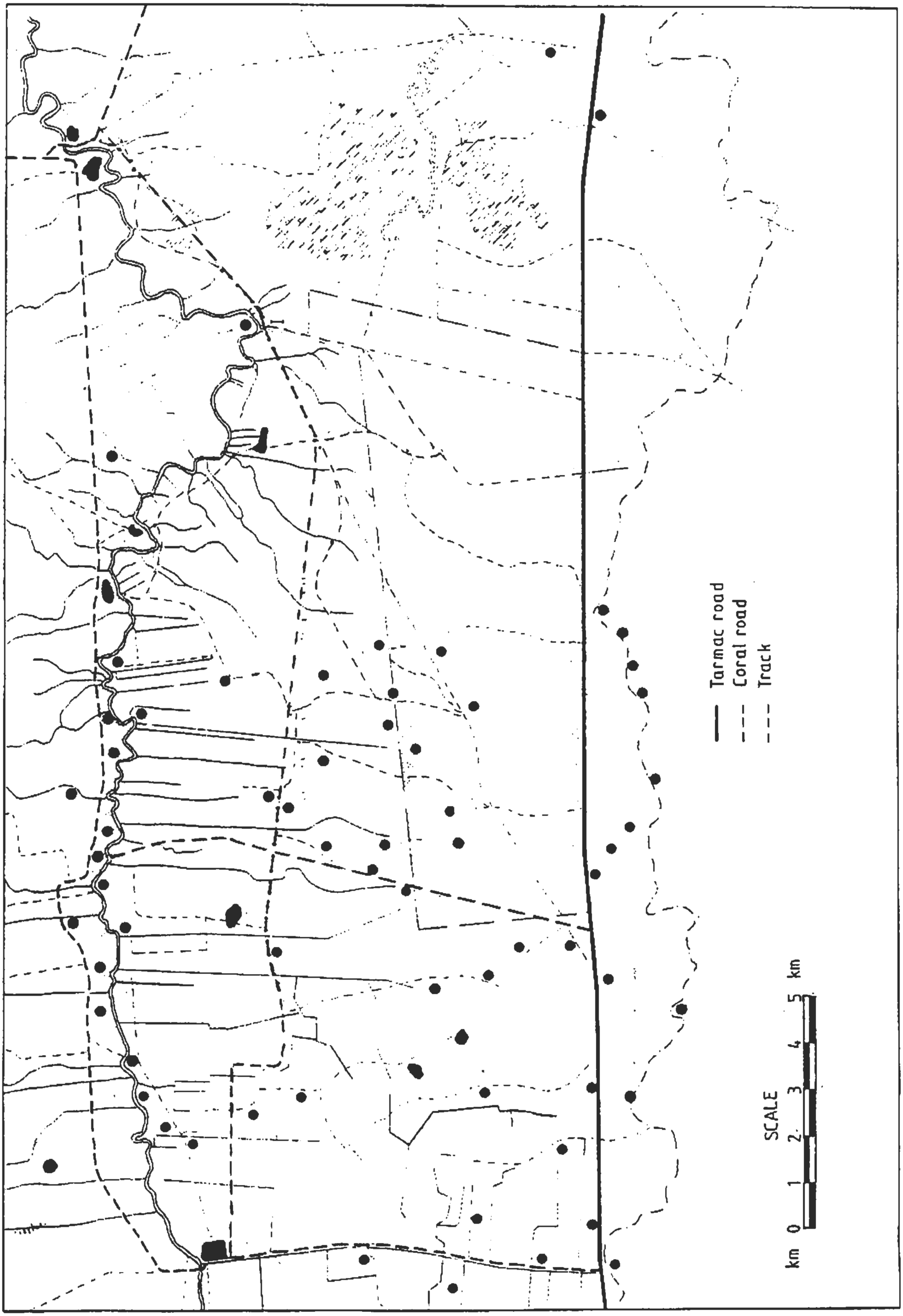
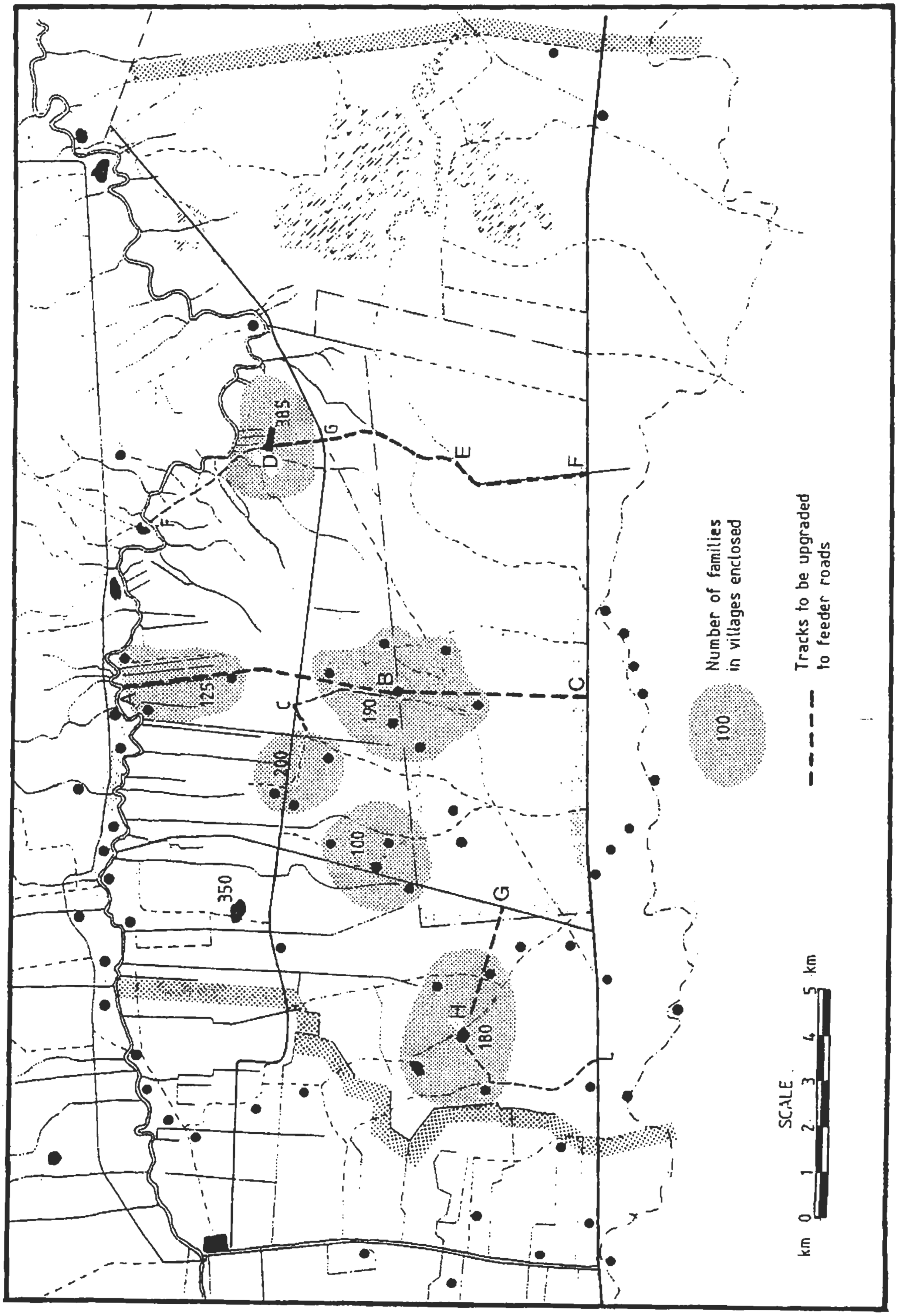


Figure 4.3

Feeder Road Programme



4.4 Survey of Selected Alignments

The lines of the selected feeder roads were surveyed and the longitudinal sections plotted. These are shown on Drawing 159201/22 in the album of drawings accompanying this report and the details are given in Table 4.1.

TABLE 4.1

Selected Feeder Road Programme

Section of track upgraded		Length	Number of culverts(1)	Families served
ABC	Sadiiq/Yarrow to Km 75	10.7	4	315
DEF	Aybuutey to Km 69	6.7	3	385
GH	Cambanaani to Km 2 on existing coral road	2.0	3	180
TOTAL		19.1	10	880

Note: (1) From Contract Drawing 1/10 in album.

4.5 Road Specification

The feeder roads must be constructed in such a manner that they will be usable during normal weather conditions but may need to be closed for short periods after very heavy rain storms. The reason for not using the feeder roads immediately after heavy rains is to avoid unnecessary damage to the surface which can be avoided if some of the moisture in the upper zone of the surface is allowed to dry out before being subjected to heavy vehicles. This simple precaution will avoid excessive maintenance which could otherwise occur.

It was considered that a suitable road surface could be obtained using crushed and rolled coral of a thickness of not less than 200 mm. This surface would be 4 m wide with a minimum of 1 m of the earth embankment on each side as shoulders to the coral surface. The embankment would be formed from consolidated, compacted earth, watered and rolled, with the top not less than 750 mm above natural ground level. The embankment would be provided with machine cut drains along each toe where required. These drains should ensure that all water collected in them is discharged either away from the road embankment or through the embankment in a pipe culvert and then away from the road where the ground slopes.

The proposed section for the road is given in Figure 4.4 and is given in more detail in the tender document (Contract Nr DSB 4). Basically the details are:

Width of road	-	6 m (1 m wide shoulders)
Width of coral surface	-	4 m
Thickness of crushed coral (minimum)	-	200 mm
Height of embankment above ground level (minimum)	-	750 mm

Details of typical road culverts are to be found in tender document (Contract Nr DSB 1).

4.6 Implementation Programme

ONAT, the government agency which has built a large proportion of coral surfaced roads in the Lower Shabeelle, constructed approximately 24 km of feeder road through the area during November/December 1987, hence a Contractor should have no difficulty in constructing the whole of the 19 km of feeder roads proposed in less than one year. Therefore the programme has been scheduled for Year 1 of the project implementation.

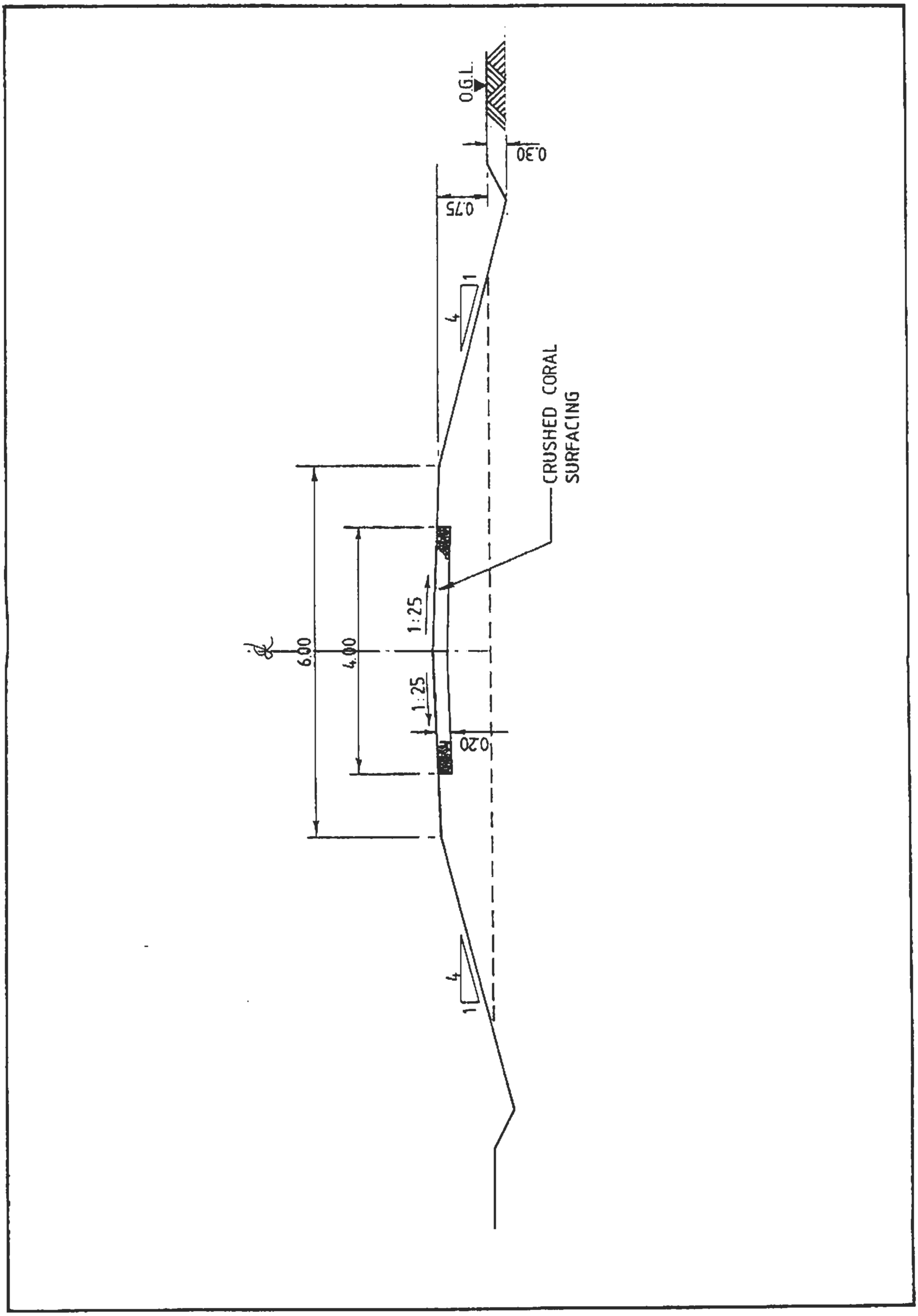
4.7 Cost Estimates

The capital cost of the roads is US$ 760 000 based on a rate of about US$ 40 000 per kilometre. This cost includes the provision of culverts to allow effective cross drainage. Ten culverts are required over the 19 km length of road approximately one per 2 km. This is much less than for the roads running parallel to the river where a sample survey showed three times this number because of the provision necessary to accommodate existing canals.

An annual recurring cost of 2.5% or US$ 19 000 has been adopted. This sum, equivalent to US$ 1 000 per kilometre per year is to maintain the road section, surface and culverts in good condition.

Figure 4.4

Feeder Road Cross Section



CHAPTER 5

BUILDINGS

5.1 School Buildings

Funds have been made available for the improvement of the school at Busley Dawd and the provision for a further standard block in traditional construction for use as accommodation for the teachers.

Materials for new work and improvements will be stored at Project Headquarters and issued as necessary. Standard connection details have been provided, and advice will be given to the community on construction approach and methods. The aim of this project is to reduce the annual maintenance burden and the advice and supervision given would take the form of a training programme.

The construction items held in the store would consist of:

(a) Timber for the construction of roof trusses, doors and window surrounds.

(b) Timber preservative against white ant attack.

(c) Galvanised iron tying wire.

(d) Nails.

(e) Black polythene sheeting.

(f) Chicken wire.

(g) Cement for wall render and floor construction.

Access to Busley Dawd and the school is by existing road, scheduled to be upgraded to a coral surfaced road during project implementation.

5.2 General Stores

Six stores in conventional construction have been provided at designated points within the project area. The stores, which have two attached offices, basic office furniture and some shelving within the storage area, will be used as collection points for produce, the storage of seed and fertiliser and for any other purpose which would suit the needs of the communities.

The stores have been situated on or near existing regraded or new roads and are shown in Figure 5.1.

5.3 Project Headquarters

The Project Headquarters has been sited at Ceel Wareego at the disused tubewell and windmill approximately 200 m off the main tarmacked road from Shalambood to Mogadishu. A new tubewell will be drilled and a new access road will connect the headquarters with the main road.

Expansive ground is expected in this area. Therefore the expansive soil will be excavated and replaced with imported granular material. There are sand dunes nearby and the replacement material is expected to be a suitable mixture of dune sand together with coral sand compacted in accordance with the specification.

The compound buildings extend over an area of approximately 0.5 ha and have the following facilities:

(a) Four semi-detached family houses for the project staff.

(b) One rest house with four bedrooms, lounge, kitchen for bachelor staff.

(c) One office block with separate offices.

(d) One central store with security fence surround.

(e) A rehabilitated or new tubewell together with water tank and pump.

(f) Generator and generator house.

(g) Fuel point and store.

(h) Reticulated water supply to all accommodation.

(i) Water-borne sewerage to septic tanks.

(j) Electrical distribution system.

These buildings are sited around a coral hardstanding. Table 5.1 gives the gross areas for each building and Figure 5.2 shows the site layout for the project headquarters.

TABLE 5.1

Project Headquarters Building Requirements

	Gross area (m^2)
Type.C housing (2 Nr semi-detached)	204
Office block 1 Nr	102
Rest house 1 Nr	102
Store	63
Generator house	30
Fuel storage	12
Coral hardstanding	

Capital costs for the project headquarters and the general stores are given in Table 5.2

Figure 5.1

Location of Project Headquarters and General Stores

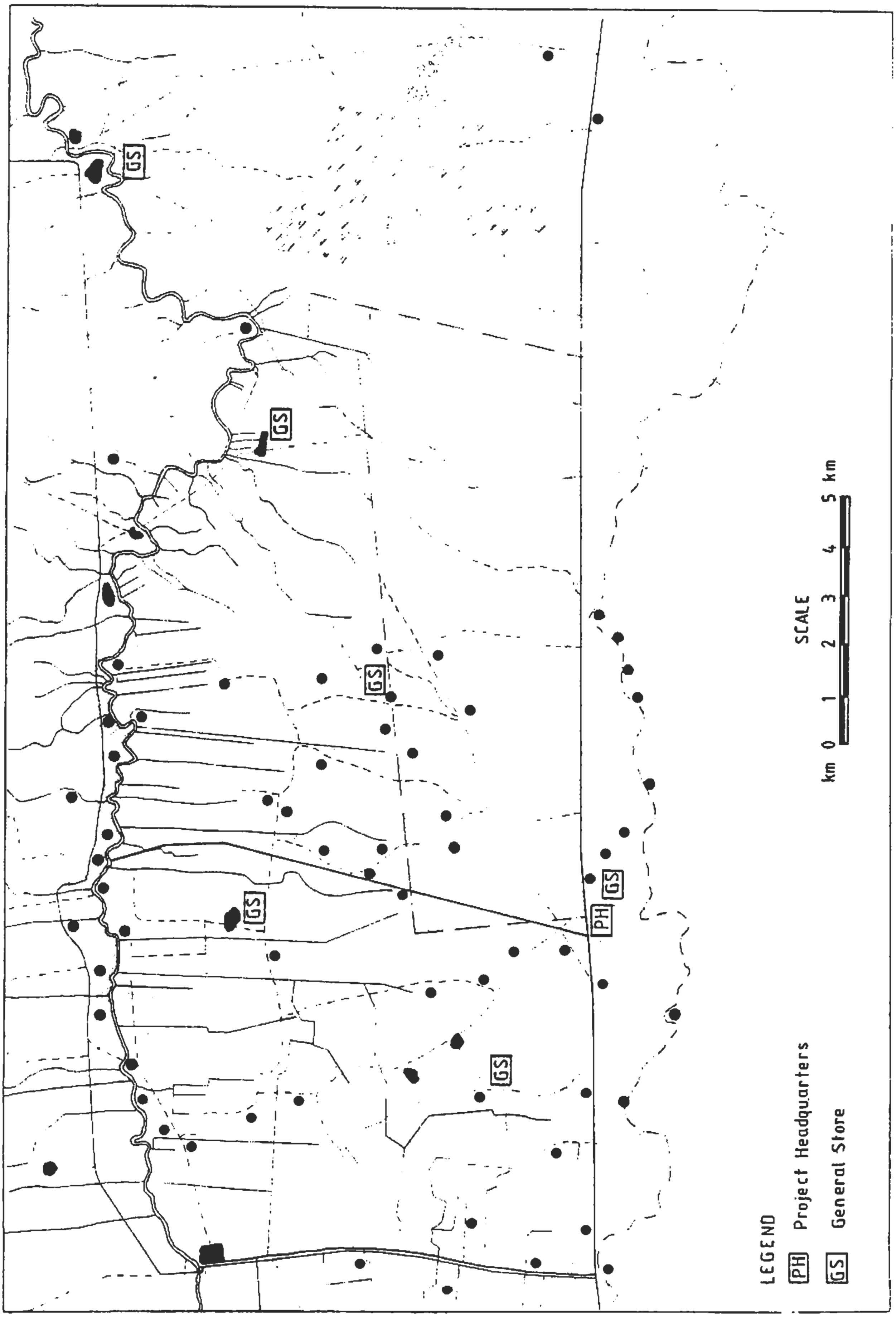


Figure 5.2

Site Layout for Project Headquarters

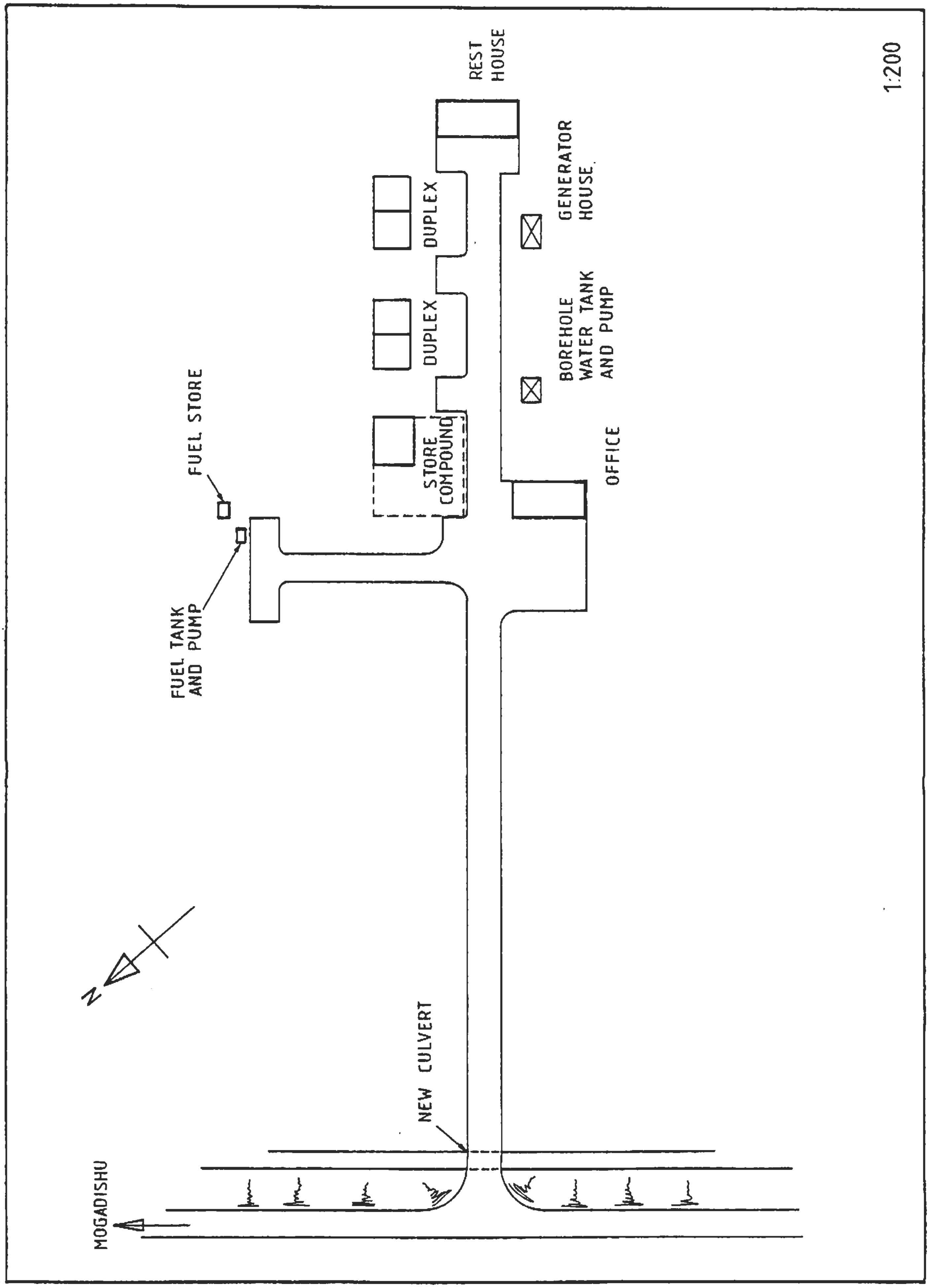


TABLE 5.2

Project Capital Costs

Item	Cost (US$)	Foreign exchange elements (%)
School buildings	25 000	90
General stores (6 Nr)	210 000	65
Fencing to stores	21 000	90
Type C housing	112 000	65
Rest house	56 000	65
Office	56 000	65
Store	25 000	65
Fencing to store	8 000	90
Fuel station	11 000	80
Borehole, pump and associated pipework	67 000	70
Elevated water tank	11 000	80
3 Nr septic tanks	23 000	60
Generator house	12 000	65
Generator	10 000	90
Access road and hardstanding	25 000	50
C housing furniture	10 900	75
Rest house furniture	6 350	75
Office equipment and furniture	4 500	90
Stores furniture (6 Nr stores)	4 150	75

CHAPTER 6

STOCK WATERING POINTS

6.1 Design

Stock watering points (uars) are required at the end of existing canals to avoid the problems of cattle migrating through the irrigated area to the river. The watering points are sized on the basis of providing sufficient water for 500 head of cattle during low river flows between the end of the der season and the onset of the gu floods. During this period it will not be possible to refill the uars by gravity flow. It is estimated that for 3 years in 4, this period will be less than 200 days. Assuming a daily water demand per head of cattle of 30 l/s the required net capacity of the uars is 5 500 m^3.

Losses from the uars will be due to surface evaporation, capillary evaporation from the perimeter soils and leakage. There will also be a recharge from rainfall on the water surface. It is estimated that the overall loss over a 200-day period will be 1.5 m.

The volumetric efficiency is the ratio of bulk excavation to useful storage provided. Depth in the most important variable affecting volumetric efficiency. An 8.0 m depth is the most cost effective for providing a given storage, but the depth has been limited to 4.0 m for ease of construction and design of inlet and outlet structures. There are negligible volumetric efficiency differences for side slopes varying between vertical and 3 : 1. Evaporation loss from the side slope storage is greater than from base storage so that a square base has been adopted to minimise the uar perimeter. End slopes of 1 vertical to 4 horizontal have been adopted to allow machine access during construction. Side slopes are 1 : 2.

The inlet from the gravity supply canal consists of a 0.45 m diameter pipe with a mass concrete outlet box. The culvert has been designed to dissipate excess head by promoting a hydraulic jump within the culvert. Water is abstracted from the uar by means of a hand-pump mounted on a reinforced concrete outlet structure. The hand pump discharges into a cattle trough.

6.2 Site Investigation

Within the project the soil horizons are underlain by a variable thickness of grey clay. Within the clay local sand lenses occur. A small mobile drilling rig will be used to ensure the proposed sites for the uars have suitable soil properties. The rig will be provided as part of the water supply programme.

6.3 Health Risks

The uars provide potential sites for the transmission of schistosomiasis. The water-borne disease has a water snail (Bulinus and Bromphalaria snails) as an intermediate host.

The snails preferred habitat is a permanent or semi-permanent source of well oxygenated water rich in aquatic plants and organic matter. The uars therefore are ideal and infected snails are are likely to be found in the shallow water around the shore-line.

Control of schistosomiasis is aimed at breaking the schistosomiasis cycle and is divided into:

(i) Elimination of the snail host;

(ii) Prevention of cercariae contact with the human host;

(iii) Prevention of parasite eggs reaching water bodies;

(iv) Elimination of parasite worms in the human host (chemotherapy).

With a large migrant population, chemotherapy is of limited use and only effective in conjunction with provision of clean safe water and sanitation. Snail control is considered the most promising method of disease control. There are four main types of molluscicide. Niclosamide (Bayluscide) is the most commonly used. It is effective against snails, snail eggs and cercariae but non-toxic to man and cattle. However it is expensive and difficult to obtain unless ordered a long time in advance. Trifermorph (Fiescon) is an extremely effective molluscicide but is not effective against snail eggs and cercariae. It is being used less frequently than in the past; one of the reasons being that it can only be ordered from the manufacturers, and in large quantities. Sodium pentachlorophenate and copper sulphate have been used for many years. Copper sulphate has the advantage of being continuously available and there is a large amount of literature on its use.

To prevent human contact with the stored water, uars should be sited far away from villages and alternative supplies of safe water should be provided at a closer site.

6.4 Implementation

The implementation for six new and one rehabilitated uar could be accomplished in one year and has been scheduled for Year 1 in the project implementation programme, see Figure 2.1, Annex 9.

6.5 Cost Estimates

The cost estimates for the uar programme are given in Table 6.1. The total capital cost is US$ 320 430 including 10% contingencies.

This figure excludes the three uars to be constructed in the Jilaal Moogi zone. These are costed separately under the Jilaal Moogi works, see Table 1.6, Annex 7.

It is estimated that the annual operation and maintenance costs for the uars will be 4%.

TABLE 6.1

Cost Estimate for Uars

Item Nr	Description	Qty	Unit	Unit rate (US$)	FE (%)	Amount (US$)
(a)	Construction of New Uar					
1	Bush clearance	1	ha	400	55	400
2	Earthworks	10 400	m^3	2.5	55	26 000
3	Structures:					
	(i) Inlet	1	Nr	5 100	55	5 100
	(ii) Outlet	1	Nr	5 500	55	5 500
	(iii) Cattle trough	1	Nr	2 700	55	2 700
4	Hand pump	1	Nr	1 200	90	1 200
5	Fencing	0.33	km	10 000	90	3 300
	Total					44 200
(b)	Rehabilitation of Existing Uar Assuming 25% of above earthworks					24 700
(c)	Total Costs of Programme:					
1	New Uar	7	Nr	44 200		309 400
2	Rehabilitation	1	Nr	24 900		24 700
	Sub-total					334 100
	10% contingencies					33 410
	Total					367 510
	Operation and maintenance costs (4%)					14 700

APPENDIX I

REFERENCES

CARITAS	1985	Progress Report, April '84 - September '85 CARITAS Somalia Water Project.
WHO	1986/87	Personal Communication

APPENDIX II

FEEDER ROADS - ORIGINAL TEXT JULY 1987

PRIOR TO CONSTRUCTION OF ADDITIONAL CORAL RD

CHAPTER 4

FEEDER ROADS

4.1 Present Situation

The main Mogadishu - Kismaayo road traverses the project area running roughly parallel to the sand dunes - the south-eastern boundary of the project - and between 1 and 4 km from these dunes. This road, which is bitumen surfaced, is at present in need of major repair because the surface layer and, in some places, the sub-base has been broken through. This road is a national highway which carries all road traffic between Kismaayo and Mogadishu and beyond, see Figure 4.1. The project boundary crosses it at Km 59 and Km 84.

There is only one other surfaced road within the project area: a coral road constructed by ONAT in the second half of 1986. The road takes off from the main road at Km 81 and crosses the area in a north-easterly direction for a distance of 12 km ending on the left bank of the river Shabeelle opposite the village of Khaliif. It is raised above the ground level and is provided with six culverts for the canals crossing the alignment.

The ONAT official responsible for its construction of this road stated that although the actual costs were not available, the cost per kilometre was between US$ 20 000 and US$ 25 000. ONAT had also recently rehabilitated the road from Km 89, just outside the project area from the main road to Janaale. This work included reforming of the embankment and coral dressing on a length of some 8 km. This road is approximately parallel and some 2 km from the south-west boundary of the project. Its rehabilitation is of direct assistance to the inhabitants of the area providing a good all-weather surface to the Janaale barrage crossing and joining the Janaale - Aw Dheegle -Afgoi road which is also coral surfaced for the whole of the way to Afgoi.

The unsurfaced dirt tracks which traverse the area are shown in Figure 4.2. They become impassable after rains, except for four-wheel drive vehicles and even they become stuck in the mud or at points where canals/drains cross the tracks. The construction standard of the culverts along these tracks, in most cases, is very poor. Some consist of tree trunks used to span the waterway and in only a few cases is there pipe of sufficient strength or of adequate diameter to carry the required flow. In addition, the earth cover over the pipes is often insufficient to prevent damage when heavy vehicles pass over them so that the pipes are cracked or broken in a very short time. Very little effort was seen of constructing any upstream or downstream protection at these culvert sites and flowing water had caused erosion in a number of cases. At some places, where canals cross the tracks, no structure has been provided so that even in the dry season when the canals are being used and for a period after, until the canal section dries out, an alternative route has to be found.

Any feeder roads to be constructed by the project must be provided with well designed and constructed culverts if the feeder roads are to be a useful project component.

A component of the now possibly abandoned Mogadishu fuelwood project was a road running parallel to the Caafimaad canal from the point where it offtakes from the river to where the canal crosses the main Mogadishu - Kismaayo road. There is also a road parallel to the river, at a distance of about 3 to 4 km from it. This road is at present being surfaced by MOA. It will greatly benefit communications within the project area but its construction will be a charge on the national road programme, and not the project. However, the road which would have been built out of funds allocated for the fuelwood project should now become part of the Dara Salaam Busley project.

4.2 Criteria Adopted in Road Selection

The positioning of the feeder roads has been developed using the following criteria:

(a) As a general rule no major area of settlement or cultivation should be more than 3 to 4 km from a feeder road.

(b) Road alignments should pass through major areas of settlement or cultivation and link up with existing main access routes to the major markets of Mogadishu and Shalambood.

(c) Areas requiring access only in the dry season, when dirt tracks suffice, have not been considered for feeder road improvements. The Jilaal Moogi zone is an example of this.

(d) Spurs from the existing coral road through the area to connect village concentrations should be based on the shortest link and maximum catchment.

(e) Priority should be given to access to the largest population density areas.

4.3 Tracks Selected for Upgrading

Figure 4.2 shows the existing tarmacked and coral surfaced roads and the unsurfaced tracks within and in the areas adjoining the project area. The figure also shows the family population for group of villages. The average size of families within the area is 4.75, see Annex 8.

All the tracks within the project area initially considered for upgrading to feeder road status are listed in Table 4.1. It will be seen that this list includes a total length of 42.5 km of tracks. Including all these tracks was considered to be too large an expenditure at this stage. Hence a further review was made, applying the criteria given in Section 4.2. This review resulted in the sections of track for upgrading by the project being selected and given a priority which reflected the order in which each should be constructed.

Table 4.2 gives the sections of track selected for upgrading for a construction programme spread over 4 years. The total length selected covers 19 km and serves 1 305 families and is shown in Figure 4.3.

The proposed programme results in over 90% of the families in the project area being served by the construction of 55% of the tracks considered suitable for upgrading.

Figure 4.1
National Road Network

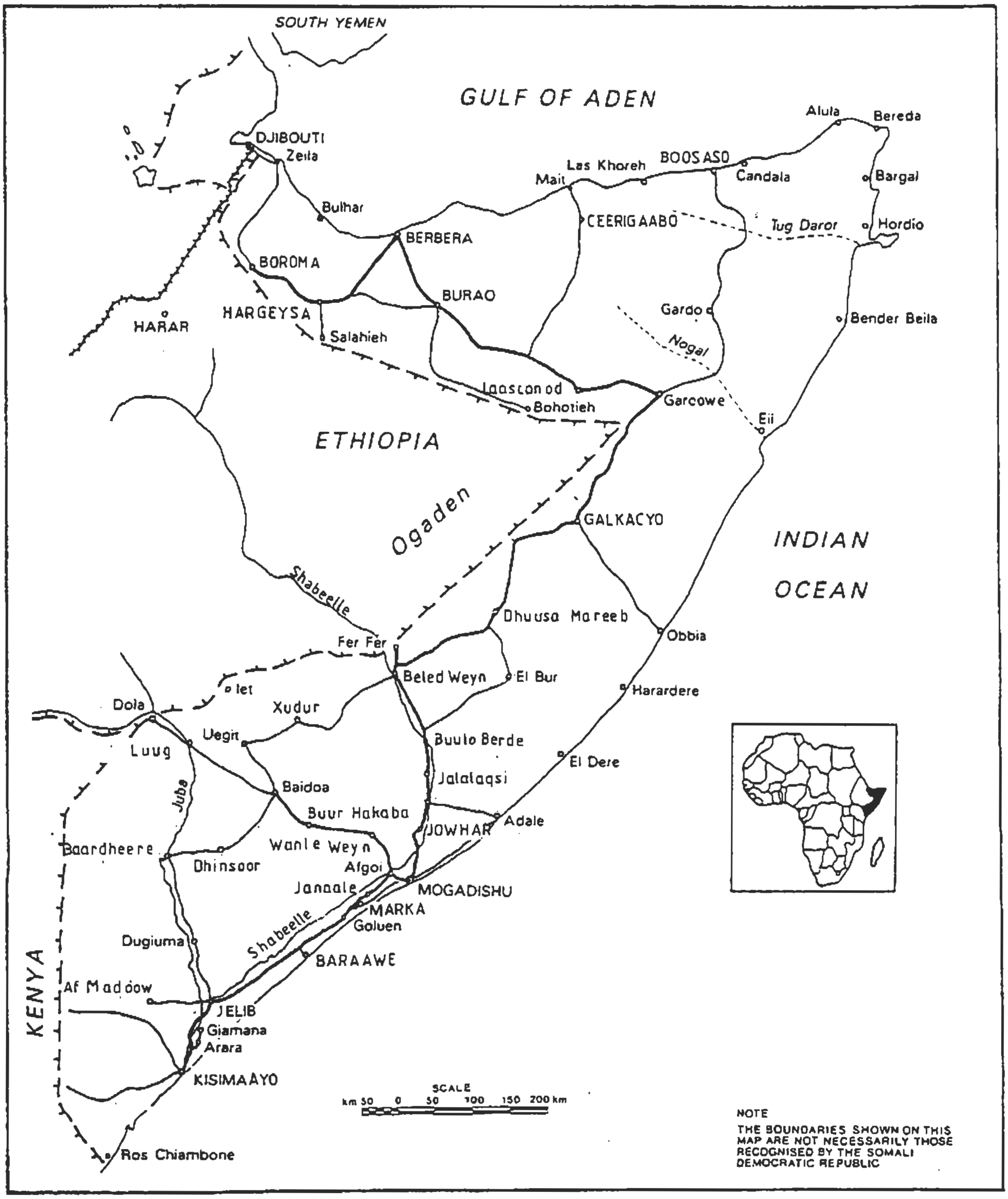


Figure 4.2

Existing Road Network

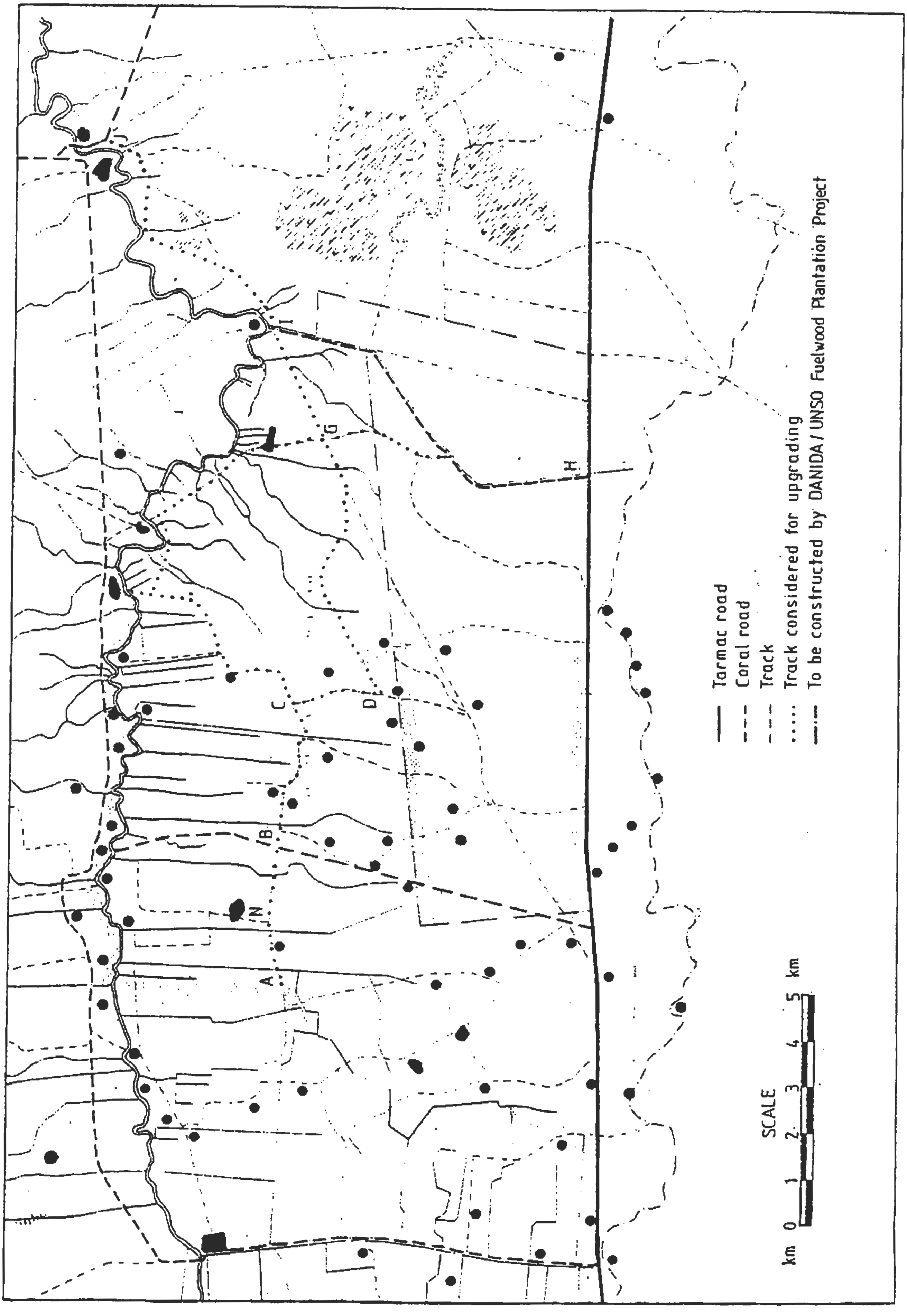


Figure 4.3

Feeder Road Programme

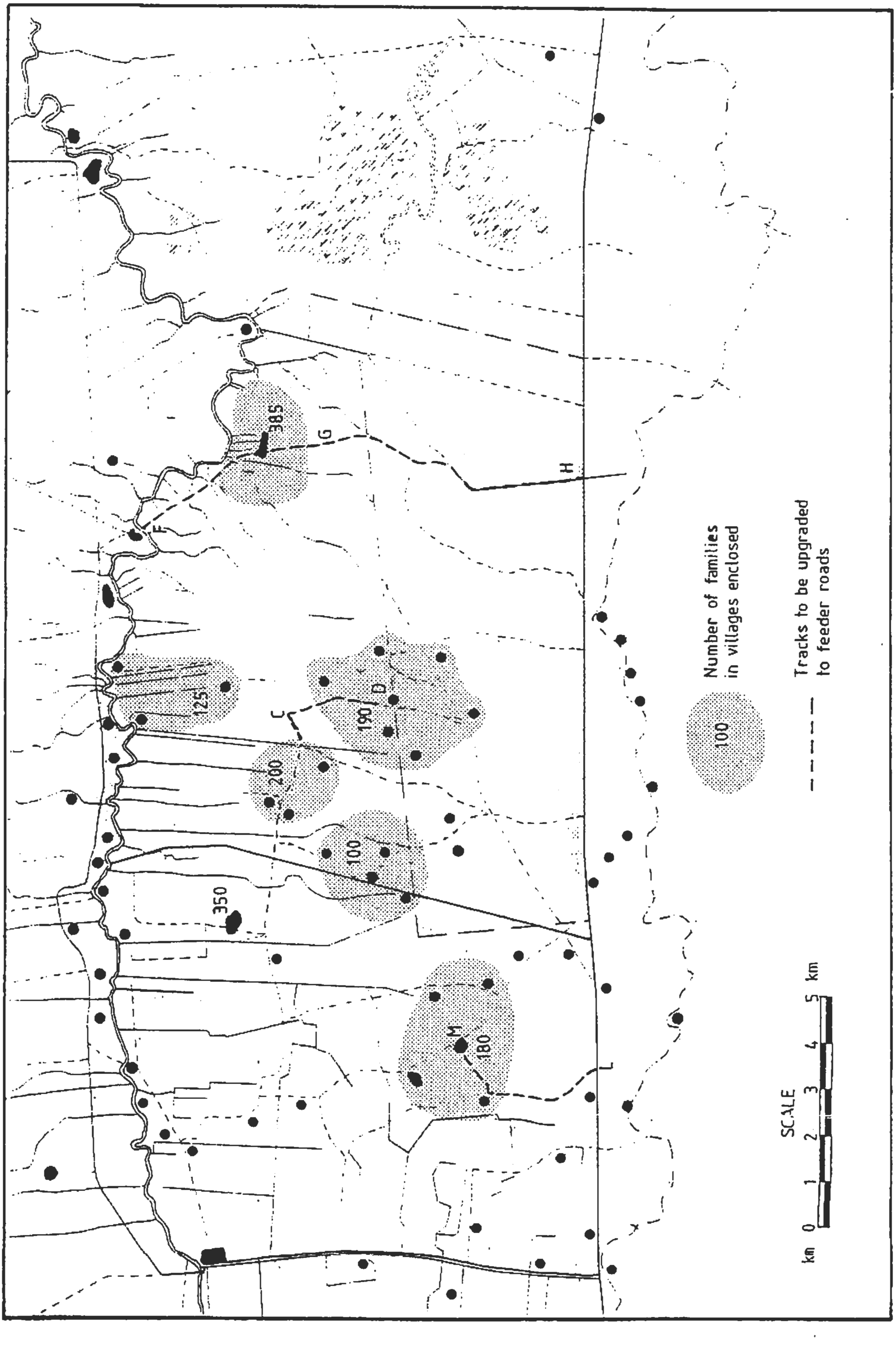


TABLE 4.1

Tracks Considered for Upgrading to Feeder Roads

Section of track	Length (km)	Catchment families	Families per km	Priority
A to B or N to B	3.2 (1.7)	350 (350)	109 (206)	(part of on-going works) 2
B to C	3.3)	200)	77)	(part of on-going works)
	) 5.5	) 390	) 71	1
C to D	2.2)	190)	66)	
C to E	5.2	125	24	5
E to F	1.3	-	-	
F to G	4.5)	385)	86)	
	) 7.7	) 385	) 50	1
G to H	3.2)	-)	-)	-
D to G	6.5	Few	-)	-
			)	(part of on-going works)
G to I	2.8	Few	-)	-
			)	
I to J	6.3	Few	-)	-
L to M	4.0	180	45	4
Total	42.5 (41.0)	1 430 (1 430)		

Note: (1) Track IHK upgrading is a component of Woodlot project. If it is not constructed before Year 1 then the present project will need to consider whether FGH warrant Priority 1 status. HK is 3.4 km and would cost approximately US$ 130 000.

(2) To construct all roads listed above would cost approximately US$ 1.85 million or approximately 25% of proposed EEC financial assistance. This is considered too large a proportion.

(3) To upgrade the track parallel to the river from Aw Dheegle to the project boundary (ABCDGIJ) would require a total of 24.3 km costing approximately US$ 1.07 million. The portions left for construction outside of project implementation is 17.1 km.

TABLE 4.2

Selected Feeder Roads and Construction Programme

Year	Section of track upgraded	Length	Number of culverts(1)	Families served
1	Dara Salaam - Caafimaad canal (FGH)	12.0	21	600
2	Coral road to Diinle Maxaad (CD)	3.0	4	390
3	Main road to Cambanaani (LM)	4.0	5	180
Total		19.0	30	1 170

Note: (1) Nr of culverts based on sample traverse showing approximately 1.6 culverts per kilometre of track.

4.4 Road Specification

The feeder roads must be constructed in such a manner that they will be usable during normal weather conditions but may need to be closed for short periods after very heavy rain storms. The reason for not using the feeder roads immediately after heavy rains is to avoid unnecessary damage to the surface which can be avoided if some of the moisture in the upper zone of the surface is allowed to dry out before being subjected to heavy vehicles. This simple precaution will avoid excessive maintenance which could otherwise occur.

It was considered that a suitable road surface could be obtained using crushed and rolled coral of a thickness of not less than 200 mm. This surface would be 4 m wide with a minimum of 1 m of the earth embankment on each side as shoulders to the coral surface. The embankment would be formed from consolidated, compacted earth, watered and rolled, with the top not less than 750 mm above natural ground level. The embankment would be provided with machine cut drains along each toe where required. These drains should ensure that all water collected in them is discharged either away from the road embankment or through the embankment in a pipe culvert and then away from the road where the ground slopes.

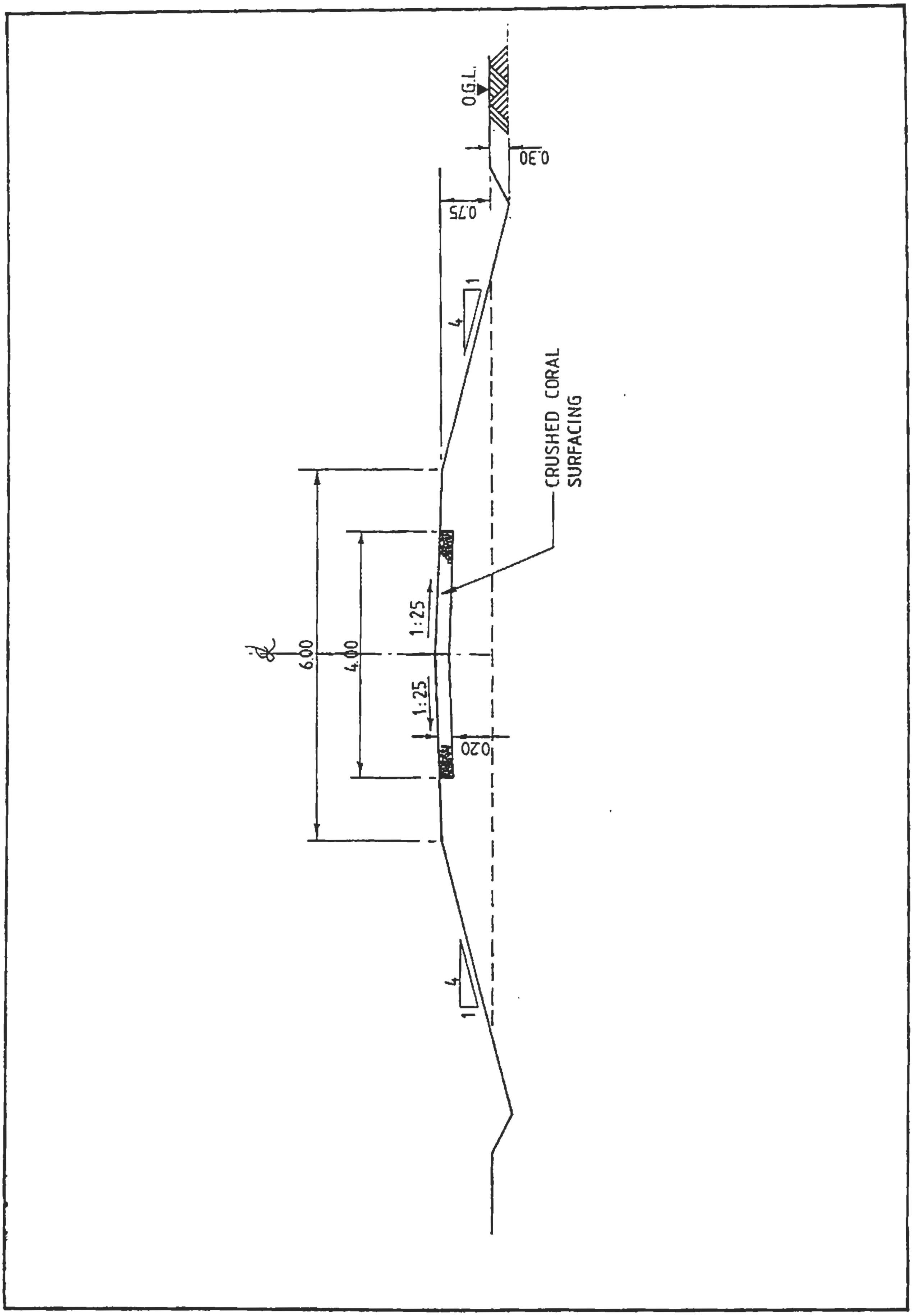
The proposed section for the road is given in Figure 4.4 and is given in more detail in the tender document (Contract Nr DSB 4). Basically the details are:

Width of road	-	6 m (1 m wide shoulders)
Width of coral surface	-	4 m
Thickness of crushed coral (minimum)	-	200 mm
Height of embankment above ground level (minimum)	-	750 mm

Details of typical road culverts are to be found in tender document (Contract Nr DSB 4).

Figure 4.4

Feeder Road Cross Section



ANNEX 7

JILAAL MOOGI ZONE

ANNEX 7 - JILAAL MOOGI ZONE

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ANNEX 7

JILAAL MOOGI ZONE

1.1 Introduction

The Jilaal Moogi area (Jilaal Moogi means 'does not know the jilaal (drought/dry period)') covers the north-eastern part of the project area. Its boundaries are the north-east boundary of the area that was designated for the Fuelwood Project, the Shabeelle river, the track from Aw Dheegle to the main Mogadishu-Kismaayo road and finally the Mogadishu-Kismaayo road itself, see Figure 1.1. The total area is approximately 6 425 ha, see Table 1.1. Of this 1 440 ha lies within the area formerly designated as the Fuelwood Project which contributes some runoff from rainfall. The remaining 4 985 ha includes about 1 285 ha that could be available for agricultural development if flood protection were to be provided.

The two swamp areas identified from the 1983/84 air photography are 1 310 ha. The zone is roughly divided into two equal parts by the Togga Farta Jawhar, an old river course, see Figure 1.2.

At the point about 3.75 km downstream of the Aw Dheegle road bridge the river bank on the left side has been breached and has been used to permit the discharge of water from the river at high flows. The breach is about 6 m wide at its invert; the invert level is about 73.50 m. A canal leads from the breach in a south-easterly direction for some 2 km where it divides; a small, narrower, deeper channel takes off to the right. Some distance further on, both channels cease to exist. Although in the headreach some attempt was made to form banks with the excavated spoil, after about 1 km all evidence of any banking disappears so that at high flows water overtops the excavated section. The farmer owning the farm opposite Jowhar adjacent to the Caafimaad canal reported that his land was flooded in the area furthest from the river. The canal survey also confirmed a number of old canal systems dating back to the 19th century which have been abandoned as a result of flooding from the breach.

1.2 Present Situation

The Jilaal Moogi area has a number of special characteristics and economic uses which demand careful analysis. Nowhere else in the project area, or in close proximity to it, is there a similar ecological environment providing seasonal resources for a wide range of economic activity, nor could this resource base be easily reproduced as a result of development activities. The area cannot therefore be equated to undeveloped bush land which might occur elsewhere in the project area.

The special attributes of the area are:

(a) It maintains a reservoir of water long into the dry season which sustains an ecology and resource base not available elsewhere.

(b) The special ecology is characterised by a range of distinct flora and fauna, including valuable grasslands, reeds, fisheries, tree species and wildlife, each of which provide significant economic benefits and out-of-season employment opportunities.

The most obvious value of the area is as a dry season grazing reserve. The natural moisture loving grass species which grow in the area (including Echinochloa and Andropogon spp) are highly palatable as young shoots. In terms of productivity these grasslands are estimated to provide twice as much dry matter as the irrigated lands but, more importantly, the fresh green growth lasts much later into the dry season. The following systems of utilisation by animals have been identified.

(i) Grazing and watering in the dry season.

(ii) Grazing and watering on a regular annual basis in the dry season which originate from Bay and the Middle Shabeelle Regions. The stock are usually accompanied by herders only.

(iii) Grazing and watering under drought conditions when the area becomes a strategic contingency reserve. This situation prevailed at the time the Consultants were surveying the area, when whole families had migrated from the Middle Shabeelle and Central Rangeland areas.

(iv) Utilisation by wildlife.

(v) The area has the highest stocking rate in Somalia during the jilaal: the vegetation continues to grow after being eaten down, because of the moisture in the soil. Its denial as a grazing reserve of last resort would cause possibly unsurmountable hardship to the many migrants now using the area, especially in bad years.

Of these systems the use of Jilaal Moogi as a strategic drought contingency area cannot be under-estimated, given the frequency with which regional droughts occur. Hippopotami which had been forced to leave the dry river bed of the Shabeelle were seen in the area in April. A number of species of wildlife were seen including warthogs, monkeys, reptiles and water and wading birds. The existence of the swamp acts as an alternative habitat for these species: without it they would become a major pest problem on the nearby irrigated lands.

The next most valuable resource of the area is produce from the swamp zone which only dries out late in the dry season if at all. This area produces a significant quantity of tall reeds which are utilised for thatching over a very wide area and are even being exported into Mogadishu by the truckload. Locally, bundles of thatching reeds were selling at SoSh 30 which, if conservatively translated into an equivalent value per hectare, would compare very favourably with a high value irrigated vegetable crop. The fact that this roofing material is within easy reach of a great number of families means that great savings can be made on the family budgets for housing costs and roof maintenance. It is also significant that this resource is exploited at a time of slack labour demands and thus provides an important dry season income and employment opportunity.

For those who eat fish, the swamp provides a valuable source of supply and employment throughout the year and particularly in those years when the river dries up. No data on production are available. Fish are sun-dried and serve as a source of food for the many fishermen and their families.

Figure 1.1

Location of Jilaal Moogi

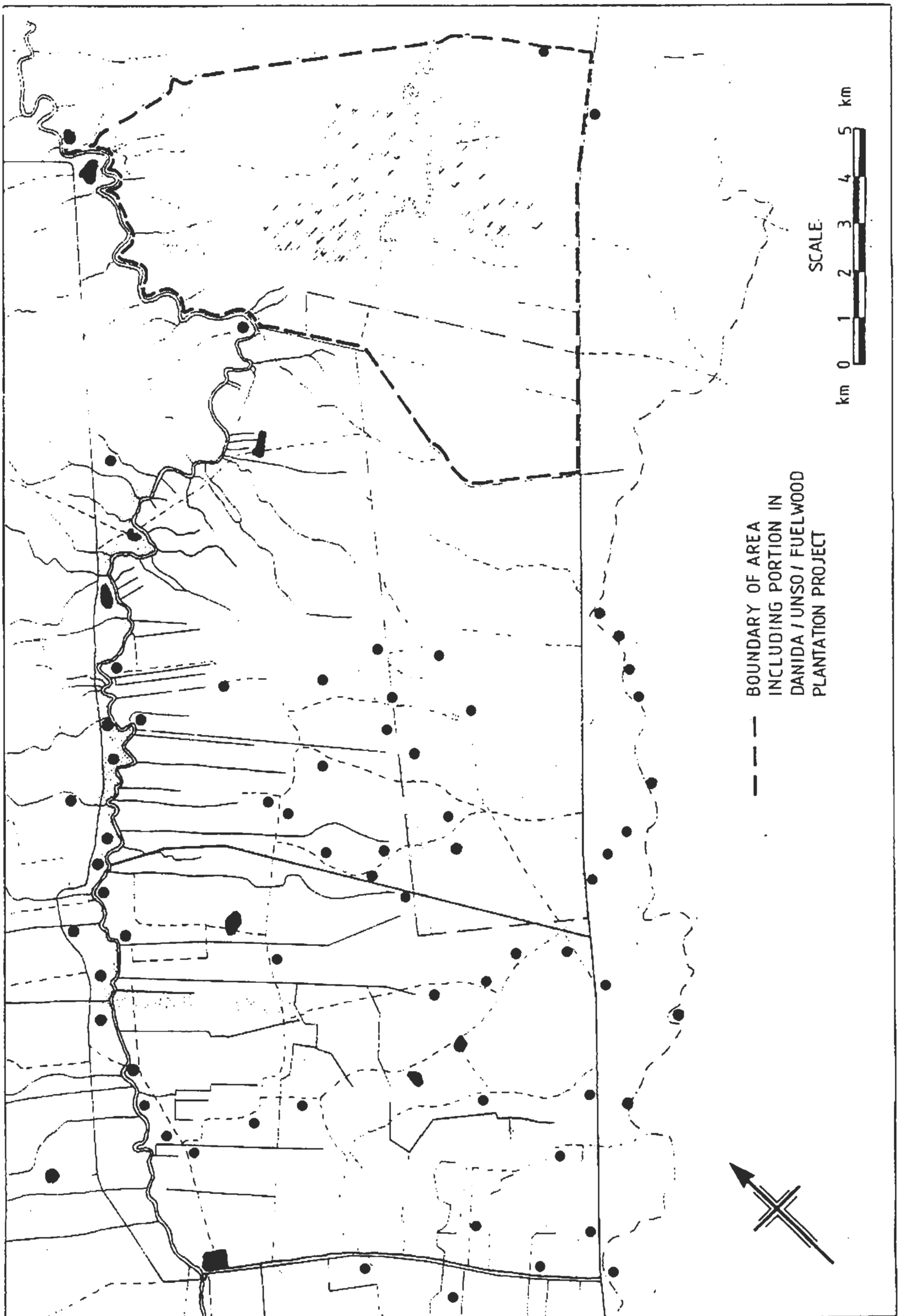
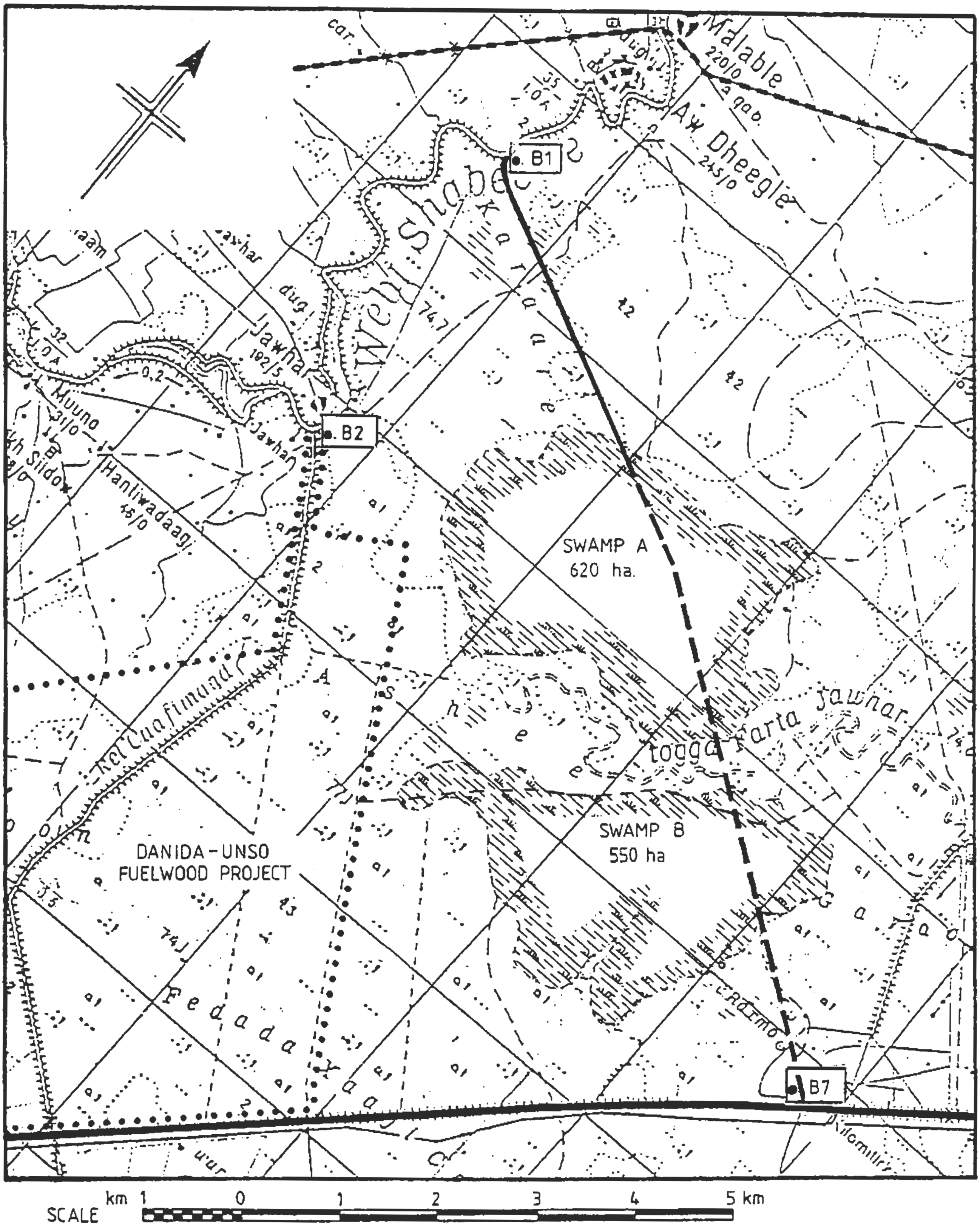


Figure 1.2

Jilaal Moogi Zone



Canal .... (solid line)
Survey line.......... (dashed line)
Project benchmarks.... ● B1
Tarmac road .... (thick line)
Coral road............ (dashed line)

The moisture status of the swamp zone enables the productivity of tree species to be maintained above that of dryland areas elsewhere in the project area. The swamp zone trees provide both fuelwood and building timber which is already in short supply elsewhere. Much of Marka's and even Mogadishu's firewood supply comes from this area. As the swamp recedes in the dry season, small-scale cutting and truck operators arrive to extract timber. This operation is again limited naturally by the flooding regime and produces additional dry season employment opportunities.

While the swamp may have attributes, it also has disadvantages. The most significant is that it provides an ideal habitat for tsetse fly. Its use as a grazing area thus faces the attendant risks of trypanosomiasis. In a drought situation, the alternative of stock losses from trypanosomiasis with guaranteed grazing to that of no grazing is acceptable to stock owners facing imminent total loss of stock.

1.3 Development Strategy

The development of the Jilaal Moogi zone was requested as a specific study by the Client early in March 1987 soon after the arrival of the Consultant's team. Originally the Client required to know whether the breach was acting as a means of flood relief at high river flows and whether this relief was in fact necessary. Subsequently, after further discussions it was agreed that the study should be enlarged to cover the following aspects:

(i) To maintain the swamp in its present form.

(ii) To use the swamp as a means of flood control for the river peak flows if a flood hazard was identified.

(iii) To drain the swamp and make the land available for cultivated farmland.

(iv) To use the swamp system to provide additional stock watering points near the Mogadishu-Kismaayo.

To maintain the swamp in its present form is the main recommendation made by the Consultant, subject to some modifications to the system. The reasons behind this are that the hydrologic analysis indicates that since the introduction of the flood protection systems installed upstream, there is little reason to suspect that serious flooding downstream of Aw Dheegle should occur in the future. Since the swamp lies mainly in a natural depression, the costs of pumping to remove the accumulation of annual runoff to allow cultivation to take place would be prohibitive. It is also unlikely that the economic benefits of seasonal cropping would exceed the existing production of reeds, livestock grazing, fuelwood, timber, fisheries and seasonal income and employment which it currently provides at very little cost. Also the present products and seasonal economic opportunities provided by the swamp zone could not be substituted or replaced by cultivation systems. Furthermore, if cultivation needs to be extended there are still large areas within the irrigation and rainfed zones available for redevelopment before moving into a swamp zone. There is, however, a good case to be made for returning the river bank strip to cultivation for a distance of about 1 km from the river by providing a small flood protection bund. Thus as water is passed down the proposed Jilaal Moogi canal it should not flood back onto the irrigated strip along the river. The area of this zone is some 1 285 ha and would contain 830 ha of existing grassland which could be developed for irrigation. The land area is summarised in Table 1.1.

TABLE 1.1

Land Areas Within the Jilaal Moogi Zone (1)

Land use		Agricultural development zone area (ha)	Swamp development zone area (ha)	Total area (ha)
Cultivated				
- Bananas	5 ha			
- Grapefruit	5 ha			
- Seasonal crops	195 ha			
		205	-	205
Fallow		190	-	190
Grassland(2)		830	1 785	2 615
Dense bush		60	605	665
Permanent swamp		-	1 310	1 310
Villages		5		
Sub-total		1 285	3 700	4 985
Area in fuelwood project		1 440	-	1 440
Total(3)		2 725	3 700	6 425

Notes: (1) The Jilaal Moogi zone extends from the main tarmac road to the river with the fuelwood project and Caafimaad canal as its south-western boundary and the track from Aw Dheegle to km 59 on the north-eastern boundary. This, therefore, includes an area along the river bank which is to be reserved for irrigation development when adequate flood protection is provided. The existing farms developed between the tarmac road and the swamp at Km 60 village and also set aside for agricultural development purposes.

(2) This area of grassland is reclassified in the main project area analysis as presently uncultivated land.

(3) All figures rounded to nearest 5 ha but summary totals are derived from additions of the unrounded figures; therefore rounding errors appear to occur in the Table.

Providing additional stock water points near the road does not seem to present any problems and might be linked to ensuring a continued water supply to the small co-operative farm at km 60 which already utilises excess water draining from the swamp.

1.4 Flood Hazard Between Aw Dheegle and Janaale and Beyond

The occurrence of flooding from overbank or through bank in the Aw Dheegle - Janaale reach of the river is mentioned in a number of reports going back to the 1920s. A map (possibly dating from 1950) showing the azianda boundaries indicated that between Mubaarak and Janaale there were nine points on the left bank where the river had broken through and caused damage.

The Water Control and Management of the Shabéelle river published in November 1969 reported:

> **"Afgoi to Genale (104 river kilometres)**
>
> Flood spillage takes place all along this reach through minor breaches of the natural banks opened by the local farmers to provide 'faf' inundation for grazing purposes. These breaches are difficult to keep repaired due to large numbers of hippopotami which break down small banks and re-open repaired breaks during their nocturnal foraging. At places such as Johaa-Morbarech (Mubaarak) the ground level to the south of the river is lower with old water courses or traditional faf inundation channels carrying flood spillage to fields and grazing areas. It seems likely that most of the serious breaks in the river bank stem from attempts by local farmers and herdsmen to inundate their land for farming or grazing purposes. The manpower is not available to control these outlets and the breach rapidly widens and scours. There is a considerable delay sometimes several months before Government help is given. The main problem, when flooding has occurred, is that access for earthmoving machinery to effect the repair is usually impossible as all access routes are also flooded. In the reach near Genale the banks are kept in a reasonable state of repair by the banana plantation owners and adequate manpower and machinery is available to repair any bank failures quickly."

These observations were supported by the areas that were flooded between the Barire canal and Janaale in 1968 and are shown in Figure 1.3. The main feature of this flooding was the continuous water along the northern side of the main road, filling the road embankment borrow pits. This extended over nearly 35 km and proved invaluable for watering stock using the main road.

The Ministry of Agriculture carried out extensive flood control works along the Shabeelle following the change of government in 1969. The Ministry's 1972 Annual Report stated:

(i) Desilting and extension of Barire canal (Gaan Barwak) covering some 15 km.

(ii) The damage to the river embankments caused by inundation farmers digging canals through them without regard to topographic conditions, proper design or control gates had increased the flood hazard in a number of places along the river including Marka District.

(iii) The Irrigation Section of the Ministry using its own tractors plus some 6 000 hired bulldozer hours carried out extensive flood control embankment improvements along both the Shabeelle and Juba during the year. The embankments on the Aw Dheegle - Janaale left bank received attention during this work. A break was reported in September 1972 some 2 km downstream of Jowhar-Aw Dheegle through which 10 to 15 m^3/s was escaping. It took 10 days to close this break.

The Consultants engaged in 1977/8 on the Genale-Bulo Mareerta Project did inspect the flood banks between Ugunji and Janaale and reported that the banks were generally adequate, with freeboards of about 0.4 m, with low sections down to 0.2 m around villages.

The present study team has visited all of the river bank from Malable to the downstream boundary of the project opposite the village of Siiqaale. No evidence was found of flooding having occurred except in the Jilaal Moogi zone which was deliberate if not controlled.

The study of the river gauge records for Aw Dheegle shows that there has been an increase in recorded flood levels in recent years. It is the considered opinion of the Consultants that this increase has been caused by at least two factors - the increased silt load causing a general rise in the bed levels due to sedimentation, and the debris and silt deposited upstream of the partially destroyed bridge at the present Aw Dheegle gauge site has reduced the effective river section. It is essential that the gauge be removed from its present location to a site near the new road bridge and that a new stage discharge curve be established. The work could be carried out by the engineering staff of the Dara Salaam Busley project who could use gauging equipment on loan from the MOA.

It is concluded that there is no need to build a flood relief structure escaping into the Jilaal Moogi area. However, as explained in Section 1.3, Development Strategy, the need to continue the present regime in the area makes the need for a supply of water to this area imperative.

1.5 Field Study

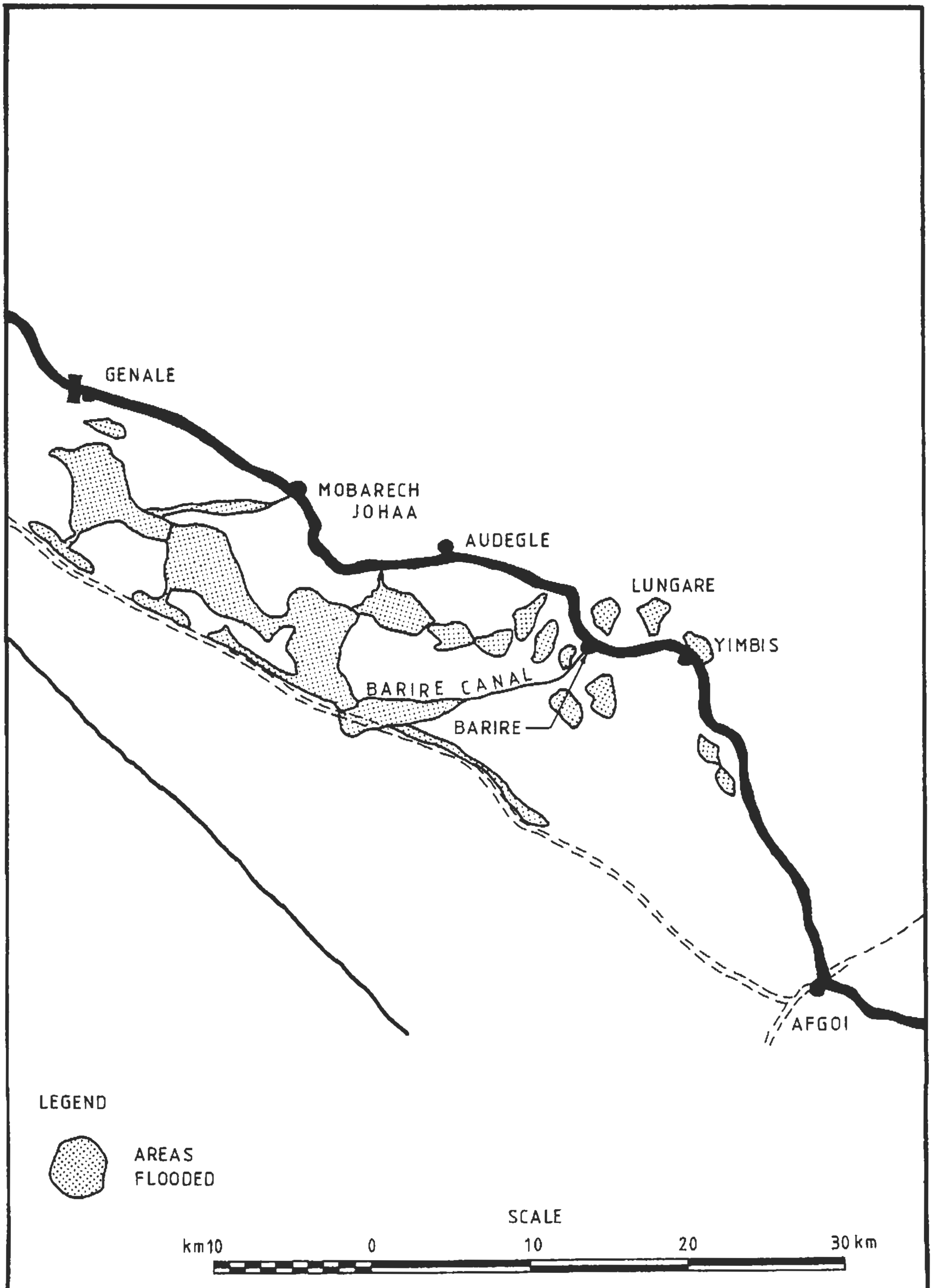
The available 1976 mapping was at a scale of 1 : 100 000 and 1983/4 air photography was 1 : 30 000. The offtake and headreach of the canal is obscured on the 1983 air photographs by smoke from a large fire located about 2.25 km from the river. Unfortunately the next air photo run Nr 60 taken a year later did not include the obscured portion of the canal.

In order to obtain a section along the proposed canal a longitudinal section was levelled from the river to the main Mogadishu-Kismaayo road. The line followed by this survey is shown on Figure 1.4. Due to very heavy bush in the vicinity of the Togga Farta Jawhar it was necessary to relocate the survey line to avoid this dense bush section. From Figure 1.4 it will be seen that this diversion section has been used to provide the levels along the straight alignment. For the purposes of the study this approach is considered adequate.

The swamp observed by the field party at the time of the survey commenced at Km 3.3, see Figure 1.4. Due to the nature of the flooding and reed growth it was not possible to define the swamp areas precisely.

Figure 1.3

Lower Shabeelle River Areas Flooded 1968



SOURCE : SHEBELLI RIVER REPORT (HTS/MMP, 1969)

1.6 Abstraction Rate

The swamp at present receives its water from two sources - precipitation and inflow provided by abstractions from the river through the existing breach and canal. The swamp loses its water through infiltration, evaporation/evapotranspiration plus the very small quantity of water taken by humans and animals.

Table 1.2 gives the probable losses by evaporation or evapotranspiration and the 75% reliability rainfall figures for the area. In addition field tests in similar soils in adjacent areas have shown that the infiltration rate into dry cracked soils is 300 mm for the first 5 hours then zero; for damp soils 80 mm in the first 7 hours then zero; and for wet soils the infiltration rate is zero.

In calculating an abstraction rate from the river the following points need to be considered:

(i) What area of swamp it is planned to be flooded.

(ii) For what period is the swamp to retain standing water. By what date is it filled and by what date should the standing water disappear.

(iii) At what flow in the river can abstraction begin.

(iv) What abstractions can be made at various river flows.

Following a preliminary study of the flow records for Aw Dheegle between 1977 and 1986 the number of days the discharge was above a specific threshold in the gu season each year were tabulated, see Table 1.3. The mean and 75% probability discharges were also obtained and these are also shown in the tabulation. High flows exceeding 60 m^3/s occur in typical years as follows:

Typical year	Flow rates m^3/s 'Gu'	'Der'
1978	70	100
1984	Nil	83
1985	61	86

From these records it would appear that 1985 is a more typical year when compared with the 'gu' 75% probability figure of 61 days and for this reason 1985 was used in considering the probable swamp operation in any year.

The criteria adopted were as follows:

(i) The area of the swamp should be 1 300 ha.

(ii) The swamp should retain water until mid-December. After this date water for stock watering will be available from the three uars to be constructed along the edge of the swamp within easy access from the main Mogadishu-Kismaayo road.

(iii) Filling of the reservoir should not take place before mid-April.

TABLE 1.2

Evaporation, Evapotranspiration and Rainfall

Month	Evaporation (mm)		Evapotranspiration (mm)		Rainfall[1] 75% reliability (mm)
	Day	Month	Day	Month	
January	5.6	174	5.6	174	0
February	6.0	168	6.1	170	0
March	6.2	192	6.2	193	0
April	5.6	168	5.6	169	35
May	5.0	155	4.9	153	31
June	4.3	129	4.4	133	39
July	4.3	133	5.1	138	37
August	4.9	152	5.6	157	13
September	5.5	165	5.3	169	1
October	5.2	161	5.3	163	3
November	4.8	144	4.9	148	25
December	5.0	155	5.0	155	3
Year	5.2	1896	5.3	1925	-

Note: (1) Not a homogeneous sequence

TABLE 1.3

Aw Dheegle - Gu Season

Year	Number of days above threshold					
	60 m^3/s	65 m^3/s	70 m^3/s	75 m^3/s	80 m^3/s	85 m^3/s
1976	69	63	56	48	40	9
1977	66	63	51	45	41	35
1978	70+	61+	46+	39+	33+	24+
1979	76	73	61	46	40	36
1980	21	21	20	18	16	15
1981	82	81	77	60	49	23
1982	67	63	61	58	54	47
1983	74	72	69	65	54	47
1984	22	19	10	0	0	0
1985	61	61	57	42	27	11
1986	70	70	63	60	57	53
Mean	62	59	52	44	37	27
75%	62	61	47	40	28	12

Note: 1979 and some other records estimated from Afgoi data, with approximate allowance for expected flow reduction.

Figure 1.4
Survey Information

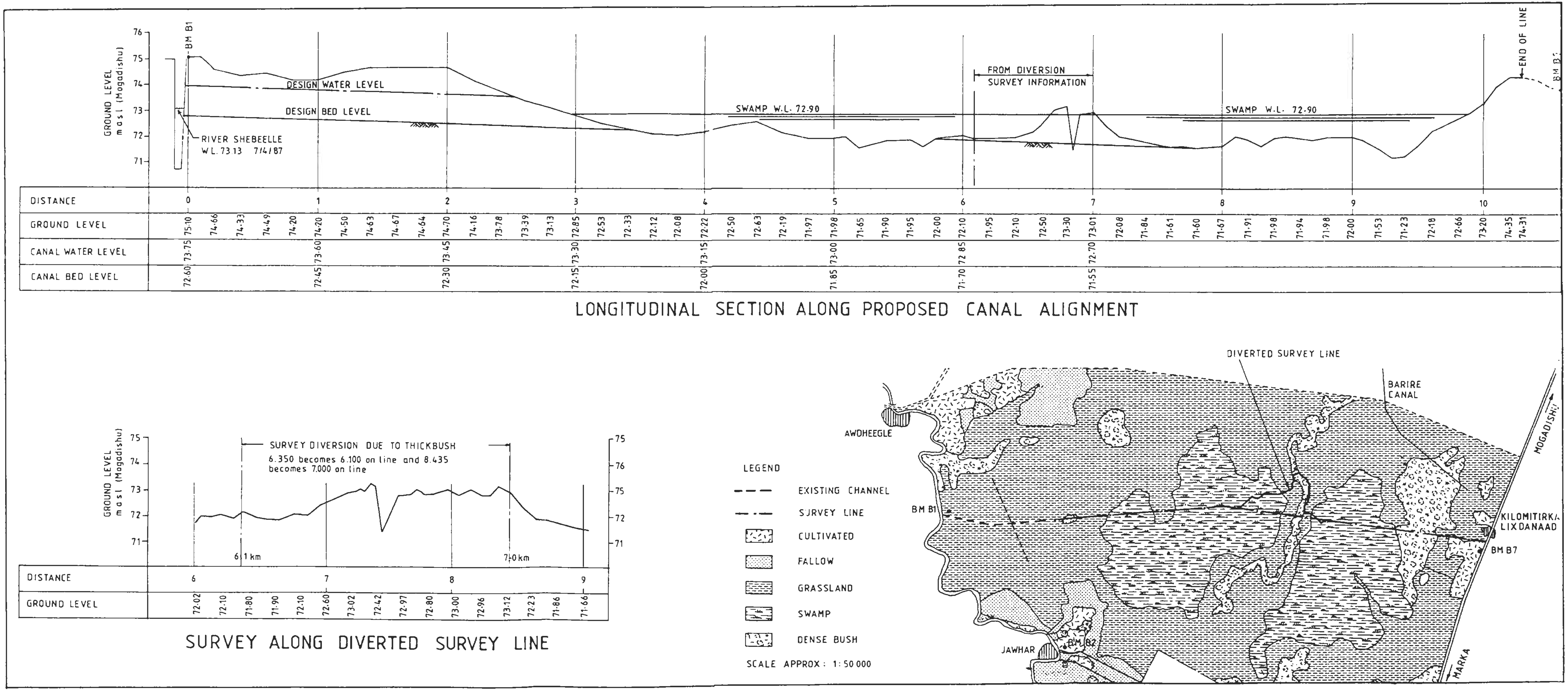


Table 1.4 shows the number of days in 1985 that the flow exceeded 60 m^3/s in each month.

TABLE 1.4

Days Flow Exceeded 60 m^3/s at Aw Dheegle in 1985

Month	J	F	M	A	M	J	J	A	S	O	N	D	Total
Number of days	-	-	-	8	31	22	1	31	30	25	-	-	148
				Gu 61 days				Der 87 days					

Inspection of the 1985 records indicates that the flow at Aw Dheegle reached 35 m^3/s by 12th April. From mid-April to the end of the month the inflow from precipitation and runoff was offset by evaporation and wetting of ground. Assuming abstraction commences with, say, 1 m^3/s on 16th April reaching 5 m^3/s at end of month, inflow (2.5 m^3/s average for 15 days) up to 30th April is therefore about 3.25 million m^3. To fill the swamp to a level of 72.90 m asl Mogadishu, holding 12 million m^3, would take a further 20 days or more.The swamp would be up to full level in the second half of May. During the period before the 'der' the 1985 records of flow at Aw Dheegle are incomplete but using the Afgoi records a flow of 60 m^3/s or more at Aw Dheegle would occur for 31 days in May and 22 days in June. This figure is reached for only 1 day in June.

If we adopt the criteria that the swamp may not need to retain water after mid-December a simple check indicates that the evaporation to reduce the water surface level from 72.90 to 71.20, the minimum ground level along the survey line, would take some 35 days. Hence the water the in reservoir need not be augmented after 10th November. Therefore, it is necessary to consider the inflows required in the second half of May until early November. The river abstraction must be sufficient to replace evaporation losses each day plus say 5% for canal losses. Table 1.5 gives the daily evaporation losses and the probable daily inflow from rainfall and runoff with a 75% reliability and the abstraction required from the river to make up losses. It will be seen that the abstraction does not reach 1 m^3/s. The size of the offtake structure was chosen at 5 m^3/s which would fill the swamp in about 40 days. Any reduction in size would result in a longer time being required to fill the swamp and since it was desired to keep the swamp area operating in a manner similar to that in the past when the breach in the bank provided the inflow, it was considered that to provide an outlet of less than 5 m^3/s would not reflect past conditions.

1.7 Head Regulator and Supply Canal

A canal head regulator has been designed to control the flow from the river to the supply canal. It is a three-bayed gated structure with three vertical lifting gates mounted on the downstream side of a breast wall. The gates are 2.0 m wide and 1.0 m high with double-spindle type operating gear consisting of twin worm gears coupled by a cross shaft and turned from one side. The upstream cill level has been set at 73.7 m corresponding to a river flow of 30 m^3/s. Below this flow no abstraction is possible. The structure has been designed for 5 m^3/s maximum flow. A USBR Type I stilling basin has been used to contain the hydraulic jump.

TABLE 1.5

River Abstractions to Maintain Swamp Level May and November

Month	Daily evaporation including 15% loss ('000 m^3)	Daily inflow from rainfall and runoff	River abstraction (m^3/s)
May (second half)	68.25	23.00	0.52
June	58.70	29.90	0.33
July	58.70	27.45	0.36
August	66.89	9.65	0.66
September	75.08	0.77	0.86
October	70.98	2.23	0.80
November (First third)	65.52	19.17	0.54

The structure incorporates a reinforced concrete bridge deck with a 4.0 m wide carriageway and 0.75 m footpaths and handrailing on either side. The main structure has been designed in mass concrete. Reinforced concrete is cheaper than mass concrete for a structure where the overall dimensions are governed only by structural considerations. However, for the head regulator the members have been sized to overcome uplift (floor slab), provide sufficient width for bridge deck bearings (abutment width) and access (pier width). Mass concrete has the advantage of requiring less skilled workmanship, being more durable and less prone to problems of vibration.

The head regulator has been designed to pass through a flood bund that is required to protect the Jilaal Moogi from flooding. A maximum design flood level of 76.4 m has been used and 0.6 m freeboard provided for the bund.

The supply canal has been designed using the Lacey regime equations. The canal has a trapezoidal section with a bed width of 7.5 m and 1:2 (V/H) side slopes. The canal has a design water depth of 1.15 m, a minimum freeboard allowance of 0.6 m and a bed slope of 15 cm/km. The total length of the canal, including the joining of the two swamp areas, is approximately 5 km.

1.8 Future Irrigable Area

With the provision of a head regulator the present flooding which was reported from the existing breach and its 'canal' can be eliminated. It may be necessary after the construction of the new structure and canal to monitor closely the extent of the upper limits of swamp when filled with water. It is not possible at this stage to know whether any small saddle dams or low banks might be necessary to avoid water from the swamp at full supply level spreading through small channels or depressions which are not obvious on the available mapping or on the air photography. Any work necessary should be of a minor nature.

A close watch will also be necessary to ensure that no water has escaped into the swamp area from the Barire canal. It was reported that the Barire canal was no longer used for flood relief or 'faf' irrigation but was used for controlled irrigation along its length.

The area tentatively demarcated for future irrigation development is located along the river and up to 2 km from it covering in total some 850 ha, see Figure 1.4.

1.9 Operation and Maintenance

The operation of the head regulator will come under the direct control of the office of the Diretorate-General of Irrigation and Land Use in Janaale. A gate operator plus an assistant will be employed to open and close the gates, to grease them and once a year to clean and paint them with an anti-corrosive paint. They will also ensure the gate openings are kept free from debris and clear any silt which could hinder gate operation.

With the Janaale irrigation office responsible for the control of the regulator, any question that the operation of the Jilaal Moogi canal which might adversely affect downstream water users will be avoided because the Janaale office will be fully cognisant of the water requirements of the users downstream of the Jilaal Moogi offtake.

The annual inspection and survey of the headworks canal and stock watering points along the main road will rest with the Janaale office which will arrange the necessary inputs, including earthmoving machinery, meter any repairs, carry out surveys and for silt clearance for the canal and uars.

1.10 Cost Estimates

1.10.1 Capital Costs

The capital costs for the Jilaal Moogi works including three stock watering points near the main road are given in Table 1.6. These costs also allow for some saddle bunds that may be identified when the reservoir is filled for the first time. Also a further sum has been allowed in the supply canal earthworks for improvement to the river bank in the vicinity of the head regulator. The extent of both these items is not considered to be large.

1.10.2 Recurring Costs

The recurring costs have been based on the following annual rates:

Earthworks	4% (25 year life)
Structures	4% (25 year life)
Fences	5% (20 year life)

These rates are those considered appropriate to Somalia following considerable experience by the Consultant of similar project annual costs.

TABLE 1.6

Estimate of Cost for Jilaal Moogi Works

Item	Description	Quantity	Unit	Unit rate (US$)	FE (%)	Amount (US$)
1	Purchase of land and compensation	-	-	-	0	nil
2	Survey and preparatory work	-	-	sum	50	7 000
3	Bush clearance					
(a)	Heavy bush	8	ha	800	50	6 400
(b)	Light bush	3	ha	400	50	1 200
4	Earthworks					
(a)	5 m^3 supply canal*	70 000	m^3	2.50	50	175 000
(b)	Water storage ponds (each of 10 400 m^3 capacity)	3	Nr	26 000		78 000
5	Structures					
(a)	5 m^3 head regulator with 4 m road bridge	1	Nr	100 000	55	100 000
(b)	Structure with hand pump to lift water from storage ponds	3	Nr	14 500	60	43 500
(c)	Fencing	990	m	10		9 900
	Sub-total					421 000
6	Physical contingencies 10%					42 100
	TOTAL					463 100

Note: * Includes for some saddle bunding in area and improvement of river bank in vicinity of head regulator.

ANNEX 8

SURVEYS

ANNEX 8 - SURVEYS

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CHAPTER 1

AGRO-ECONOMIC SURVEY

1.1 Introduction

In early March 1987 the Consultant conducted a rapid agro-economic survey in the project area. The respondents were spread fairly evenly across the area as its boundaries were then perceived; however, the boundaries were later changed by MOA. No stratification other than geographic distribution has been attempted: no distinction was made in selecting small and large, irrigated and non-irrigated farms; or owner-occupiers or tenants. Therefore the findings of the survey may not have much quantitive validity but undoubtedly give valuable indications regarding farming practices, constraints to production and other similar problems. Respondents were identified in their villages or on their farms which, in view of the fact that March is a slack month as far as fieldwork is concerned, may have introduced another bias. The questionnaire used is attached. (Appendix I) The responses are collated, analysed and discussed below.

1.2 Analysis of Responses

Thirty nine farmers were interviewed. Since residents not owning or operating farmland were bypassed, the fact that all respondents were farmers is not to be taken as a general indicator for the occupational distribution of project area inhabitants.

1.3 Farm Population

The families of the residents totalled 434 head, of which 163 (37%) were working on the land and 63% were either too old or to young to work.

1.4 Area Farmed

The area operated and owned by the respondents extended to 1 149 ha, of which 25 ha was rainfed. The 1 127 ha that had some form of irrigation was mostly flood-irrigated, as can also be seen from the crops grown (Section 1.11.1) Only 7 ha of the irrigated land was stated to have been rented; the rent charged was SoSh 1 000/ha. Farm sizes averaged 29 ha; if farms of 60 ha and over are deducted (4) the average is 8.25 ha.

1.5 Methods of Irrigation

Gravity irrigation predominated. In addition, two of the irrigators had access to water pumped from the river or a canal; one had an irrigation well. The farmer pumping from a canal only grew maize and sesame; the other two, pumping from a well and the river, grew also high-value fruit and vegetable crops and used the pumped water on those. One rented the pump; the other one owned it and did not share with other growers.

1.6 Land Preparation

As expected, no land was prepared by animal power. Three farmers did it by hand; their farms were 1 ha, 3 ha and 6 ha. Three others used tractors for as much of their area as they could and prepared the rest by hand. All but three farmers were relying on rented tractors; the contractors were private individuals with just one exception (see below). The farms were in the 6 to 10 ha class, two were double cropped and one was cropped at 154% intensity. Thus, they cannot be regarded as indifferent farmers: the constraint, as also stated by them, was availability of tractors to rent.

Only three respondents owned tractors. One, who farmed on 500 ha, did no contract work for others; the other two who had 60 ha and 30 ha respectively, did contract work to the extent 200 hours and 300 hours each. The work done included both tillage and haulage. The third, who owned 500 ha, worked only on his self-cultivated land and those of his tenants/sharecroppers/labourers who were given land as part of their wages.

Only one respondent rented from ONAT and he expressed his dissatisfaction with the service. The fact that ONAT was usually late in providing machines was corroborated in discussion with other farmers.

1.7 Input Supplies

1.7.1 Seeds

Twelve respondents kept their own planting material, the others tried to buy seeds. Only 6 of the remaining 27 had no difficulty in finding supplies; the other 21 did, and often had to plant other than improved seeds.

1.7.2 Fertilisers

Fertilisers were used by 20 respondents, 12 of whom found it difficult to get supplies.

1.7.3 Pesticides

Pesticides were used by 27 farmers, 12 of whom found it difficult to obtain them.

The following table shows reported yields of maize, grouped according to inputs used.

	Reported average yield (q/ha)	
	Gu 39 growers	Der 11 growers
No purchased inputs	10	5
Seeds only	7.6	3.5
Fertilisers only	-	-
Pesticides only	15	5
Seeds and fertilisers	-	-
Seeds and pesticides	12.5	-
Fertilisers and pesticides	24.2	37(!)
Seeds, fertilisers and pesticides	19	-

Only one farmer reported purchasing fertilisers and pesticides (and no seeds) he reported 37 q/ha yield for both seasons, the highest yield reported by all farmers. While other sources, (notably AFMET) under farmers' conditions have reported gu yields of this order of magnitude, no other source records similar der yields; this figure therefore needs to be taken with some caution.

It is of interest to note that the highest yields, 37, 27, 25 and 20 q/ha, were all reported by farmers who used pesticides; two (27 q/ha) and (20 q/ha) used pesticides only, and three (25 q/ha, 27 q/ha and 37 q/ha) used fertiliser and pesticides; and one (20 q/ha) purchased all his inputs. The der growers had similar results.

The conclusion would appear to be that the greatest benefits are likely to come from pesticide applications, followed by fertilising. Yield levels in the project area may not, at present, be constrained by the genetic potential of the planting material available to farmers although undoubtedly this may well be the case as other growing conditions improve.

1.8 Livestock

1.8.1 Cattle

Only 12 respondents stated they owned no cattle within the project area. The other 17 owned 281 head, or about 16 head each. Sales totalled 17 head; 5 owners sold them. Their total herd size was 77, implying an offtake rate of 22% which is, of course, quite unrealistic. This further underlines the fact that the livestock situation is heavily interdependent with, and intergrated into, that of non-resident, transhumant kinsmen from adjoining non-riverine areas. Only 4 cattle owners sold milk regularly. One owner reported owning male animals (6 out of a herd of 26) and none reported young stock - presumably because of the time of the year.

1.8.2 Sheep

Sheep were reported by 9 farmers who owned 145 head or 16 head each. Only 7 were reported sold; no data on home slaughter could be obtained but it was observed to occur.

1.8.3 Goats

Goats numbered 57, owned by 6 respondents. No cash sales were reported.

1.8.4 Camels

Camels were reported by 7 owners owning 87 head or 12 each. They varied between milking herds of 20 to 30 head and the odd animal used as a load carrier.

1.8.5 Donkeys

Donkeys were reported by only two households; subsequent visits have shown them to be more common than the survey would indicate. They are used to pull water carts; - oxen are also used for the purpose but less commonly and donkeys tend to be more common as the distance from the river increases. Donkeys are used in large numbers in towns and villages adjacent to the project area by the professional water and fuelwood carriers.

1.8.6 Poultry

Poultry were reported by 18 respondents, totalling 238 head or 13 per flock; ranging from 1 to 50. The sale of eggs is confined to the larger flocks, where it is done on a regular basis.

1.9 Agricultural Extension

The AFMET project has been operating in the area since 1981. Twelve of the respondents said they did not know who their Field Extension Agent was or were not aware of the fact that they had one. Most who did not know their FEA were located in areas some distance from Janaale, the site of the Regional Extension Office. This would appear to show AFMET's problems in ensuring the mobility of their staff.

1.10 Drinking Water

Six respondents drew their drinking water from wells, two from stock watering ponds (uars); the remaining 31 from the river. Distances from water varied between negligible and about 8 km; those who had to walk 1 km or more to a water source (29) averaged nearly 5 km each way. These responses further highlighted the burden imposed on the families to provide domestic water under present conditions.

1.11 Crop Production

1.11.1 Maize

As expected, maize was grown by every respondent in the gu; 11 grew it also in the der. Gu yields over the 34 irrigated farms averaged 14.6 q/ha, ranging between 5 and 37 q/ha. The five non-irrigated farms averaged 4.6 q/ha, ranging between 3 q/ha and 5.5 q/ha. The effect of inputs, particularly pesticides, on yields has been analysed earlier (Section 1.7).

The 9 irrigated farms that grew maize in the der averaged 9 q/ha, ranging between 37 q/ha and 6 q/ha. As noted before, the 37 q/ha yield report is suspect. Two of the rainfed farms also grew maize: yield reported was 3.5 q/ha and 4 q/ha.

1.11.2 Sesame

Sesame is occasionally a haagai but mostly a der crop. It was grown by 35 farmers; they had an average yield of 4 q/ha, ranging between 2.5 q and 10 q/ha. The one rainfed farm that grew it got 4 q/ha; it had good access to runoff and therefore was, for all practical purposes, 'irrigated'.

1.11.3 Tomatoes

Tomatoes were also grown under irrigation and were reported by 11 respondents, all of whom also grew gu maize and der sesame. The crop is interplanted in cotton or sesame but is also grown in pure stands. Reported yields were 44.7 q/ha, ranging from 9 q/ha (the next lowest 20 q/ha) to 80 q/ha. In the project area only the cherry type was grown which is sold in the Shalambood market, mostly for onward shipment to Mogadishu. ITOP, the canning factory in Afgoi, did not, in 1986/87, endeavour to make contracts in the project area.

1.11.4 Water Melons

Water melons were reported by 6 farmers: it seems to be a crop for the more up-market, commercial producer: all but one also grew tomatoes. The one who did not, switched from tomatoes the previous year to melons in 1986.

1.11.5 Other Crops

Other crops grown were bananas, papayas, grapefruit, mangoes and coconuts. They are grown on farms near the river, with the best access to irrigation which, if need be, can provide emergency supplies to other crops. Yields reported by these farmers of crops other than the orchard crops named were gu maize - 15 q/ha, obviously not irrigated except by gravity: tomatoes, yielding 30 q/ha - still not an outstanding yield. Yet yields of orchard crops and melons were good: grapefruit 200 q/ha, mangoes, 320 q/ha, melons 700 pieces (say 6 t/ha).

On the whole, the reported yields were low. Since there do not appear to be any serious limiting factors, it would seem that with good agronomic practices considerable yield improvements could be obtained.

1.12 Cropping Intensities

Croping intensities, i.e. the extent of double cropping, is a measure of managerial skill, labour supply and the need to maximise production either for subsistence or gross income. It is also an indicator of rainfall and irrigation supplies, especially in the der season.

The survey gave the following cropping intensity figures; it is to be recalled that in 1986, the year to which the information refers, the der rains were poor.

All farms surveyed:	144%
Farms below 60 ha	153%
Rainfed farms	151%
Irrigated farms	154%

Thus intensities, excluding three large farms only partly cultivated by the owner who reported his own, and not his tenants/sharecroppers crops, is around 150% for all class of farms.

On the extremes, no fewer than 9 farms reported 200% intensities, i.e. complete double cropping, with maize and sesame. In contrast, only two farms, both rainfed, reported no rabi crops: as noted these two farms were not able to harvest runoff water which was essential in view of the poor der rains.

Fallowing would not appear essential to attain the average yield levels of the project area. Farms with 200% intensity averaged a gu maize yield of 15 q/ha, i.e. about the overall average. If the lowest, 8 q/ha, is ignored the average is 16.2 q/ha.

1.13 Conclusion

The survey results show a wide range of yields and cropping intensities, indicating that the possibility of higher yields and higher intensities certainly exists. Therefore, if issues other than farming technologies can be resolved - and many farmers have obviously resolved them already - the scope of improvements is quite wide.

CHAPTER 2

BASELINE SURVEY AND DATA REQUIREMENTS

2.1 General

One of the project components is to monitor the effects of the project on the area's resident population and evaluate their progress in economic and social terms. For this to be meaningful it is essential, early in the project execution period to conduct a baseline survey that would give an accurate picture of the present situation against which future developments can be measured. Follow-up surveys would have to be conducted 3 and 5 years after the completion of proposed works in any given area. Ideally, a third assessment, 7 or 8 years after completion of all project works, should also be conducted. Since however that cannot, administratively, be funded out of the EDF grant, it will not be further discussed.

The easiest way to measure progress is to interview, on all occasions, the same respondents, asking the same questions. Practically this may present difficulties. People may move out of the area, die, or simply cannot be found. The problem can be partly overcome by carefully recording the location of the farm and the dwelling house of the respondent by reference to such village records (written or verbal) that exist and by selecting a sufficiently large number of respondents amongst whom a statistically meaningful sample can still be found by year 5.

2.2 The Contents of the Survey

It is a general truism that the marginal cost of asking additional questions from a respondent is insignificant compared to the cost of analysing the responses. The value of the additional responses, and their contribution to the overall understanding of the problems and achievements of the area, should also be carefully assessed. It is therefore strongly urged that, within the objectives of the survey and without jeopardising its purpose, the questionnaires should be as short and concise as possible.

The important issues are to determine progress in the farmers' economic status: changes in farm size, crop and yields, services received, irrigation facilities, their qualities, and frequencies; access to physical inputs and credit; hired machinery for tillage; and harvesting facilities. Changes in family size and status, personal wealth and major assets need to be determined, not necessarily in great detail but certainly on an indicative basis. It may be possible to include a study of the effects of improved nutrition on the development of children and young people amongst the less well-off section of the community, an issue of special interest to the health authorities.

2.3 The Implementing Agency

The ultimate responsibility for conducting and support of the survey will rest with the Project Co-ordinator. It is not however suggested that it be conducted 'in-house': logistically as well as for ensuring a high professional standard, it would be advisable to engage a specialised agency. Possible alternatives are the Agricultural University of Afgoi, the Mogadishu University's Economics and Social Department or the Planning Department of the Ministry of Agriculture, which is understood to be in the process of organising a Monitoring and Evaluation section with assistance from GTZ, the German bilateral aid agency, and FAO. This backing and professionalism, plus the Planning Department's additional familiarity with the agricultural development scene, would appear to ensure that its evaluation would be of high professional quality and without prejudice.

The Ministry of National Planning also has a Monitoring and Evaluation Section. This section is engaged almost entirely in monitoring the progress of the various donor-supported projects and although it has an evaluation function, it does not at present have the resources to exercise it. Nevertheless it may be advisable to involve them in the baseline and subsequent follow-up surveys, if only to draw on the expertise to formulate the questionnaires and discuss analytic methods.

A suggested questionnaire, for no other purpose than to serve as a very rough guide and discussion starter towards the preparation to the questionnaire that would be tested in the field, is appended (Appendix II).

2.4 Costs

It will be assumed that in year 5 the aim is to have 75 respondents, which would be about a 3% sample of the now estimated number of farm families. To secure this number the initial number interviewed should be at least 120 to 130 to allow for about an eventual 40% loss. Stratification, to ensure that all classes and the entire area likely to be affected by development works is covered, needs to be worked out with great care. It is expected that one interviewer can interview four respondents in one day: the apparently low figure is because in year 1 the stratification has to be worked out and in the repeat interviews the persons initially interviewed have to be traced. Thus, interview time would be about 35 man-days, processing time, assuming minimal aids for tabulation and calculations, 15 man-days. Based on these assumptions and allowing for supervision, field transport and office support, the estimated costs are in Table 2.1.

TABLE 2.1

Cost of Baseline and Follow-up Surveys
(SoSh '000)

Baseline	
Interviewers 35 man-days at SoSh 1 000	35.0
Supervisors 3 man-days at SoSh 1 200	3.6
Transport for above	3.0
Field allowances at SoSh 300	11.4
Data processing 16 man-days at Sh 1 000	16.0
Supervisor 15 man-days at SoSh 1 200	16.0
Typing, stationery	3.0
Contingency 15%	11.7
Total	99.7

First Follow-up

Costs are expected to be substantially the same because the interviewers will have to search longer to find respondents still in the project area. Processing time will be the same because the time saved in processing fewer interviews will be taken up by the necessary comparisons.

Total	SoSh 89 700

Second Follow-up

Because of the fewer interviews but more time taken for processing and the need to collate three sets of interviews, only a 10% saving is expected.

Total	SoSh 80 700
Total costs without price escalation	SoSh 260 100

CHAPTER 3

TOPOGRAPHIC SURVEY DATA

3.1 Survey Datum

All levels contained in this report are based on the 1963 Mean Sea Level - Mogadishu established during the 1962 to 1965 survey done as part of the UNDP/FAO Agricultural and Water Surveys Project which reported in 1967. This project established a network of benchmarks along the major roads in Somalia stretching from Mogadishu to Kismaayo, Belet Weyn and Luuq via Baidoa and up the Juba Valley via Baardheere. These benchmarks located at approximately 4 km intervals were levelled to third order accuracy with the vertical control accurate to about $20\sqrt{k}$ mm, where k is the distance between such marks. It was from these benchmarks that the Gauge zeros of the river gauging stations on the Shabeelle and Juba rivers were established between 1962 and 1965 during the same UNDP/FAO project. The zero for Aw Dheegle gauge located near the old, now unusable, road bridge at the village of Malable, some 300 m upstream of the new road bridge over the river at Aw Dheegle village was tied into these benchmarks.

3.2 Mapping Datum

Russian technical aid on behalf of the Government of Somalia prepared maps for the whole of the Somali Republic at scales of 1 : 100 000 and 1 : 200 000. These maps, issued in 1976, were drawn from aerial photography especially flown for the purpose. Spot heights and contours with intervals varying between 5 m and 20 m were shown on the mapping. These were obtained by photogrammetric methods from the photography with ground surveys carried out to obtain vertical and horizontal control. However, the Russian technicians did not use the 1963 datum for the mean sea level at Mogadishu for their vertical control. The Consultant, in an earlier assignment at the Jowhar Sugar Estate, did relate the Russian mean sea level datum used in the mapping to the 1963 mean sea level datum. It was found that the Russian datum was 0.120 m above the 1963 datum. Hence all levels shown on the Russian mapping should be reduced by 0.120 m if it is to be correlated with the 1963 datum. The use of the 1963 datum is recommended for all irrigation and drainage planning since the water levels in the two major supply rivers are tied to this 1963 datum - which, until the mapping prepared by Russian technical aid was published, had always been known as the national datum. This recommendation to use the 1963 datum follows a similar one made by the Consultant in the mid 1970s which, as far as is known, has been adopted for all work related to water use from the major rivers.

3.3 Benchmarks used for Project Surveys

Concrete benchmarks were established along the road between Aw Dheegle and the Janaale barrage during the 1962 to 1965 survey mentioned in Section 3.1. These were described in the list issued in 1969 by the Survey and Mapping Department, Ministry of Public Works and are shown below in Table 3.1.

TABLE 3.1

Benchmark Tabulation - Aw Dheegle - Janaale

Benchmark	Elevation (m)	Location in kilometres from Aw Dheegle
309	71.943	(5.0 km) Mubaarak
310	72.660	(9.2 km; Noarok junction)
311	71.973	(14.0 km; road intersection)
312	70.666	(19.2 km; 6.0 km from Janaale)
313	69.714	(0.5 km north of Janaale)
313A	72.736	(Janaale bridge)

Source: Elevations of benchmarks - Mogadishu - Ing. Milan Klimes (1969).

A traverse was made of the road at the beginning of the present study but none of the benchmarks listed could be located. It is believed that when the road between Aw Dheegle and Janaale was widened and coral-surfaced recently, all the benchmarks were destroyed during the earthmoving operations. This supposition was partly confirmed as the inhabitants of Mubaarak reported that BM 310 at the junction in that village was disturbed by the bulldozing at the time of the road improvements. Subsequently it lay on the ground until it was later removed or stolen. One man clearly remembered the figures 310 engraved on this lost marker.

Without the 1962 to 1965 benchmarks to use for the surveys within the project area a search was made to find any other usable markers. The only one found was a concrete block with iron pin located near the south-east corner of the culvert where the Caafimaad canal passes under the Afgoi/Marka road. This marker was engraved 'PS 173' but a search of the records at the Survey and Mapping Department, Ministry of Defence failed to identify this as being part of the Russian or any other survey recorded at the Survey and Mapping Department.

As no levelled points within, or close to, the project area were available it was decided to use the top of the gauge on the upstream face of the Janaale barrage and the gauge zero of the Aw Dheegle gauge. The values for these two points are:

Top of Janaale gauge (5 m)	71.87 mamsl (1963 datum)
Zero of Aw Dheegle gauge (3 m)	73.09 mamsl (1963 datum)

All the survey work carried out is based on these two third-order reference levels.

3.4 Surveys Completed

Figure 3.1 shows the level traverses surveyed during the assignment. The total length of the survey lines was about 130 km, some double levelled. In addition two sample areas covering 1.06 ha and 2.13 ha were surveyed on a close grid to determine the land levelling requirements of two already cultivated areas which the owners had levelled to some degree.

3.5 Levelling Circuits and Adjustments

Figure 3.2 shows diagrammatically the lines levelled and the rise or fall between respective reference points (BMs or TBMs). The length in kilometres of each leg of the survey is shown in parenthesis thus (12.6). A check of each showed that the differences recorded all fall within the permissible error of $20\sqrt{k}$ mm (see Section 3.1).

An adjustment was carried out for the circuits and the benchmark values recorded in Section 3.6 are those obtained after this adjustment was completed.

3.6 Benchmarks Established

Eight permanent benchmarks, each consisting of a 2 m long 50 mm diameter pipe, were established. These benchmarks were of a patented anchor type which were lowered into an augered hole leaving approximately 300 mm above ground level. Then the anchoring device was spread from the lower end of the pipe by exerting pressure down the centre of the pipe driving the anchor in four directions. This results in benchmark which can only be removed by excavating down to a depth of 2 m and of sufficient area to release the anchoring grapnels.

The benchmarks established are shown on Figure 3.1 and were given the designations of B1 to B8, respectively. Their locations and reduced levels are given in Figures 3.3 and 3.4.

3.7 Air Photographic Cover

The project area is covered by air photography taken in March 1983 with some additional cover done in January 1984. The flight lines and photographic cover per run are shown in Figure 3.5. The scale of the photography is 1 : 30 000. No mosaics were available to the Consultant for his studies but laydowns of the photography were prepared by the Consultant's staff and measurements of the main features were checked against the Russian 1 : 100 000 maps, see Section 3.1, and it was found that the horizontal accuracy was acceptable.

With air photography of the scale 1 : 30 000 the best vertical interval that could be obtained from a photogrammetric mapping exercise with adequate ground control has been quoted by two different agencies as 5 m or 2 m with interpolated contours at half these amounts, that is 2.5 m or 1 m intervals. The 1 m interval would be satisfactory for overall feasibility studies but for final design 25 cm contour interval is desirable. It is therefore recommended in the implementation programme, (Annex 9) that the photogrammetric mapping be done by a specialist firm and given priority in the implementation schedule. With this mapping the project staff would infill any additional survey detail to permit construction and land registration to proceed smoothly.

Figure 3.1

Lines Surveyed and Benchmarks Established

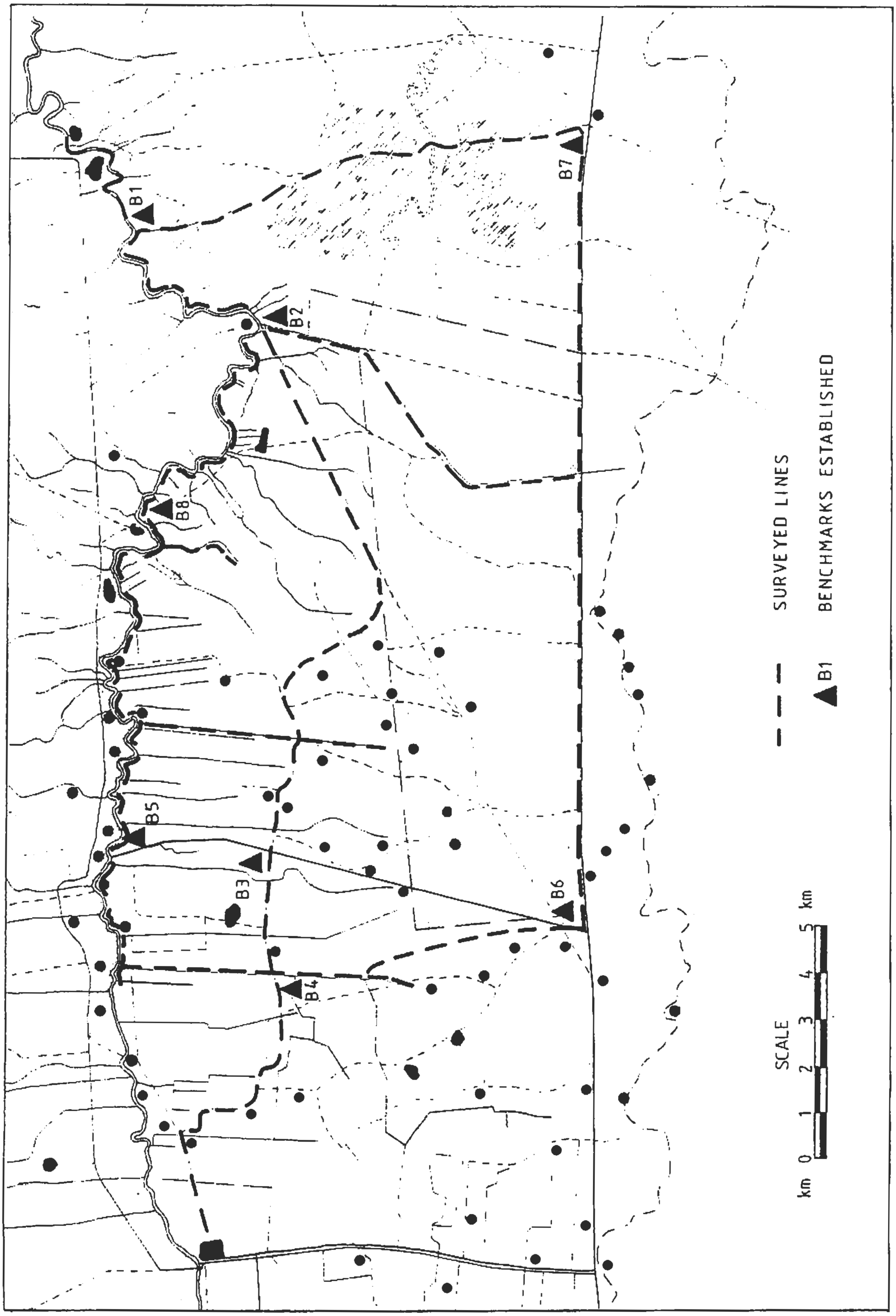


Figure 3.2

Level Circuits Diagram

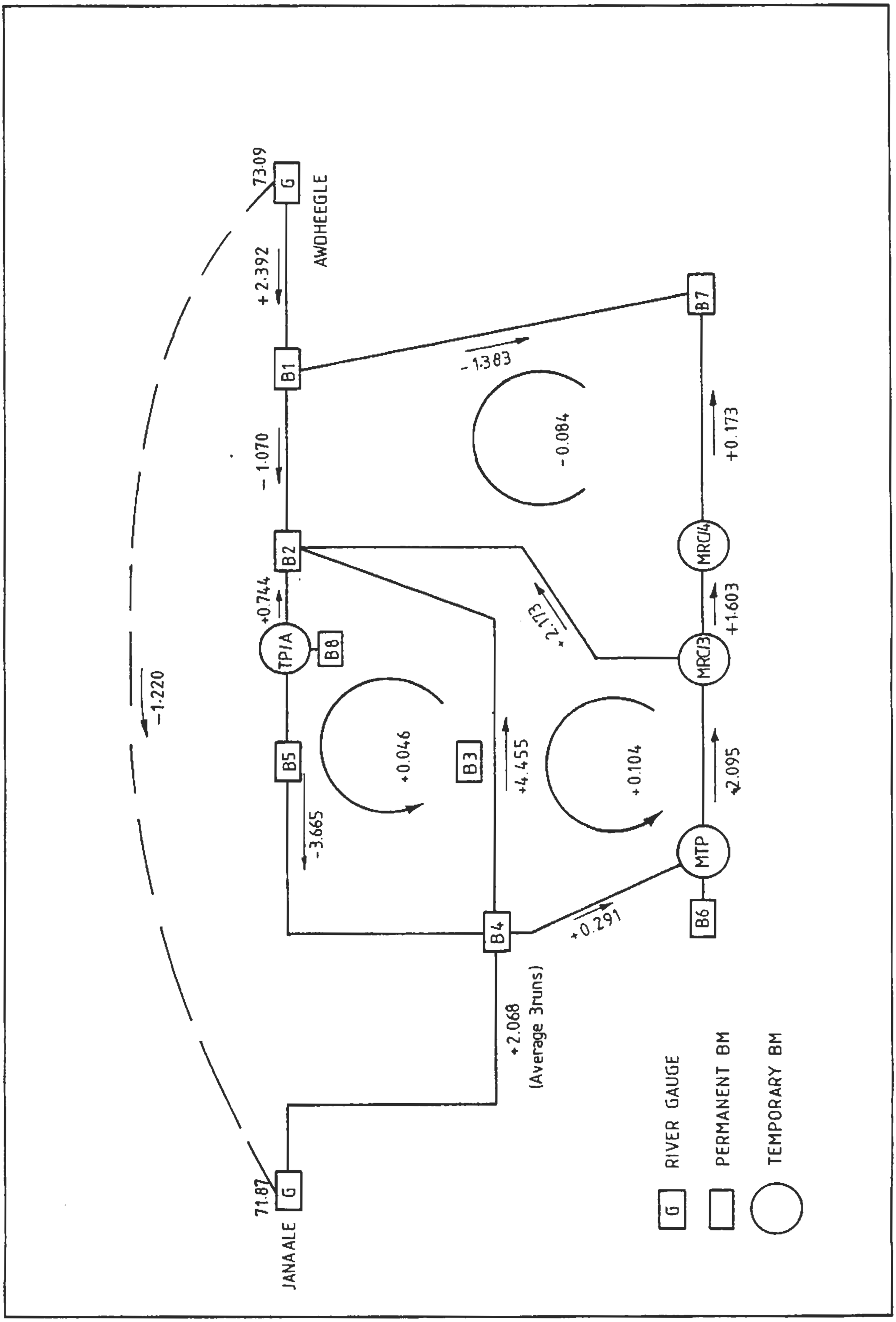


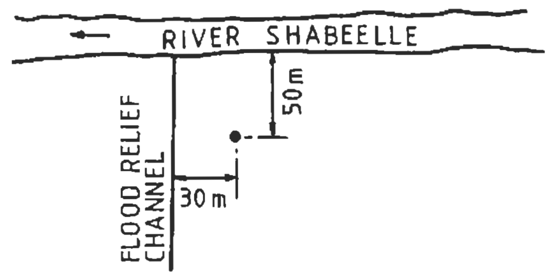
Figure 3.3

Registry of Permanent Benchmarks

DATUM:
JANNALE BARRAGE GAUGE

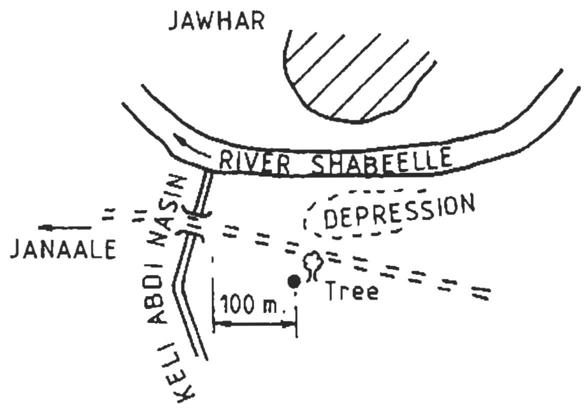
PERMANENT BM No. B1 — ELEVATION 75.34

Located on left bank of flood relief channel approximately 50 m from river bank



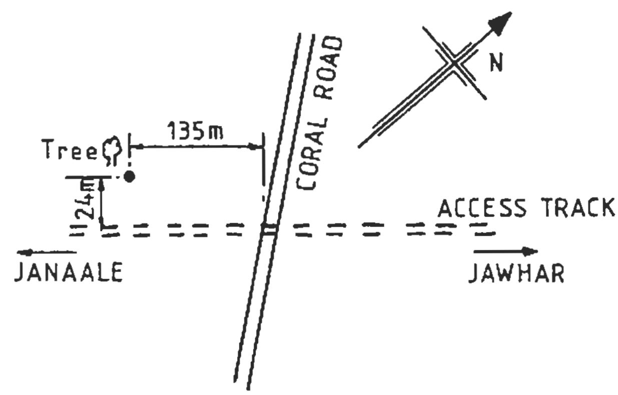
PERMANENT BM No. B2 — ELEVATION 74.27

Located opposite Jawhar approximately 50 m from river bank, and 100 m upstream of the Caafimaad canal



PERMANENT BM No. B3 — ELEVATION 69.47

Located near junction of main access track and coral road from Ceel Wareegow to Khaliif
1 m away from base of tree



PERMANENT BM No. B4 — ELEVATION 69.81

Located near junction of Gure canal and main access track

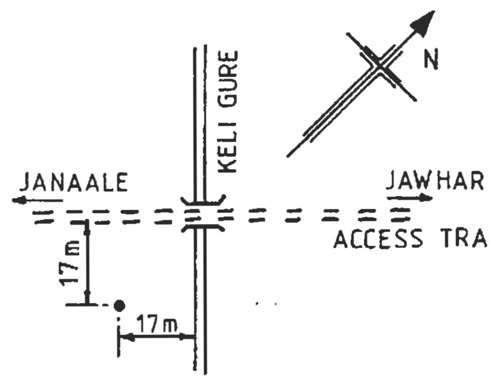


Figure 3.4

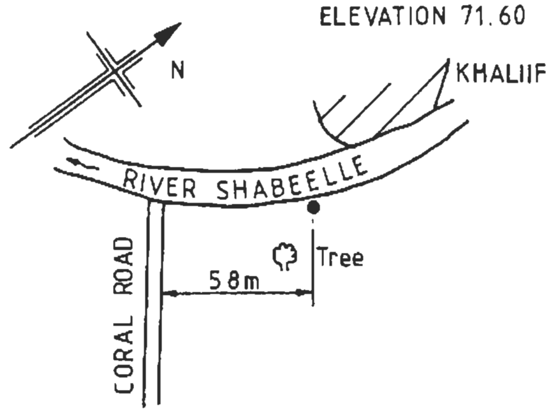
Registry of Permanent Benchmarks

DATUM:
JANNALE BARRAGE GAUGE

PERMANENT BM No B5

ELEVATION 71.60

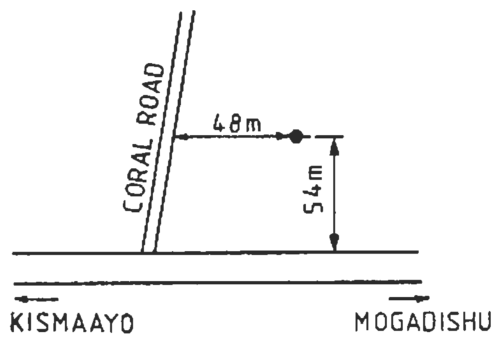
Located near junction of coral road from Ceel Wareegow to Khaliif and river Shabeelle



PERMANENT BM No. B6

ELEVATION 69.73

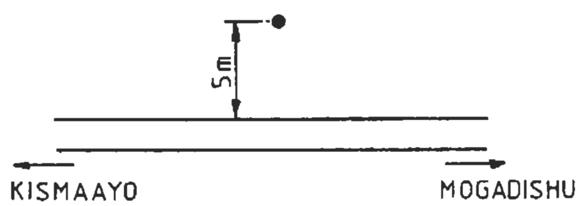
Located at junction of surfaced road and coral road at Ceel Wareegow



PERMANENT BM No. B7

ELEVATION 73.95

Located on north side of main Mogadishu-Kismaayo road approximately 375 m south of Kilomitirka Lixdanaad and 250 m north of road culvert



PERMANENT BM No. B8

ELEVATION 74.26

Located on flood bund opposite Dara Salaam at junction with access track

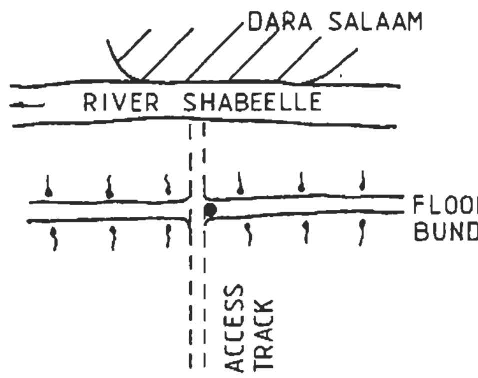
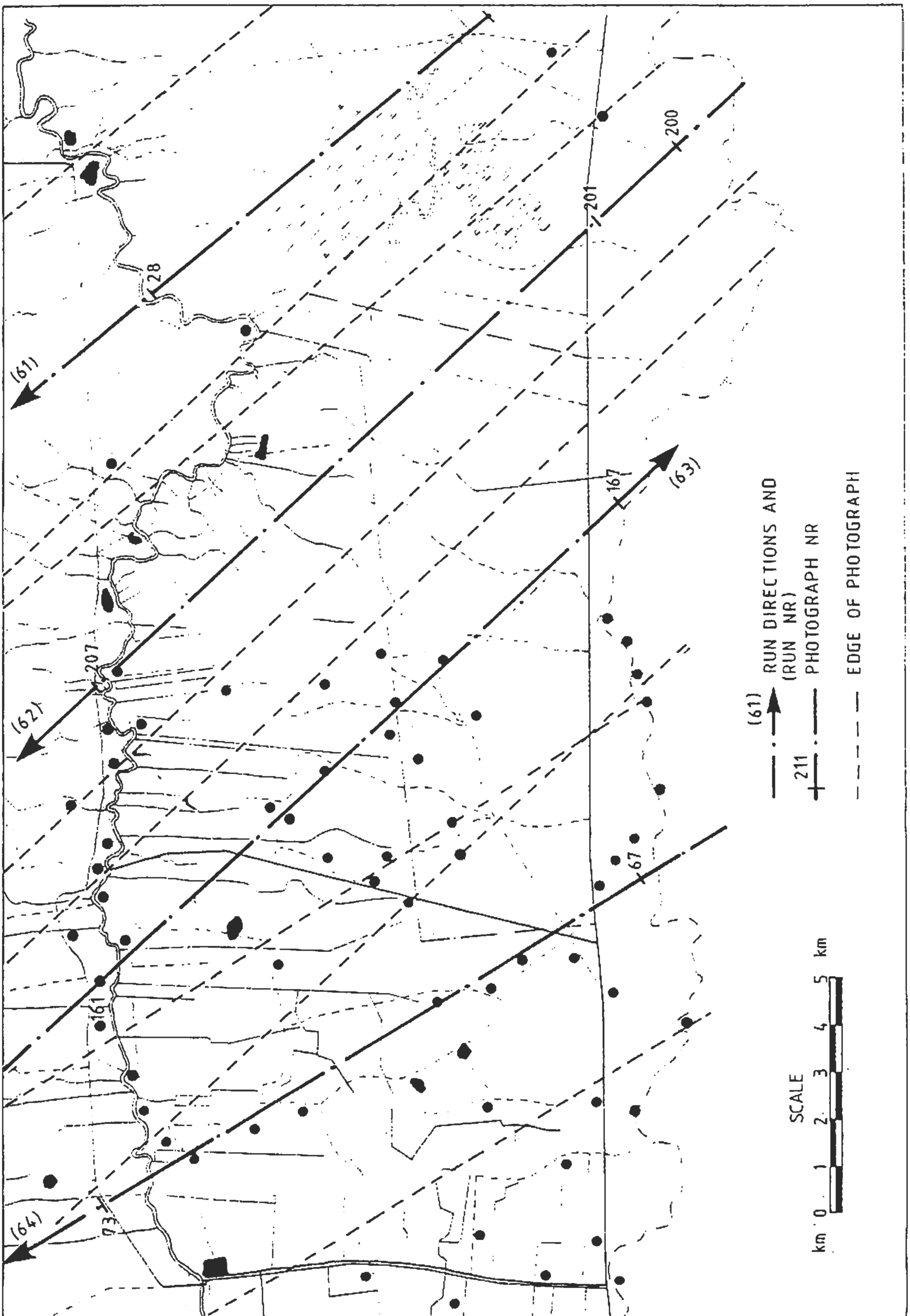


Figure 3.5

Air Photographic Cover



APPENDIX I

AGRO-ECONOMIC SURVEY

1. Name of Village

2. Name of Farmer

3. Number of dependants - working
   - too young
   - too old

4. Total area of holding of which:

   Rented - irrigated
   - rainfed

   Owned - irrigated
   - rainfed

5. If you have irrigated land, is it watered by:

   gravity - pumped from river/canal - well.

6. If pump irrigated, do you share with others?

   No - Yes

7. If you share, with how many?

   Who operates the pump?

   How do you pay for it?

8. Land preparation by: By hand Oxen Tractor

9. If tractor: Do you own it? Rent it?

10. If rented: From private owner ONAT

11. If ONAT do you have it, more or less, when you request it?

12. If you own a tractor, do you do contract work for others?

13. If yes, is it Tillage Haulage Both

14. About how many hours of contract work do you do in a year?

15. Any difficulties in getting: Seed

Fertiliser

Pesticide

16. How many livestock do you own?

Cows	Oxen
Young stock	Sheep
Goats	Camels
Donkeys	Poultry

17. Livestock/livestock products sold last year:

	Nr	Value
Cattle		
Sheep		
Camels		
Donkeys		
Poultry		

18. Value sold: Eggs Milk

19. Do you know your extension agent?

If yes, what is his name?

20. Source of drinking water:

river uar well

21. How far do you go for water?

22. What crops do you grow?

	Gu					Der				
	Area	Source of seed	Do you use fertiliser?	Do you use pesticide?	Yield	Area	Source of seed	Do you use fertiliser?	Do you use pesticide?	Yield
Maize										
Sesame										
Sorghum										
Groundnuts										
Mung beans										
Sugar cane										
Tomatoes										
Chillies										
Green pepper										
Melons										
Pumpkin/squash										
Bananas										
Grapefruit										
Mango										
Papaya										
Coconut										
Bitter orange										

APPENDIX II

DRAFT QUESTIONNAIRE FOR BASELINE AGRO-ECONOMIC SURVEY

Name of Village/settlement Respondent Nr.

Personal Data

1. Name of farmer Age (approx)
2. Number of wives
3. Children: boys age

   girls age
4. How many have been/are in school?
5. Other dependants in household

	Parents	Parents in-law	Sister	Brother	Uncle	Aunt	Others
Alive							
Not alive							

6. How many people in your household last year were:

   born

   died

Property

7. Type of house and numbers:

   aqual
   wish
   brick
   other

8. Numbers of livestock permanently in project areas (cattle all ages):

   sheep
   goats
   camels
   donkeys
   poultry

9. Numbers of livestock with kinsmen, occasionally in project area (cattle all ages):

   sheep
   goats
   camels
   donkeys

10. Land farmed: (ha) irrigated
rainfed

of which owned
rented

11. Do you own a tractor?

12. If yes, which implements:

plough
disk harow
other (name it)

13. Do you have a radio?

Services

14. How far do you or your family have to go for the following:

drinking water
veterinary services
seeds
fertilisers
pesticides
firewood
household necessities

15. Do you regularly purchase:

seeds
pesticides
fertilisers

16. Are items purchased readily available (list by type)

Production

17. Area of crops given in previous gu and der (ha):

	maize	sesame	cotton	tomatoes	melons	others
gu						
der						

18. Yields obtained from irrigated crops (q/ha):

	maize	sesame	cotton	tomatoes	melons	others
gu						
der						

19. Yields obtained from rainfed crops (q/ha):

	maize	sesame	cotton	tomatoes	melons	others
gu						
der						

20. Inputs purchased for:

	maize	sesame	cotton	tomatoes	melons	others
seeds						
fertilisers						
pesticides						

Land Preparation and Planting

21. Do you use a tractor for land preparation?

22. If rented from when and at what cost?

    private/ONAT
    cost (total or per ha or hour)

23. Do you plant with:

    yambo
    plough in the seed
    with drill

24. Do you weed:

    by hand
    with animals

25. Do you weed with

    family labour
    hired labour

26. If hired, how many persons (men/women/children) did you employ; for how long

27. Have you ever had land levelling done?

Harvest and Crop Sales

28. In the case of maize and sesame, do you bring home the slover:

    Yes
    No

29. Was it consumed by you or your family's animals or sold?

30. If consumed by you or your family's animals, was it:

Chopped
Fed whole

31. How much grain did you sell last year?

Maize
Sesame

32. Value of other crops sold?

Tomatoes
Cotton
Melons
Others

33. Did you buy any of the following crops last year and how much (in weight or cash value):

Maize
Wheat
Milk
Meat
Eggs

Livestock Sales

34. Of the animals normally kept in your household, how many animals did you sell last year and how much, in aggregate, did you get for them (SoSh)?

Cattle
Sheep
Goats
Camels

35. How many animals did you slaughter for home use?

cattle
sheep
goats
others

36. Value of goods sold last year (SoSh):

eggs
meat
milk
ghee

Animal Traction

37. Has the use of oxen or donkeys for farm work been demonstrated to you, or did you see it anywhere during the last year.

If yes, please give details?

Credit

38. Have you borrowed money for any purpose during the last year?

39. If yes, how much? SoSh

for what purpose?

wages for weeding
land levelling
tractor hire
buying tractors/implements
seeds/fertilisers/pesticides
other production uses

40. When do you have to repay?

41. Did you borrow from a private individual or a project or other Government institutions?

If the latter, please state name:

Off-farm Activities

42. Does any member of your household have a regular off-farm income?

Do they do casual work?

43. Is the income available for the whole household or only to the one earning it?

Note: The foregoing questions are not intended to be a complete list: others may be deemed advisable and some may be found unnecessary. It should, however, be reiterated that the cost of asking a question in a survey is much less than the cost of analysing the answers and therefore it is most important to determine whether the likely answers are worth the trouble taken over the analysis.

ANNEX 9

MANAGEMENT AND IMPLEMENTATION

ANNEX 9 - MANAGEMENT AND IMPLEMENTATION

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CHAPTER 1

PROJECT ORGANISATION AND MANAGEMENT

1.1 Introduction

Project organisation and management needs to be viewed from two dimensions which central authority, specifically which division of the central authority, has ultimate control, responsibility and accountability of the project:

(i) during the period of project implementation while outside financial support is available, and

(ii) in the post-implementation period.

1.2 The Implementing Entity

Both during and after the implementation of physical works the entity that will be responsible for the project is the Ministry of Agriculture (MOA). The organisation chart of the Ministry's head office in Mogadishu, as now contemplated, is shown in Figure 1.1. It will be noted that it shows four Directors-General (DG) reporting to the Permanent Secretary; the key one for the purposes of this project is the DG Irrigation and Land Use Department. As noted on the chart, administratively he reports to the Permanent Secretary but technical supervision and accountability of his work is under the Vice-Minister of Agriculture (Technical).

The headquarters organisation (see Figure 1.2) includes Directors for Finance and Administration, and Land Use. The Directorate for Shabeelle Water Management is not yet firmly established. In addition, not shown on the chart, there are some more junior engineers at headquarters, who report to the DG and perform engineering planning, supervision and support tasks, as they arise.

There would eventually be three Regional Directors: the current regional offices would be upgraded to Directorates. The one concerned with the Dara Salaam-Busley Project would be in Janaale. The managers of all development projects in the area would report to the Regional Director concerned but they would retain a degree of autonomy in their decision making and would be finally accountable to the DG. This arrangement would ease the burden of the Vice-Minister (Technical) to whom at present all the project managers report.

Other MOA entities directly affecting the project are the DG Production who would ultimately control the Extension Service, and the DG Research, who decides on research priorities amongst the problems put to him through the AFMET project and the research stations. The nearest agricultural extension authority to the project is the Regional Extension Officer, (REO) Lower Shabeelle region, stationed in Janaale. During project implementation the REO's role would be to ensure that agricultural technicians within the project pass on the same message, and the same technologies as the REO's technicians; he would exercise only technical supervision and coordination.

The administrative structure within the project is shown in Figure 1.3. The Project Coordinator is in overall charge but exercises technical supervision only over the SMS and the people controlled by him. The Forest Ranger and the Livestock Assistant will not be working full-time in the project: the Forest

Ranger's job is technical support of the relatively small tree planting programme. He would pay periodic visits to the project area as required. The Livestock Assistant would be called upon to supervise the livestock mustering points which may mean several days' intensive work every three months or so. However, during the implementation period, their salaries and operating costs would be a project expense.

It is expected that consultant support will be required during project implementation.

A Senior Consultant would initially carry out the function of the Project Coordinator. He would be assigned a counterpart immediately on his arrival. During the first 30 months of his expected 36-month assignment he would gradually pass over all his functions and duties to the Somali counterpart. During the last 6 months of his assignment he would act as an adviser on a standby basis and would be principally engaged in preparing notes on the project area and the perceived development constraints and discuss means to overcome them.

The Project Engineer would be assisted by an Engineering Consultant. They would share all the work with the Somali engineer progressively taking over the more difficult tasks under the Engineering Consultant's technical supervision. The Consultant's assignment would be for 36 months.

An independent auditor would verify and certify project accounts for 1 month every year, i.e. for 5 months.

An unspecified allocation of 10 man-months is provided to enable the Project Coordinator, advised by his Senior Consultant, to call upon expertise not provided, as the need arises. Thus, the total consultancy budget is 87 man months.

Job descriptions for the key functions are in Appendix 1.

1.3 Post-implementation

Once all the project works are completed, the project headquarters organisation is expected to diminish. The SMS and the animal traction instructors would be transferred to the REO Janaale and would work throughout the Lower Shabeelle region. The Forest Ranger's involvement would gradually come to an end as all bounty payments for surviving trees are completed; if the scheme of village firewood plantations and shelterbelts continues (as the Consultant believes it should), it would become a MLFR/NRA enterprise. The Livestock Assistant's function would become part of his district duties under MLFR. The Project Engineer's department, having completed all construction supervision and having prepared all the land levelling plans and the training of the Canal Committees in the maintenance and operation of the remodelled canals, would be reduced to supervision of maintenance, operation and control of the canal gates. The Project Accountant would principally deal with the financial side of credit administration and the record keeping (including financial records) of the sale of veterinary drugs to users and fertilisers and pesticides to the retailers. He may well move his office to the Regional Directorate.

It is, however, expected that the Project Coordinator's function would remain for several years as that of a general ombudsman for the project area. He would continue, initially, to administer the medium- and long-term credit revolving funds until an appropriate scheme takes over or it is passed on to a bank. But

MINISTRY OF AGRICULTURE

PROPOSED ORGANISATION CHART

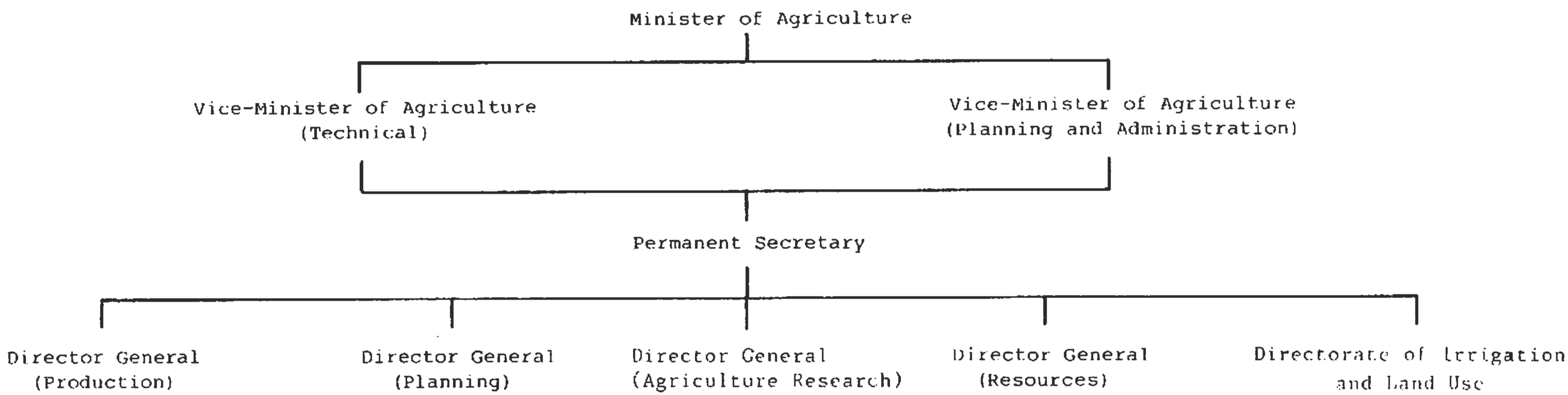


Figure 1.1

Figure 1.2

DIRECTORATE OF IRRIGATION AND LAND USE

PROPOSED ORGANISATION CHART

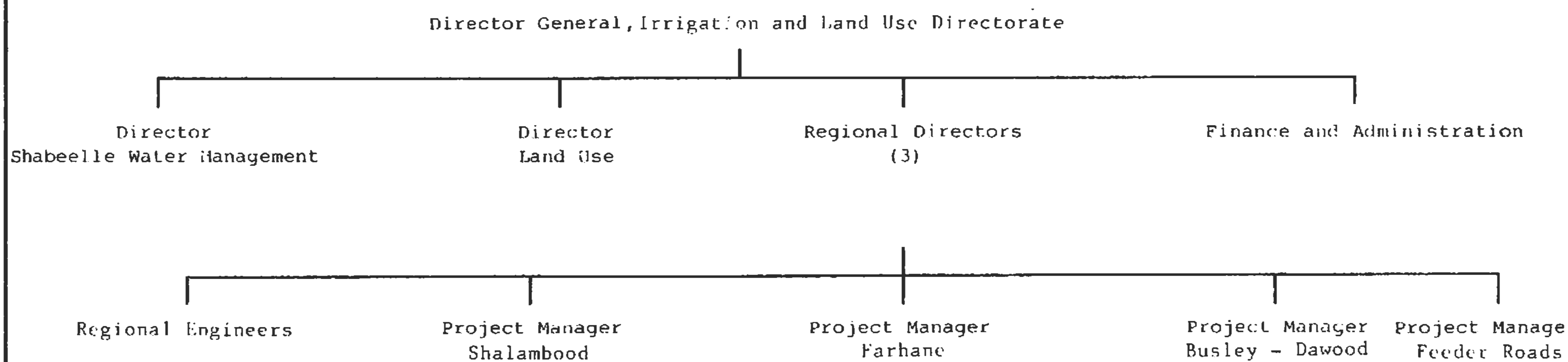
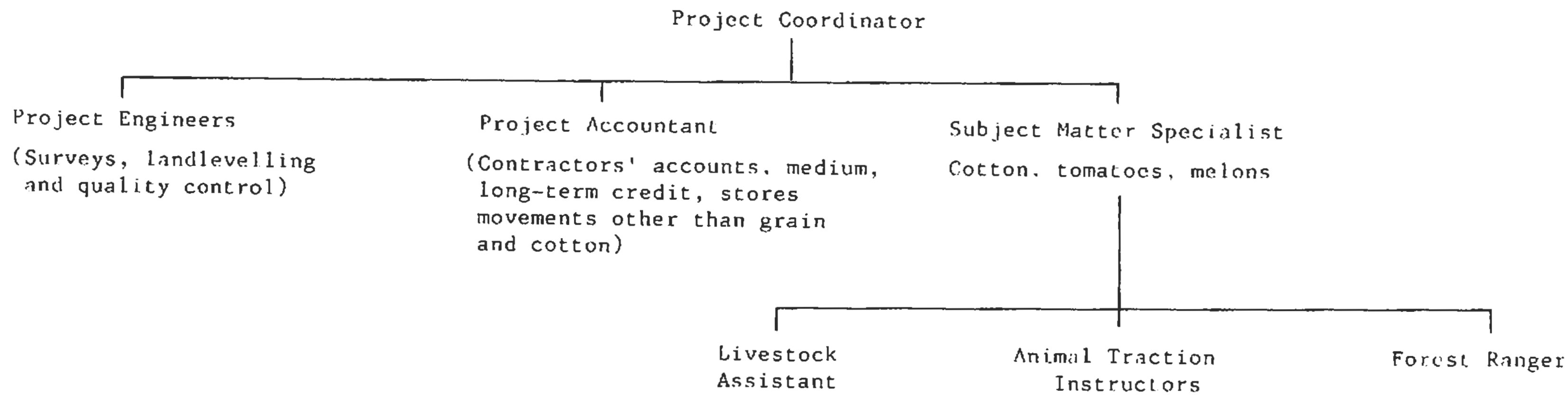


Figure 1.3

PROJECT HEADQUARTERS

PROPOSED ORGANISATION CHART



even after this has taken place, the PC would continue to persuade farmers to level their land and assist in obtaining quick action to mark cut and fill in the fields and arrange for certification of work done. Similarly, he would retain his interest in popularising animal traction for weed control and endeavour to organise local shared services for the task where this is practicable. He would continue contact with project area farmers and draw attention to production problems that are perceived to be of major local importance but perhaps less so in the regional context and therefore possibly not deemed important enough for AFMET to take them to the DG Agricultural Research.

Job descriptions of the PC, the Senior Consultant expected to assist him during the project implementation period, as well as that of the Project Engineer and the Engineering Adivser who would assist him during the implementation period are in Appendix I. The job description of the SMS is in Annex 4, Appendix I.

1.4 Post-Implementation Management Tasks

Post-implementation management tasks of universally shared services, i.e. excluding the Operation and Maintenance tasks devolving on the Canal Committees, are expected to amount to SoSh 800 per hectare of cultivable land. Since the benefits derived from the services go directly to the area's farmers, it is fair that they pay for it. It is therefore recommended that an average charge of SoSh 800 be levied, weighted possibly towards irrigated lands and larger holdings more than the rainfed and small farms. The collecting authority would be the appropriate branch of the Ministry of Finance but the PC's office would advise and assist with assessments. The budgetary allocation however, should not be related to the actual rate of collection.

CHAPTER 2

IMPLEMENTATION

2.1 Introduction

The comprehensive development of some 22 000 ha is a major task. The project plans consist of a number of separate independent components which have to be implemented concurrently.

To ensure that the implementation proceeds smoothly and according to plan it is essential that key project staff are in place about 6 months before the actual start of construction. The proposed implementation schedule is shown in Figure 2.1 where construction is expected to commence at the beginning of Year 1. The lead-in period Year 0 permits the issuing of contracts, review and evaluation of the tenders submitted and award of the contracts. Adopting this timing should result in the contractor being ready to commence construction on Day 1 Year 1. It is expected that Year 1 coincides with the 1988/89 construction season, which starts in November. This would imply having key staff in position by about May 1988.

Until the buildings at the project headquarters are completed project staff would have to use hotel accommodation either in Shalambood or Marka. Every effort must be made to avoid employees travelling to the project from Mogadishu. If staff live in Mogadishu fuel costs will increase and the vehicles will require additional maintenance and spares to take account of the additional distances covered. Also the time the staff actually spend in the project area will be reduced and hence their work output diluted.

2.2 Establishment of the Shabeelle River Authority

The establishment of a river authority has been suggested for a number of years. It is now planned to set up such an authority in the near future under an agreement with USAID for the Shabeelle Water Management Project. Obviously such an authority will, if effective and provided with the necessary staff, result in a much more organised and planned distribution of the water along the river, especially during the low flow periods. With the existing Jowhar Offstream Storage and the planned Duduble Offstream Storage in operation it is essential that the shared water, especially at low flow periods, be allocated where it provides the greatest economic return. For the privilege of sharing this stored water it is fair and reasonable to expect the user to pay a premium over and above the water charge levied by the authority for abstractions at other than low flow periods.

The proposed authority will have a circle centred in Janaale which will result in an expansion of the work load now carried out by the very small staff of the existing office. One reason the staff numbers and calibre have been constrained outside Mogadishu has been problems of financing them. With the proposed introduction of water and other charges there is no reason why the authority should not be a self-financing entity which will help in the equitable division and distribution of the existing water of the river to the benefit of all the users.

Any project staff of the Dara Salaam Busley Project will need to liaise closely initially with the Janaale Irrigation Section and subsequently with the Janaale centre of the authority when that is established.

2.3 Implementation Schedule

Figure 2.1 shows the proposed implementation timing for the various components of the project. As mentioned in Section 2.1 the pre-construction tasks must take place in Year 0 to ensure a prompt Year 1 commencement. Pre-startup staff would have to include the Project Coordinator, the Senior Consultant, the Engineering Consultant and Project Engineer, together with two surveyors. The Coordinator will be fully occupied in getting the project moving, in alerting the inhabitants and farmers of the area of the project's objectives and timetable, and in explaining the reasons for the components included in the project. To ensure success it is essential that the inhabitants/farmers of the area can identify with the benefits that will accrue to them from the project. An example is the provision of water supply to some of the villages - here it must be the villagers who make the request and show the determination to ensure that any system built will be maintained subsequently. The farmers along the canals selected to monitor the effect of the installation of field outlet pipes must be convinced that the installation will help to increase water efficiency and hence crop yields/areas.

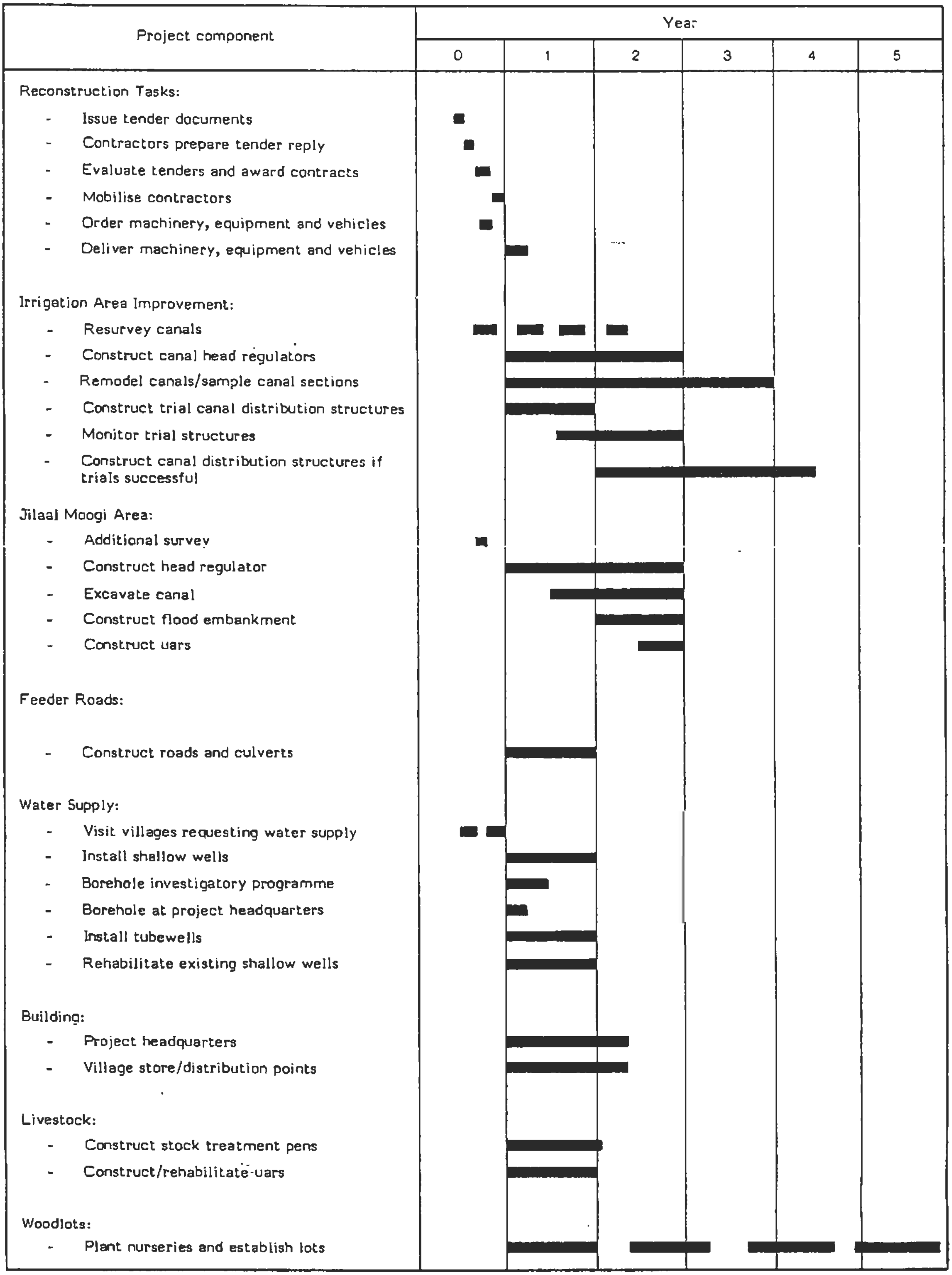
The essential rapport between the project staff and the local people must start immediately the staff arrive on site so that the inhabitants are fully informed of what is proposed prior to the arrival of the contractor with his staff and equipment. The lead-in period also allows for any locally resident labour (skilled/unskilled) registering with the local labour office so that the contractor can include them in the labour force.

The Project Engineer, the Engineering Consultant and surveyors have to do the necessary preparation to issue tender documents, answer queries, assist contractors making site visits, evaluate tenders, assist the MOA in award of contracts, etc. Also, additional survey work required before construction will need to be started and the results plotted. The final location of the shallow wells has to be identified after discussion with villagers. Liaison and discussions with the local farmers and Canal Committees will need to start as soon as possible.

The implementation period is considered long enough for the work to be completed provided there are no hold-ups in the arrival of materials and equipment there is no reason why the proposed timetable cannot be met.

Figure 2.1

Proposed Implementation Programme



APPENDIX I

JOB DESCRIPTION OF KEY MANAGERS

1. Project Coordinator

Function:

During the project implementation period, the Project Coordinator would oversee all activities in connection with implementing, organising and managing project-related construction works and to ensure that the appropriate technical inputs are used to promote agricultural development.

After the completion of physical works, to ensure that all administrative and support activities formerly centered in his office are continued with no interruption and no deterioration of the quality of service formerly provided.

Duties:

During the project implementation period the Project Coordinator's duties will include, but not be confined to, the following:

(a) Direct the Project Engineer to prepare all detailed final designs to enable the contractors to work without interruption on canal remodelling, road construction, building construction and stock watering points.

(b) Ensure that the well exploration and construction programme proceeds according to the arranged timetable.

(c) Organise the promotional and administrative aspects of the work of the SMS cotton, melons, tomatoes and the trainers of draught animals.

(d) Maintain contact with project area farmers, familiarise himself with their problems and bring them to the attention of the appropriate research and extension authorities.

(e) Prepare semi-annual progress reports and work plans for the Project Coordination Committee and the Planning, Monitoring and Evaluation Department of the Ministry of Agriculture.

(f) Guided and assisted by the Senior Consultant, identify the disciplines and the times needed for additional technical consultancy inputs into the project.

After the physical completion of project works, the Project Coordinator will ensure that:

(g) the services transferred to the Regional Extension Officer, Janaale, will fairly support the project area farmers;

(h) repayments for medium and long-term credit are made in due time and that would-be borrowers are both informed of the availability of funds and are aware of any changes in the mechanism to borrow;

(i) the special extension and agricultural research interests of the project area continue to be taken care of within the extension and research organisations.

Supervision:

The Project Coordinator reports to the Director-General, Land and Water Use Department, through the Regional Director in Janaale.

The Project Coordinator directly administers the work of his senior staff and, within his field of competence and qualifications, exerts technical control over their activities.

Qualifications:

A degree in agriculture, not less than 7 years' experience in district agricultural extension work; preferably having led, or worked in, multi-disciplinary teams.

2. Senior Consultant

Function:

The Senior Consultant's principal function is to guide and assist the Project Coordinator in fulfilling his task during project implementation and to train him to continue the work after the implementation period is over and the Senior Consultant leaves.

Duties:

The Senior Consultant's duties will include, but not be confined to, the following:

(a) Training, assisting and advising the Project Coordinator in carrying out all his tasks (see ToR(a)-(i) for the Project Coordinator).

(b) Making an in-depth assessment of all the different farming systems and production objectives of the different farmer groups, endeavouring to determine ways to motivate them towards more productive farming systems and identifying the socio-economic constraints, if any, of their achievement.

(c) During the final six months of his assignment, prepare comprehensive notes on the project area and on operation and management constraints for the Project Coordinator's future guidance.

Supervision:

The Senior Consultant will work with the Project Coordinator and, as relevant, the Regional Director in Janaale. He reports to the Director-General, Land and Water Use Department, keeping the two above-mentioned officials fully informed at all times. He will have administrative control over the Engineering Consultant who, however, will retain his professional independence.

Qualifications:

The Senior Consultant will have an agricultural background with extensive experience of leading, and/or having been a member of multi-disciplinary teams working on irrigation and water development projects. He must have had not less than 10 years' experience in preparing and managing multi-disciplinary agricultural development projects, some of them preferably in Africa.

3. Project Engineer/Engineering Consultant

Introduction:

The project requires the services of a fully qualified site engineer. He must be able to prepare, or supervise the preparation of, final detailed designs of all structures and excavations (canals and stock watering points), prepare and check bills of quantities, supervise construction details and be able to carry out the necessary quality control checks. It is possible that a Somali engineer with the necessary qualifications and work experience cannot be assigned to the project, and therefore most of the work would probably have to be done by an expatriate Engineering Consultant. It will, however, be most important that by the end of the Engineering Consultant's assignment the counterpart Project Engineer be fully trained, not only to enable him to carry out similar assignments in future projects but also to be able to continue, or train someone to continue, the expected post-implementation functions of the Project Engineer.

The job description that follows will therefore apply equally to the Engineering Consultant and the Project Engineer. The common reference is 'Engineer'. The differences will be in the emphasis on training and delegation function allotted to the Engineering Consultant: he must delegate as many of the tasks as possible, as soon as possible, to the Project Engineer.

Functions:

The Engineer's principal function will be to ensure the timely delivery of final designs on which construction can proceed uninterruptedly; to ensure quality control; to prepare the land levelling maps, develop operating procedures and ensure that the Canal Committees are capable of effectively operating and maintaining their units.

Duties:

To fulfil his functions, the Engineer's duties will include, but not be confined to, the following:

(a) Prepare, or supervise the preparation of, final designs of canal layouts, structures and turnouts, which includes all the necessary surveys and mapping work.

(b) Prepare, bills of quantities for the necessary structures and excavations.

(c) Supervise the preparation and checking of payment requests by the contractors.

(d) Arrange for, and supervise proper quality control of all aspects of the contractors' work before approving payment claims.

(e) Train and supervise surveyors doing the basic fieldwork for land levelling.

(f) Arrange for the appropriate computer program for cut and fill calculations to be available, train junior graduate staff in the use of the program and in marking out the new levels in the field.

(g) Organise the field checking and certification of land levelling works, including procedures for progress payments if appropriate.

(h) Develop operation and maintenance procedures for all canals and arrange for the training of personnel sent by Canal Committee chairmen in operation and maintenance procedures.

(i) Giving due consideration to water allocation issues, develop an operation and maintenance schedule for the head regulators and organise their regular inspection and supervision, during and after the irrigation season.

(j) Prepare quarterly progress reports of accomplishments, problems encountered, solutions recommended and the evaluation of previous actions taken.

(k) Be informed of the development scheme on the right bank of the Shabeelle, especially as it will influence project works and performance.

(l) The Engineering Consultant should, as early as he deems appropriate, delegate as many of the aforementioned tasks as appropriate to the Project Engineer, so that the last few months of his assignment should be spent on general advice and refinement of operations and the production of the appropriate maintenance and operation manuals.

Qualifications:

The Project Engineer should have at least a degree in Civil Engineering and as much practical working experience as possible. The Engineering Consultant should, in addition, hold a second degree in irrigation and drainage or water resources. He must have had working experience on a tropical, preferably African, irrigation scheme. He must have a demonstrable record of having successfully trained counterpart staff.

ANNEX 10

IMPROVEMENT OF TILLAGE ON CRACKING CLAYS

ANNEX 10 - IMPROVEMENT OF TILLAGE ON CRACKING CLAYS

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CHAPTER 1

INTRODUCTION

1.1 Background

The DSB Agricultural Development Project is 75 km south-east of Mogadishu, the Shabeelle river forms the northern boundary of the project and its waters are used for seasonal flood irrigation.

	ha
Gross project area	27 535
Mogadishu fuelwood project	5 400
Arable and pasture	22 135

Land use for arable crops : (about 22% of project area)

Rainfed	approximately	1 150	ha
Flood irrigation (50-60% cropping)	approximately	4 385	ha
Perennial (tree irrigation)	approximately	115	ha
Total		5 650	ha

Farm Sizes (approximate):

65%	of the holdings are	0.5 - 1.0	ha
24%	of the holdings are	1 - 2	ha
9%	of the holdings are	2 - 5	ha
2%	of the holdings are	over 5	ha

The soils are predominantly shrinking, montmorillonitic clay vertisols (Annex 1).

1.2 Present Tillage and Planting Methods

The crop calendar is shown in Figure 1.1. The first crop is almost invariably maize; the second crop is mostly sesame but occasionally also maize. Precipitation levels shown for the seasons are approximate and also highly variable (Annex 2).

The traditional method of land preparation is by hand. It consists of the removal of such vegetation that survived the jilaal season, followed by the excavation of small holes with a planting hoe ('yambo') on an approximately 30 to 40 cm square grid. Another person - usually a woman or child - places 6 to 8 maize seeds into the hole and firms it down by foot. While weed removal normally takes place before the onset of rains or before irrigation water can be applied, planting is done either before the rains - no more than

30% - or after the first showers or irrigation, usually in late-April - the balance of 70%. The method normally results in good germination and seedling establishment. However, it also enables the weed seeds to germinate and the dormant stoloniferous grasses to start growing, thereby creating increasingly serious weed control problems, which often make a fallow necessary, thereby losing potential production. The second crop is planted in September-October following a heavy irrigation, or flooding by 'harvested' water or just on rainfall.

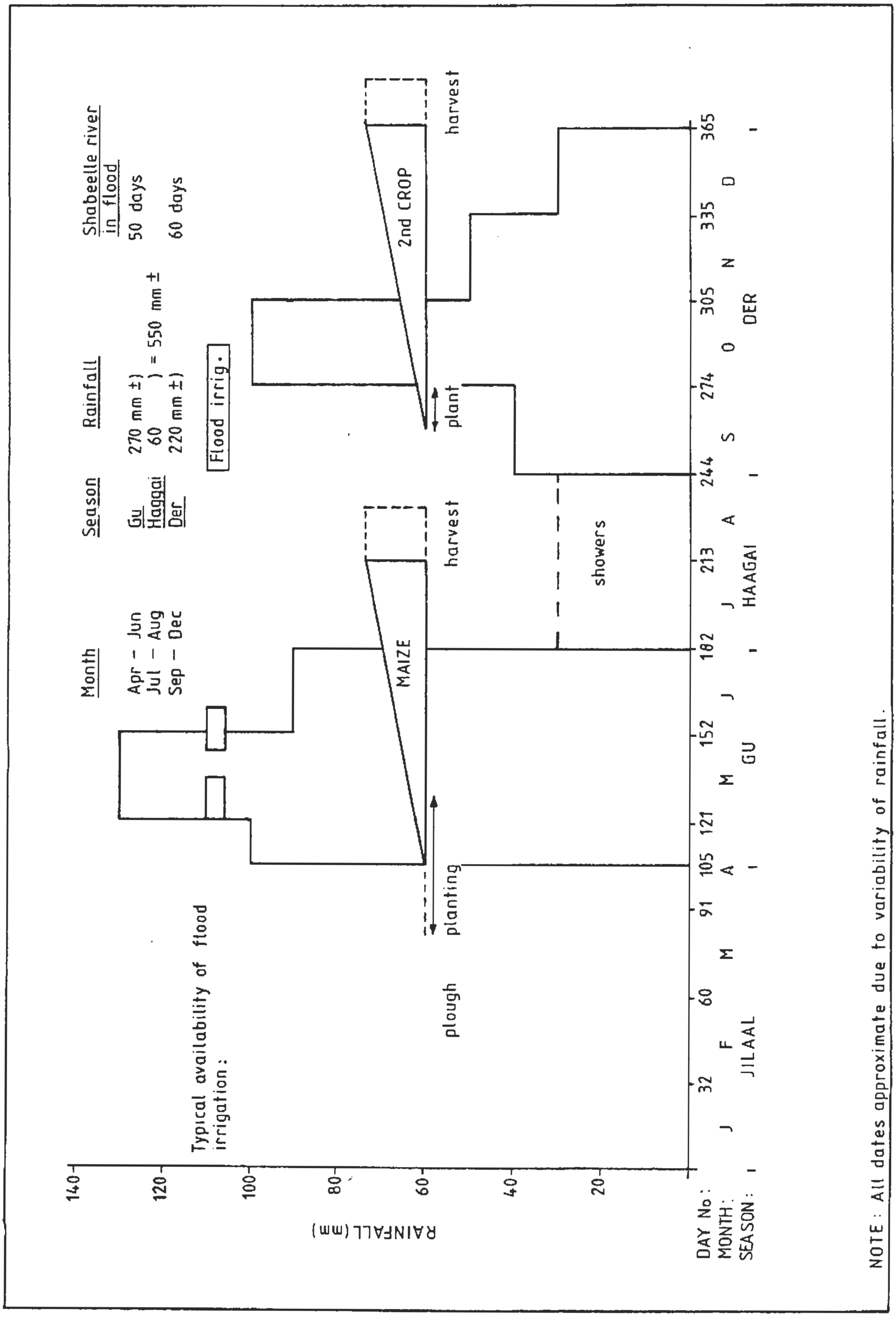
Animal power is not normally used for cultivations. Their use is confined to light transport activities with small carts, mainly for water carrying. The animal most commonly used is a single donkey, but single oxen and bulls and, very rarely, a pair of oxen or bulls are used. The male camels are exclusively used as load carrying burden animals.

At present much of the land preparation in the project area, and an increasing area all over the cultivated lands in Somalia is with tractors, typically using mounted 3-furrow disk ploughs. Ploughing is normally done before the rains at the end of the jilaal, when the soil is quite dry. The usual depth is 12 cm to 18 cm. The resulting surface usually has large clods which should, but rarely are, further broken down with a disk harrow, to produce an acceptable seedbed. The operation is also power intensive : the 3-furrow plough, as well as the double gang disk harrow about 2 m wide requires a 70 to 80 hp tractor to pull it.

After the tractor, planting is either done by scattering the seed into the open furrow as the tractor passes, or, usually after disking, with the yambo as described above. Both methods often result in poor germination and subsequent heavy seedling mortality because of the large air spaces left by both methods, which would require a heavy rainfall or a deep irrigation for the spaces to disappear. However, unlike with land preparation by hand, the weed growth is usually more readily controllable.

Figure 1.1

Schematic of Crop Production Calendar



CHAPTER 2

DIAGNOSTIC APPROACH TOWARDS THE IMPROVEMENT OF CULTURAL PRACTICES

2.1 Introduction

Cultural practices need to be improved to increase the reliability of crop establishment and to conserve water and energy resources. The first step is to establish the purpose or need of each major input into the production process. This is particularly valid for high energy, high cost tillage practices. In particular the purpose of ploughing needs to be questioned. This can only be carried out effectively by developing an awareness of the main constraints to crop growth through an increased understanding of the basic resources available for crop production. These are: climate; soil; power/energy forms (manual, animal and machine) and management levels/farming systems.

Information has been collated regarding the relative merits of various tillage systems for vertisols (Willcocks and Browning, 1986) through detailed field experimentation. This has led to an increased understanding of the principles of land preparation for these unique dynamic soils. It is important to note that considerable rethinking of certain well established concepts of soil physical properties are necessary to understand montmorillonitic clays; for example it is practically meaningless to quote the bulk density due to the dynamic nature of the vertisols.

From a scientific base, therefore, information is now available regarding the principles of land preparation on vertisols which makes it possible to describe what needs to be achieved, and how to achieve it. Given an understanding of the basic resources of the area, it is feasible to prescribe appropriate practices for crop production in the Dara Salaam - Busley and other similarly situated projects in the Shabeelle valley through a diagnostic approach beased on the edaphic requirements of the crop (Willcocks, 1986).

2.2 Climate

Rainfall, irrigation and temperature data provide essential information on the seasonality of cropping and thereby indicate possible management options that optimize the timeliness and scale of operations. Figure 1.1 depicts a possible double cropping calendar for the project. It must be stressed, however, that precipitation is extremely variable and improved farming systems must optimise the availability of water and keep inputs to a minimum.

2.3 Soils

Soils within the project area are described as 'good'. The mechanical analyses (Figure 2.1) show that most are clays with a clay content in the region of 60%. There is, however, some variation of soil type within the project as there are some silty loams, (profile : PG 03) and sandy loams (profile : PG 05) as shown in Figure 2.2. Since most contain montmorillonite and the clay content is more than 40% it is evident that these soils are mainly vertisols, which are, by their cracking nature, self-loosening soils.

During drying shrinking occurs resulting in the formation of deep cracks (fissures) with rough cleavage faces. Continued dry (jilaal) season desiccation of the soil results in the formation of a loose, dusty surface. Under the combined influence of livestock, wind, cultivation, rainfall, irrigation and gravity much of this surface soil is dislodged and accumulates within the fissures. When water enters the cracks, through the onset of rains or irrigation, swelling of the accumulated soil occurs at the bottom of the cracks. This results in considerable stress at this level (typically 0.75 to 1 m depth) due to the expansion of the montmorillonite clay. These pressures are relieved by an upward movement of some of the soil mass along slickensides (Newman, 1983) which results in an intermixing of soil surface material with the lower horizons. This is known as homogenisation.

Because vertisols shrink and fissure, they are also referred to as clod-forming soils. This can lead to severe management difficulties in the tropics because there are no frosts to break down clods lifted to the surface by inappropriate tillage operations. In addition, these soils are very sticky when wet. To sum up, their physical properties mean that vertisols require careful management.

The suitability of the edaphic environment for effective crop root growth can best be estimated by excavating soil pits next to crop plants to a depth of about 1 m so that the development of mature crop root systems can be inspected. Crop roots are a valuable and readily available dynamic instrument as they will clearly show if soil physical factors are seriously limiting to root penetration. Since the dry bulk density of these soils is rarely limiting to root growth and homogenisation occurs naturally it is necessary to consider carefully the question: What is the purpose of ploughing?

Experiences with vertisols (Willcocks, 1980 and 1986) has established that the primary purpose of any field preparation/tillage operation is the control of weeds and the preparation of seedbed. Too often inappropriate high energy temperate techniques of tillage are used for the cultivation of vertisols in the tropics resulting in an unnecessary waste of resources.

2.4 Farm Power

Although tractors are available for tillage, practically the only animal draught available are donkeys, at present used exclusively to pull purpose-built carts for the conveyance of water and other light goods. Planting and hoeing operations are carried out manually.

2.4.1 Manual Systems

Timeliness of planting can usually be achieved because deep soil loosening is not necessary and shallow planting operations and after-cultivations are adequate. The effective control of weeds is the main challenge to the farmer who only has a hand hoe with which to work. Many studies in Africa have shown that row planting can facilitate weeding operations; convenient row planting techniques are therefore needed.

Investigations into the use of chemical weed control the use of herbicides, as opposed to mechanised weeding systems, (Table 2.1 and Figure 2.3) have shown that it can have a significant role in smallholder agriculture.

Figure 2.1

Particle Size Analysis of Clay Soil Profiles

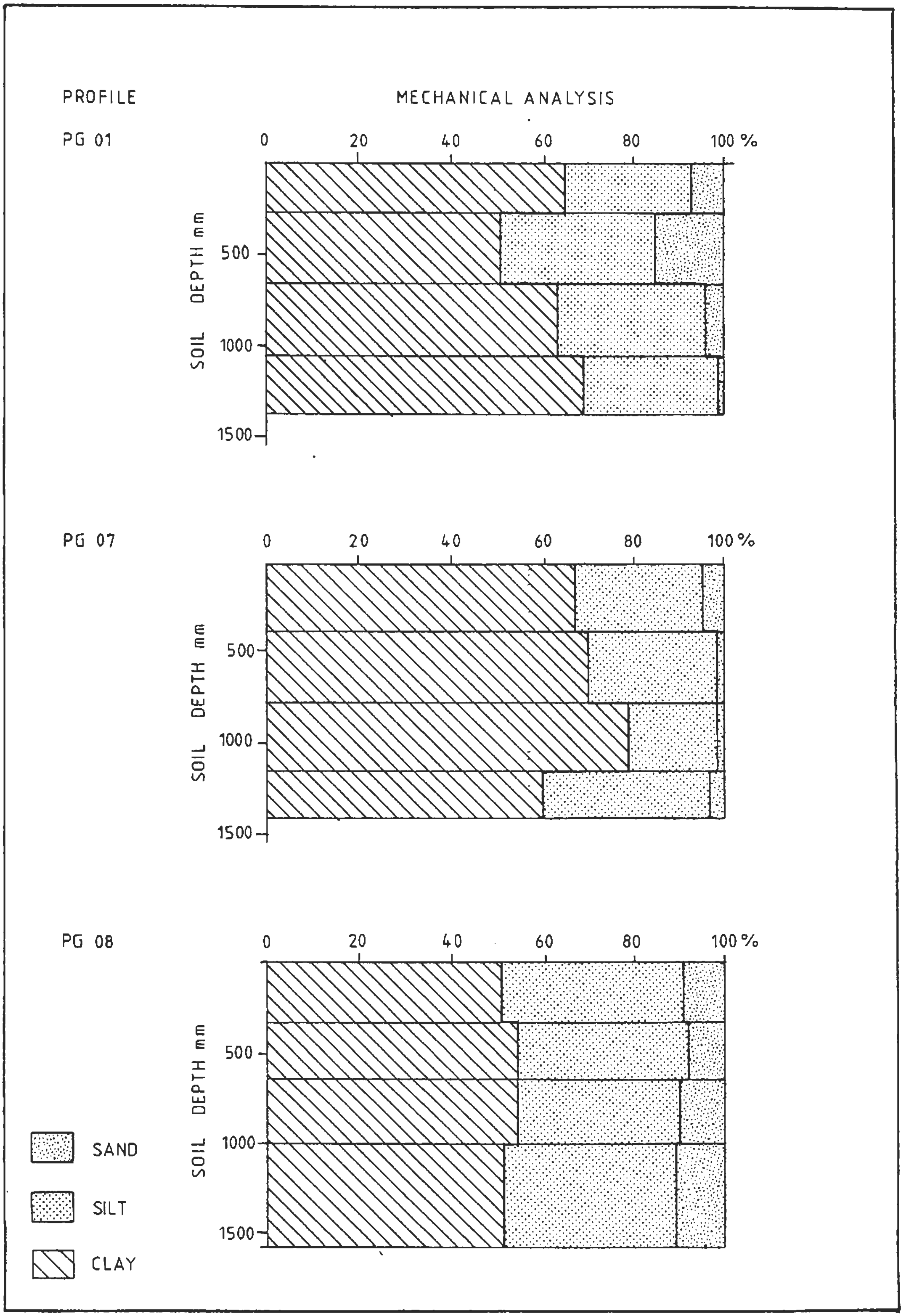


Figure 2.2

Particle Size Analysis of a Silty Loam and a Sandy Loam Profile

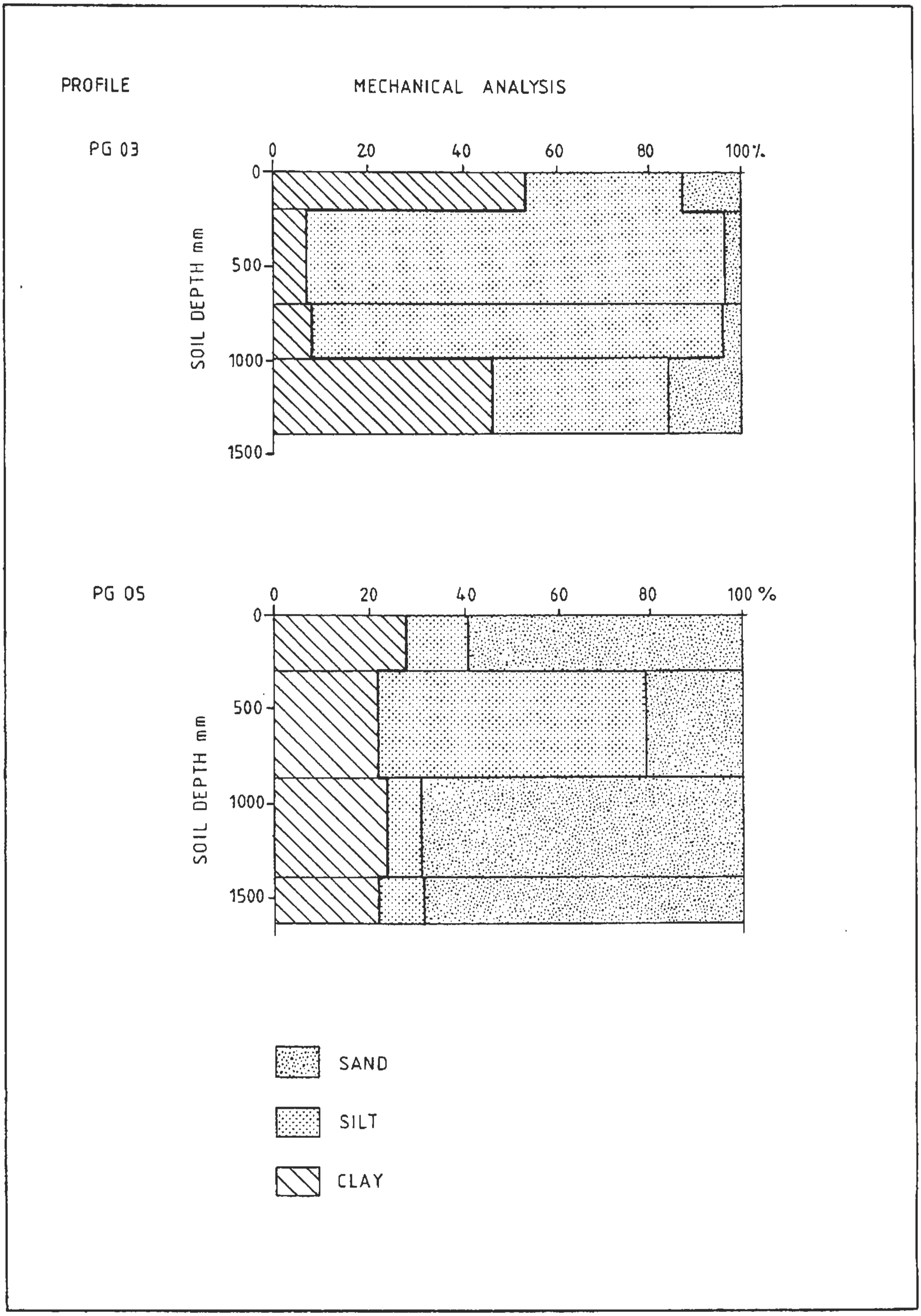


Figure 2.3

Input Requirements
Conventional Tillage vs. Herbicide

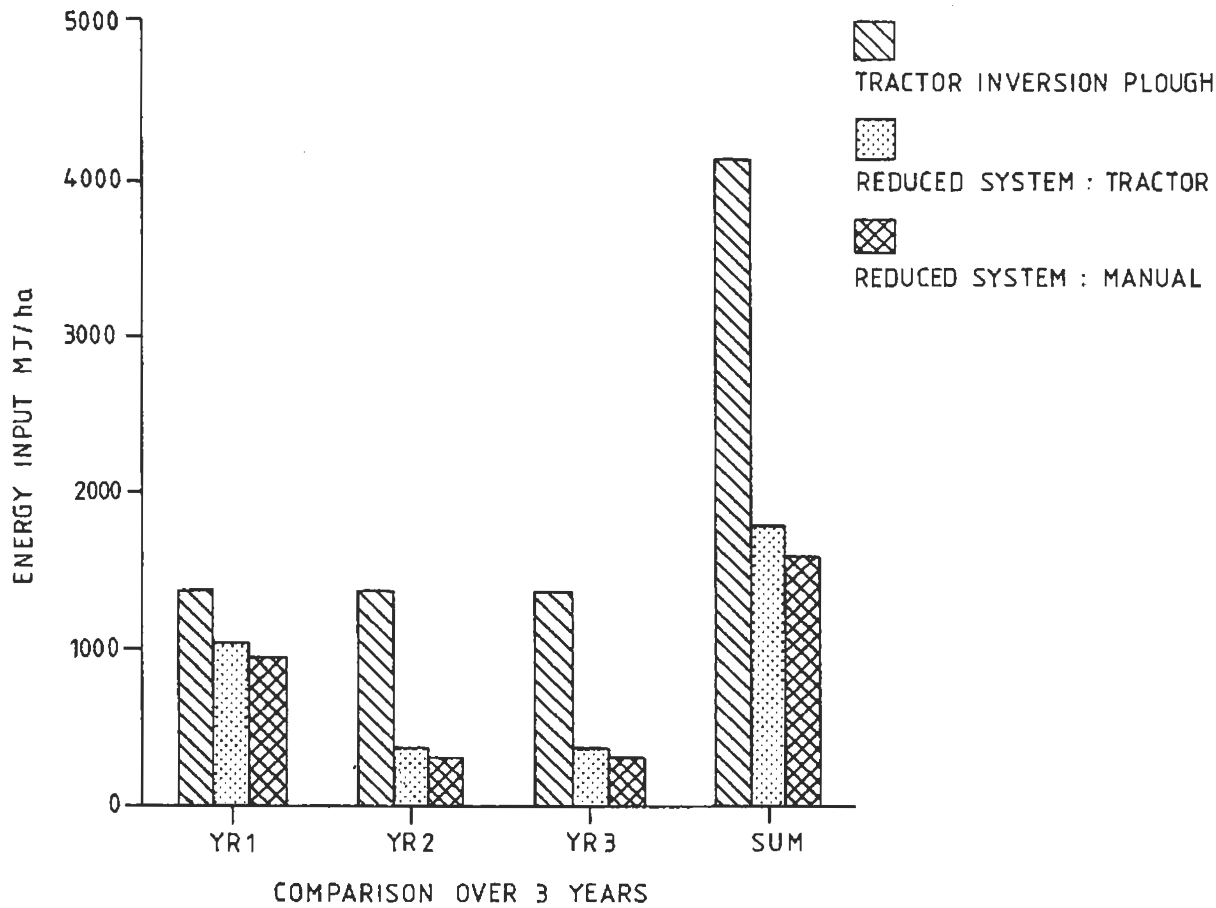


TABLE 2.1

Comparison of Commercial Energy Requirements for Conventional and Reduced Primary Field Preparation (provisional data)

Conventional primary tillage			(T) Tractor	Reduced system		(M) Knapsack	
Activity	Fuel l/ha	Energy* MJ/ha	Activity	Fuel l/ha	Energy* MJ/ha	Activity	Energy MJ/ha
Year One							
Plough	-	120	Sprayer	-	35	Sprayer	50
Ploughing	22.5	1 260	Spraying	1.7	95		-
		1 380	Glyphosate	-	908	Glyphosate	908
			(@ 2 kg/ha a.i.)		1 038		958
Year Two							
Ploughing	22.5	1 380	Polydisk	-	100	Sprayer	50
			Tillage	5.0	280	Herbicide	276**
Year Three							
Ploughing	22.5	1 380	Polydisk	-	100	Sprayer	50
			Tillage	5.0	280	Herbicide	276**
Three Year Total		4 140 (100%)			1 798 (43%)		1 610 (39%)

Note: * Energy values include allowance for depreciation and repairs of equipment estimated as +40% of net fuel use (@ 40 MJ/l) for tractors.

** Paraquat herbicide @ 0.6 kg/ha active ingredient

a.i. active ingredient

2.4.2 Tractors

Detailed investigations on the tillage of vertisols have demonstrated the high draught deep tillage is: unnecessary, detrimental to seedbed preparation, unproductive in the use of equipment and very costly.

Table 2.2 and Figure 2.4 show the high speed shallow tillage systems like the wide level one-way disk or single-disk harrow are the most cost effective. Deep soil inversion tillage with mouldboard or disk ploughs is unnecessary and would be as costly as the chisel plough operation recorded on vertisols in the Sudan. Both methods, but the use of the disk and mouldboard ploughs in particular, bring up large clods which then have to be reduced to a seedbed tilth with costly secondary tillage (Figure 2.4).

2.4 Levels of Management/Farming Systems

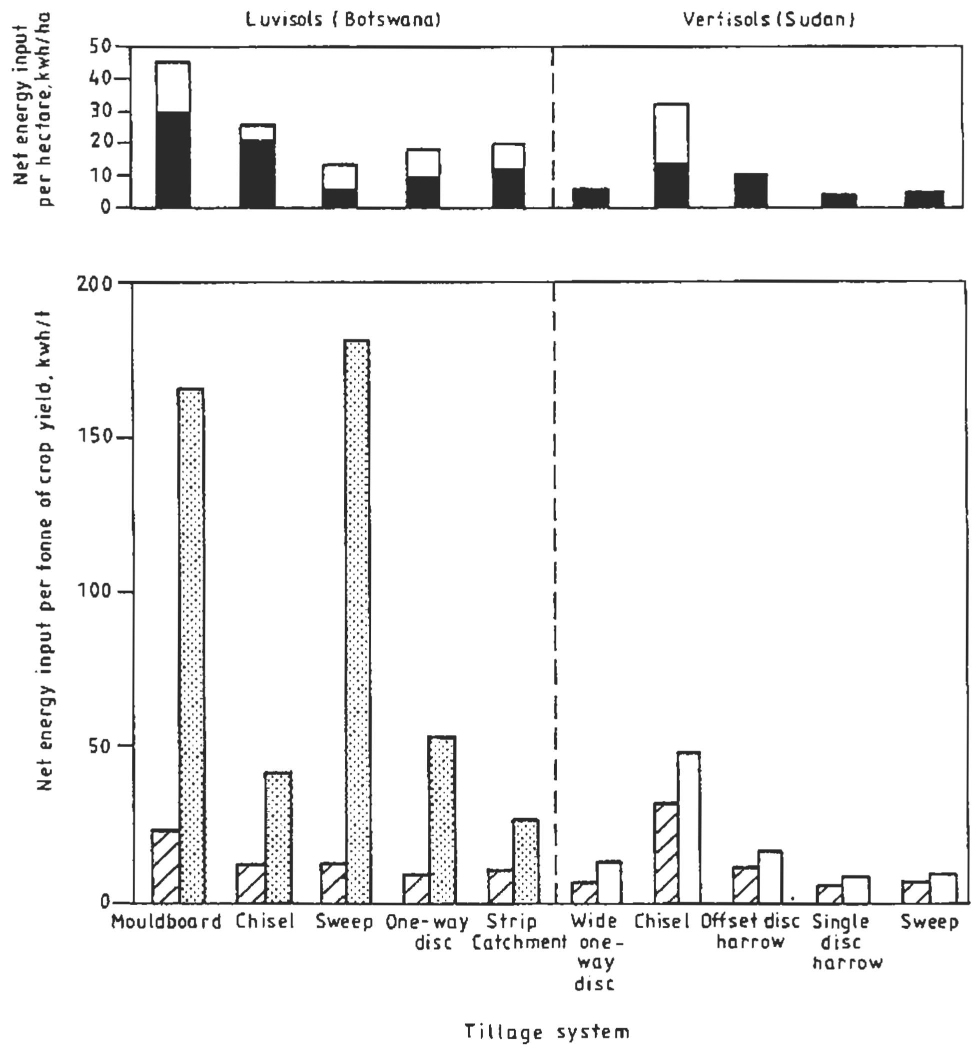
It is important to establish the priorities and secondary needs of the farmers. To achieve this, multidisciplinary field studies of the currently practised farming systems are necessary (Willcocks, ASAE, 1986). These studies should establish what levels of management are available and quantify the perceived difficulties with the climate, soil and power resources so that improved technology can be targeted directly towards the alleviation of the real constraints within the crop production systems. Such investigations will entail fundamental questioning regarding the primary purpose of any tillage operation and particularly the need for ploughing. The prime purpose of this exercise would be to establish improved methods that would lead to more productive sustainable systems that would lead to a quantum jump in reducing tillage costs and otherwise affect costs of production.

Figure 2.4

Net Energy Inputs per Ha.

Measurement of Implement draught power and net energy requirements on Vertisols (montmorillonitic clays) in Sudan

TILLAGE Plough Type (1)	Depth of work nominal m (2)	Width of work m (3)	Forward speed m/s (4)	Draught: Force: Net work rate ha/h (5)	Draught: Force: KN (6)	Draught: Force: Per m width KN/m (7)	Draught: Power KW (8)	Net energy: Implement requirement MJ/ha (9)	Net energy: Implement requirement KWh/ha (10)	Net energy: Applied to soil KJ/m^3 (11)
Wide one-way disc 24 discs (dia 460 mm) in 3 aligned gangs (Approx 20 kg/disc)	0.06	3.77	1.52	2.1	7.6	2.0	11.6	20	5.6	34
Chisel 7 tines at 400 mm centres	0.15	2.80	0.99	1.0	15.0	5.4	14.9	54	14.9	36
Offset disc harrow 28 discs (dia 650 mm) In 2 gangs	0.08	2.65	1.42	1.4	10.1	3.8	14.3	38	14.3	48



Net energy inputs (top) per hectare ■, primary village inputs □, secondary cultivations where necessary and (bottom) per tonne of crop yield (▨ sorghum; ⊡ maize; □ cotton) for the various tillage treatments on (left) dense Luvisols (Botswana) and (right) Vertisols (Sudan).

(SOURCE: WILLCOCKS (1984)

TABLE 2.2

Measurement of Implement Draught Power and Net Energy Requirements on Vertisols (montmorillonitic clays) in Sudan

Tillage Plough Type	Depth of work nominal (m)	Width of work (m)	Forward speed (m/s)	Net work rate (ha/h)	Draught Force (kN)	Draught Per m width (kN/m)	Power (kW)	Net energy Implement requirement (MJ/ha)	Net energy Implement requirement (kWh/ha)	Net energy Applied to soil (kJ/m^3)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Wide one-way disk 24 disks (dia. 460 mm) in 3 aligned gangs (Aprox. 20 kg/disk)	0.06	3.77	1.52	2.1	7.6	2.0	11.6	20	5.6	34
Chisel 7 tines at 400 mm centres	0.15	2.80	0.99	1.0	15.0	5.4	14.9	54	14.9	36
Offset disk harrow 28 disks (dia. 650 mm)	0.08	2.65	1.42	1.4	10.1	3.8	14.3	38	10.6	48

Source: Willcocks, 1984

CHAPTER 3

SUMMARY AND RECOMMENDATIONS

3.1 Introduction

Improved cultural practices for vertisols need to

(i) conserve water and energy resources,

(ii) increase the farmers' ability to achieve timely planting and

(iii) facilitate effective control of weeds.

The overall conclusions of tillage investigations with vertisols are

(a) if one tries to force a seedbed on vertisols with deep tillage the exercise is certain to be costly, time- and energy-consuming, with uncertain results. Therefore every effort must be made to harness the unique nature of this dynamic (swelling) self-loosening soil.

(b) the primary objective of seedbed preparation in vertisols is the control of weeds; other, well-known characteristics of a good seedbed are brought about by the natural processes of swelling and shrinking characteristic of these soils. Weed control can be effectively achieved with a low input shallow weeding operation using a hand hoe, animal-drawn weeder or high speed wide level one-way disk harrow cultivating about 2 ha/h with a 45 kW (60 hp) tractor. The use of safer herbicides like glyphosate which is systemic in action also shows great promise for traditional smallholder agriculture, (Willocks, 1981).

3.2 Manual Methods of Crop Production

Traditional planting hoe (yambo) techniques result in good crop emergence but poor control of weeds between crop plants. More rigorous weeding operations after crop emergence would increase crop yields but may require labour inputs which are beyond the means of the average farmer to bring to bear. Regular row planting should ease subsequent weeding operations during crop growth especially by animal drawn hoes. The use of 0.75 to 0.80 m rows would encourage some suppression of weeds through the crop canopy and later stages of crop development.

Trials in Sudan on vertisols have shown jab planters to be as effective as planting hoes (saluka). Their use facilitates the planting of more regular rows, thereby easing subsequent weeding operations.

The control of weeds using manually held weed-wipers may be possible for small scale farmers as chemical (glyphosate) use is even lower than with spray technique. The use of simple pull-along sprayers should also be tried. Glyphosate is a comparatively safe chemical (mammalian toxicity 1/2 400 that of paraquat) and an effective herbicide but its cost per litre is likely to remain high until 1994 when the patent runs out. In spite of its high price, costs are likely to be about US$ 12 per hectare. The use of weed wipers is a high technology system. Nevertheless, the logistics and costs of supplying, managing and supporting a manually held weed-wiper operation deserve careful investigation. The foreign currency cost per hectare may well prove to be less than the system now practised. Therefore, it is recommended that trials into the use of more effective weeding by regular row planting and the use of herbicides be initiated.

3.3 Animal Draught Cultivations

Animal draught is commonly used in India for multiple cropping on vertisols. Proven systems have been successfully employed for decades. Improved use of animal power is being developed at the Central Institute of Agricultural Engineering (CIAE) at Bhopal, in conjunction with the Overseas Division of the Agricultural and Food Research Council (AFRC) Institute of Engineering Research at Silsoe, Bedford, UK.

The key to any animal draught programme is whether the local farmers are used to handling animals for draught operations. Technically animals are well suited to the shallow tillage operations that are needed to control weeds on vertisols. They have the advantage of being able to get on to the field after rain much sooner and more frequently than any conceivable form of light tractor, even if their introduction for secondary tillage in Somalia were to be seriously considered.

Oxen and buffalo are normally used in India. Trials are under way in Sudan with donkeys pulling light planting and weeding implements. Similar work has recently started in Somalia, in Bonka.

Provided farmer participation is assured, it is recommended that on-farm demonstrations be set up to encourage the use of donkeys and possible draught oxen for light planting and sweep weeding operations. The use of paired jab planters should be encouraged so that subsequent weeding operations can be coordinated on two crop rows per pass. It is also recommended that this programme should include the exchange of ideas with similar work in India and Sudan.

3.4 Tractor Tillage

Tillage constitutes the greatest labour and energy input in most farming systems. In many situations the need or reason for soil loosening is never questioned, and with the introduction of tractors many farmers have tended to plough deeper than was possible with manual and animal power. Experience in the tropics has shown that the importation of temperate techniques of soil inversion weed control tillage like mouldboard or disk ploughing have often proved inappropriate and costly.

Deep tillage on vertisols is not only unnecessary but unacceptably slow and expensive and a concerted effort should be made to encourage the adoption of a shallow (0.05 to 0.10 m) weeding system of tillage using proven wide polydisk implements.

The timing of cultivation is important and ideally should not be conducted before sufficient rain has fallen to replenish soil moisture through the cracks and to germinate the first flush of weeds which can then be killed by the cultivation. Clearly, optimum timing will not always be possible and some compromise will be necessary to ensure economic utilisation of the equipment, (See 'Managerially Optimum Model'*) and hence jilaal cultivations will always be necessary on part of the area. Where pre-rains tillage becomes a managerial necessity during each season's operations, most open cracks will be filled and light rains can be sufficient to wet the shallow seedbed profile to a moisture content sufficient for seed germination. This moist seedbed profile will, however, be perched and problems will arise if subsequent rainfall is delayed or poor, or irrigation is not possible. Moreover water replenishment of the deeper profile via the cracks will have been inhibited which may produce further constraints.

Tillage equipment for these shallow operations needs to be high speed so that each unit can cultivate the maximum area during the short season (Figure 1.1) before the rains make the vertisols too sticky for tractor use. High speed equipment is essentially shallow draught and since there is no need to loosen vertisols deeper than 0.1 m, wide weed control equipment is highly suitable. Detailed draught measurements were conducted in Sudan to measure the inputs of various tillage systems (Table 2.2) to establish the energy cost to cultivate 1 ha and to produce 1 t of crop (Figure 2.4). Deep tillage as conducted in temperate agriculture is not only very costly also but inappropriate under these conditions, since it produces a cloddy tilth which requires further energy to break down the soil to an acceptable seedbed. This is indicated in Table 2.2 and Figure 2.4 where the slow chisel plough system required secondary cultivation and had unacceptably high input costs per hectare; similar costs would be incurred with soil inversion disk and mouldboard ploughing. The energy cost of the deep tillage (chisel) system per tonne of crop yield was about four times that achieved with shallow tillage. In addition to this the seasonal area potential of the deeper cultivation system would only be about 25% of that achievable with shallow disking equipment at 2 ha/h. Clearly, therefore, high speed shallow cultivations are the most convenient and economic for the extensive cultivation of vertisols.

Smallholder agriculture in an extensive region like the project area could benefit from this technology provided that several adjoining plots could be cultivated at once so as to keep field efficiencies of the equipment high. This will become a communal organisation and management issue once the benefits of the system are established.

Note*	zero option	=	productivity of agricultural system without improved technology component.
	technically optimum model	=	potential productivity of improved system or technologies operating under ideal conditions (e.g. as often found on research stations).
	managerially optimum model i.e. on-farm conditions (frequently sub-optimum technically)	=	potential productivity of improved technology when used under pre- and post-optimum conditions in addition to optimum (e.g. tillage cannot always be conducted when soil is friable since soil can be hard early in the season and weedy later). These considerations on system capability are particularly important for implements since they need to be used over sufficiently long periods to keep cost/ha or cost/t low.

In small (less than 1 ha) fields a 9 disk tractor-mounted polydisk could be more appropriate than a 24 or 36 disk wide level one way disk harrow.

Comparative trials in Sudan have shown that the use of a wide level of disk significantly reduces the need for early weeding of the crop compared with no-till planting methods of mechanical weed control using a planting stick. The wide level disk can also be used to drill grain at the time of cultivation.

3.5 Proposals for Investigational Study

It is evident that there is an urgent regional need to develop improved cultural practices for cracking clays. Improved systems of soil management should, therefore, not only be applicable to, and benefit, the Dara Salaam Busley Agricultural Development Project but be relevant to the needs of most of the Shabeelle valley.

Because the study would thus have implications and applicability far beyond the confines of the project area, and because, for maximum demonstration effects as well as to extend the investigation to all appropriate soil types, it would be inappropriate to make it a component of the project under consideration. Nevertheless it is recommended that, preferably under the auspices of a donor agency willing to support technical investigations and technology development, an investigation be mounted to review current farming practices, with the criteria discussed in this annex in mind, and identify the primary and secondary constraints to crop production. The team should include an agricultural engineer, an agriculturist and an agricultural economist. The investigations should describe and analyse current practices in terms of cash, labour and physical and technical constraints, with particular reference to production limitations imposed by having to delay operations beyond the optimum time through causes beyond the farmer's control. Based on this review, it should be possible to prepare a small investigational project that could, as its end result, recommend appropriate cultural practices and its logistic organisation.

APPENDIX I

REFERENCES

Newman, A.L.	1983	Vertisols in Texas - Some Comments. USDA. Soil Conservation Service. Temple, Texas. 27 pp.
Sir M. MacDonald & Partners Ltd	1987	Dara Salaam Busley Agricultural Development Project, Progress Report and Memorandum of Understanding, Somali Democratic Republic. Ministry of Agriculture. MacDonald Agricultural Services Ltd, Demeter House, Station Road. Cambridge, 51pp + MOA.
Willcocks, T.J.	1980	Tillage Requirements of Vertisol Soils in South Kordofan and the Role of the Agricultural Mechanisation Project of Kadugli, Sudan. OD/NIAE Report, 46 pp.
Willcocks, T.J.	1981	Reducing the Energy Required for Mechanised Cultivations in Developing Countries. In: Fazzolare, R.A. & Smith, B.S. (editors) 'Beyond the Energy Crisis, Opportunity and Challenge. Vol III.' Third International Conference on Energy Use Management. Berlin. Pergamon Press, Oxford, pp 1945-1955.
Willcocks, T.J.	1986	A Diagnostic Approach for Mechanisation in Developing Countries. ASAE Paper Nr 86-5010.
Willcocks, T.J. Browning, J.	1986	Vertisols ('Black' Cracking Clays) A Bibliography with some Abstracts/Extracts, Content Analyses and Comments. Overseas Division/AFRC Eng., Bedford UK, 121 pp.

ANNEX 11

TENDER DOCUMENTS

ANNEX 11 - TENDER DOCUMENTS

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SECTION 4	DOCUMENT PREPARATION	1-2
APPENDIX A	COPY OF LETTER FROM MINISTRY OF AGRICULTURE DATED 9/4/1987 REFERENCE A.AH.B. 43/298/87.	

ANNEX 11

TENDER DOCUMENTS

1. General

Under the Terms of Reference, Item I:

> 'Every work or material necessary for project execution must be described in detail and tender dossiers will be prepared accordingly taking into consideration the rules and conditions applicable to projects financed by EEC'.

2. Document Format

As required under the Terms of Reference, tender documents have been prepared for all the work and services and for the supply of all vehicles, equipment and machinery required to execute the project over the 5-year implementation period.

An opportunity was taken by the Consultant to discuss the rules and conditions applicable to projects financed by the EEC with the Engineering Adviser to the Delegate of the Commission of the European Communities in Mogadishu and subsequently by telephone with Mr John Ward, DG VIII Development/E3, at the headquarters of the EEC in Brussels.

Following the latter discussion, it was agreed that for the supply document the format should follow the General Conditions for Supply Contracts Financed by the European Economic Community, European Development Fund, Part B, Invitation to Tender dated 1982. For the works and services there were no objections to using Part I - General Conditions of the 'Conditions of Contract (International) for Works of Civil Engineering Construction', 3rd edition, March 1977, prepared by the Federation Internationale des Ingenieurs-Conseils (FIDIC) and the Federation Internationale Europeene de la Construction (FIEC) and approved by those organisations. The use of FIDIC would not be withheld provided that the Client had used them in similar work in the past and that the Client had given his approval in the present circumstances. This approval had been given by the Client in his letter dated 9th April 1987, reference A.BH.B 43/288/87, Appendix A. Hence for the works and services the FIDIC conditions have been adopted.

3. Principal Unit Rates Adopted

The Client and Delegates of the EEC, Somalia have requested that 'a confidential document with the estimated unit prices of the most important items in each contract should be provided' by the Consultant.

To meet this requirement the Consultant has prepared Annex 12, Principal Unit Rates Adopted under a separate CONFIDENTIAL cover as part of this study.

4. Document Preparation

Three documents have been prepared, these are:

Contract Nr DSB 1	Civil Works and Road Construction
Contract Nr DSB 2	Buildings
Contract Nr DSB 3	Supply of Machinery, Equipment and Vehicles

These documents have been bound as separate volumes and are submitted with this report.

JAMHUURIYADDA DIMOQRAADIGA SOOMAALIYA

oOo

Ministry of Agriculture

Lam. ——————Waxaa ku xiran —————— Mogadishu, 9/4/1987

Jawaabta warq. L. ——————————

oo A. AH. B. 43/288/87

Ujeeddo: Tender Documents

Mr. Andrew Seager
Team Leader
Darasalam/Busley Study

Having read your letter of March 30, 1987, your Ref: 1592/1/1/398, in respect to the tender documents required as per article 2.5.1 of the agreement, I would like to inform you that the sample instructions for tendering is acceptable as along as the conditions of contract are those prepared by F.I.D.IC and is acceptable to the European Economic Community, represented here by the Commission.

In that respect I would like you to clear-up also with the Commission before proceeding with contract preparations.

Yours sincerely,

Mohamoud Mohamed Ali
Director Land & Water Resources

cc: Mr. G. Vitilo,
EEC Commission
Mogadishu