BASIC DESIGN STUDY REPORT
ON
THE PHASE III PROJECT
FOR THE WATER SUPPLY IMPROVEMENT
IN MOGADISHU CITY
IN
SOMALI DEMOCRATIC REPUBLIC

FEBRUARY 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the Somali Democratic Republic, the Government of Japan has decided to conduct a Basic Design Study on the Project for Mogadishu Water Supply Improvement (Phase III) and entrusted the study to Japan International Cooperation Agency (JICA). JICA sent to Somalia a survey team headed by Mr. Masayuki Matsushima, Kyoto Municipal Waterworks Bureau, from August 31 to September 27, 1988.

The team exchanged views with the officials concerned of the Government of Somalia and conducted a field survey in Mogadishu. After the team returned to Japan, further studies were made. A mission was, then, sent to Somalia in order to discuss the draft report and the present report was prepared.

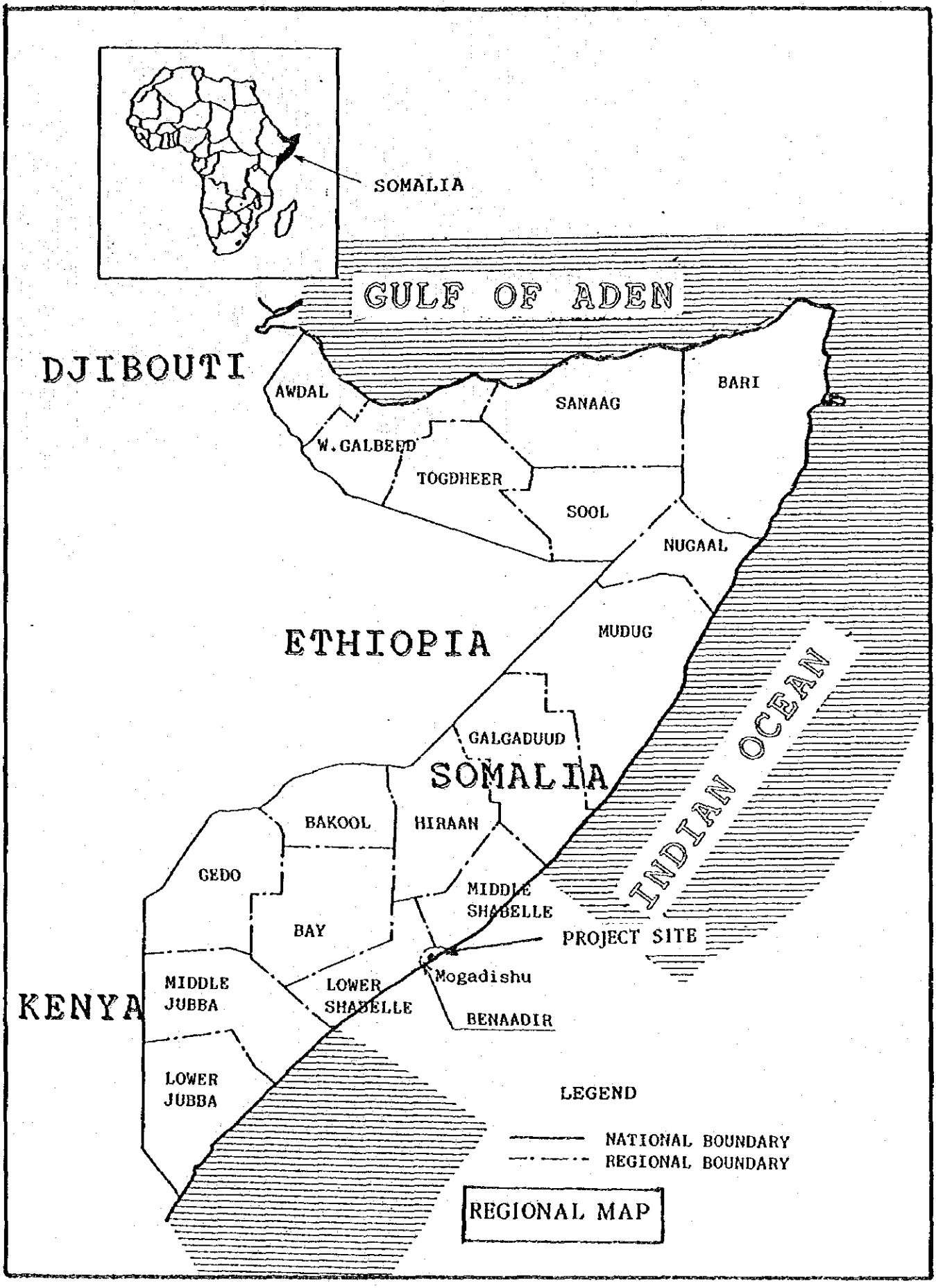
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our countries.

I wish to express my sincerest appreciation to the officials concerned of the Government of the Somali Democratic Republic for their close cooperation extended to the team.

February 1989

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency


SOMALIA
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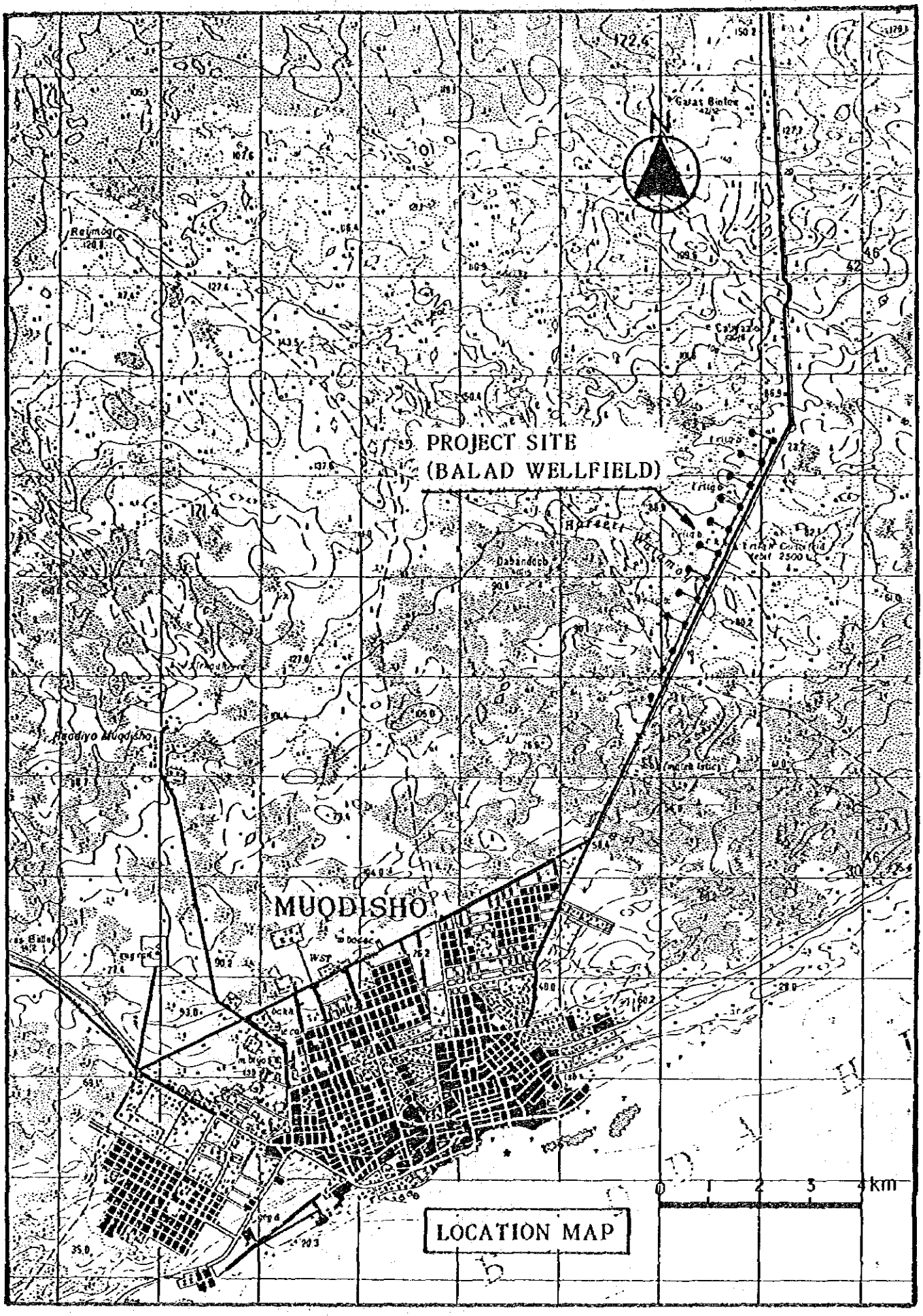
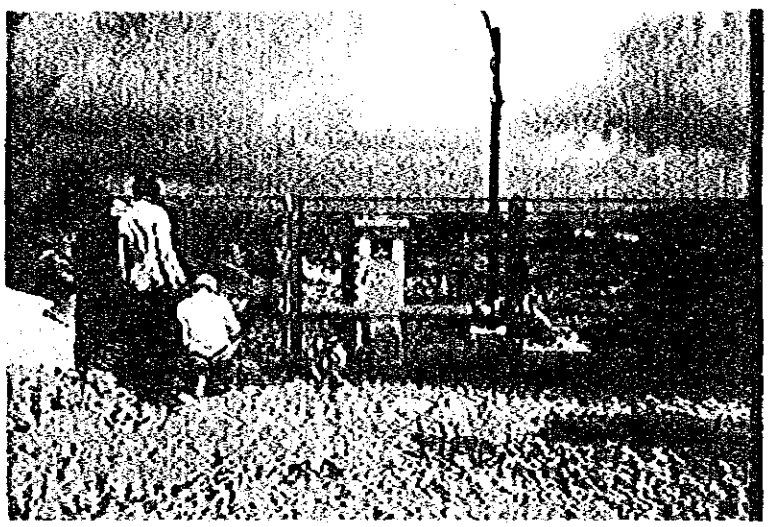
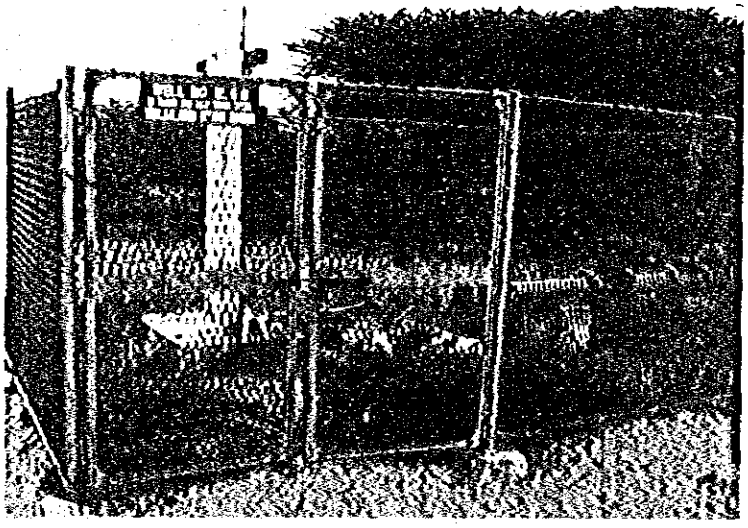
GALGADUUD
SOMALIA
INDIAN OCEAN
BAKOOL
HIRAAN
GEDO
BAY
MIDDLE SHABELLE
PROJECT SITE
Mogadishu
BENAADIR
LOWER SHABELLE
KENYA
MIDDLE JUBBA
LOWER JUBBA
LEGEND
NATIONAL BOUNDARY
REGIONAL BOUNDARY
REGIONAL MAP

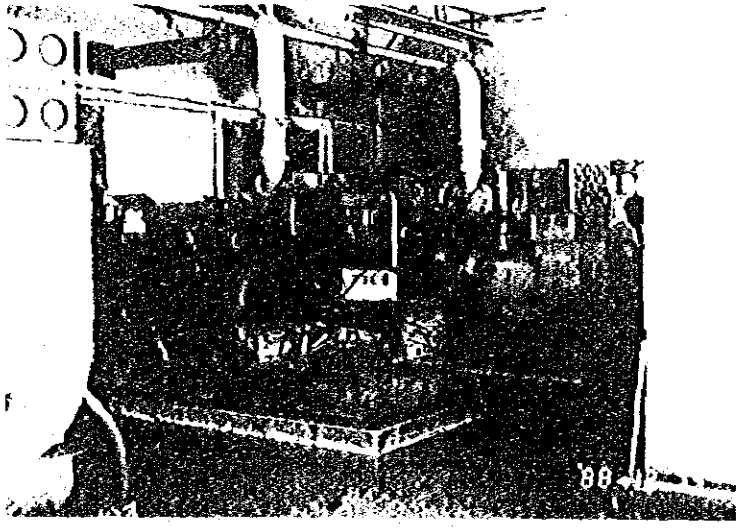

PROJECT SITE
(BALAD WELLFIELD)
MUQDISHO
Raadiyo Muqdisho
Dabandoob
0 1 2 3 4 km
LOCATION MAP



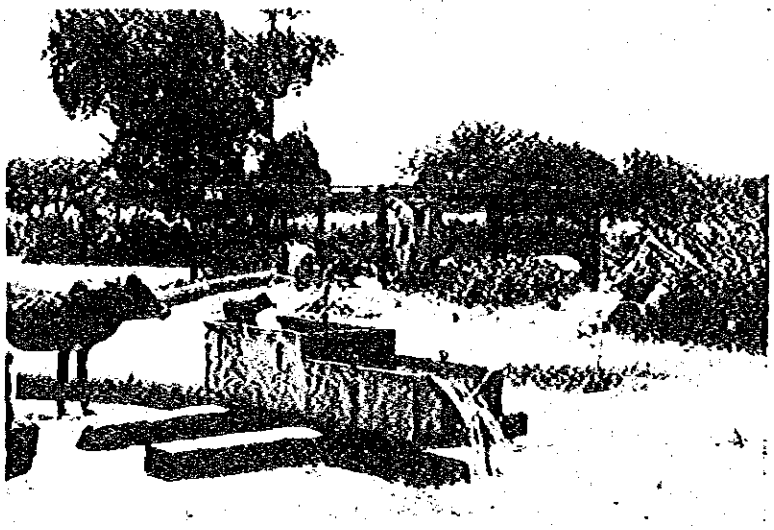
‹Well No. 10.5A›
10.5A was constructed in the Phase II Project and is operating at present.



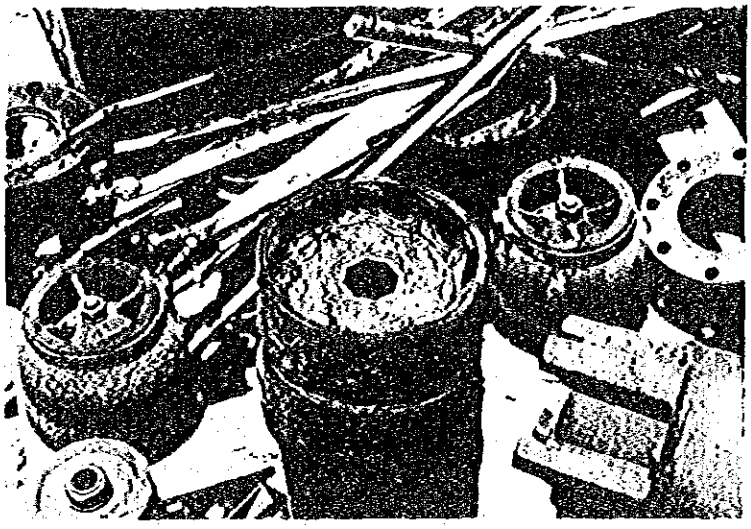
‹Well No. 12.5B›
12.5B was rehabilitated in the Phase II Project, but the submersible pump has removed due to pump damage by the sand.



‹Inside of the Power Plant›
The American-made generator (right side) is operating, but another one (left side) is out of order.



‹Well No. 14.0A›
The pumping test was carried out in this study.



‹Pump casing›
The pump casing of removed submersible pump is kept in the stockyard. The inside of pump casing is damaged due to the sand.

SUMMARY

SUMMARY

Mogadishu City, the capital of the Somali Democratic Republic, had a population of 440,000 in 1976 , and it is estimated at about 1,000,000 in 1988. Due to this rapid increase in population, it is an issue to consolidate the infrastructures of Mogadishu City. The Government of Somalia has put high priority on health, sanitation, and improvement of water supply facilities in the National Development Plan. A master plan of development of new water resources was made as a concrete measure but has not been commenced due to the financial difficulties.

The existing facilities of water supply for Mogadishu City consist of two well fields: Balad Wellfield constructed in 1973 under USAID's finances and Afgoi Wellfield constructed in 1986 under the cooperative finances of the World Bank, Arab Fund and EEC. The Mogadishu Water Agency (MWA) is responsible for the operation and maintenance of the these wellfields.

The Balad Wellfield, constructed by USAID, produced water of 24, 000 m^3/day against the planned discharge rate of 28, 000 m^3/day. However, it decreased to 15, 600 m^3/day due to pump damage which occurred directly after its construction and damage of the well body which resulted from inadequate maintenance. The Balad Wellfield was rehabilitated from 1985 to 1986 under the grant aid by the Government of Japan. As a result of this rehabilitation work, the Balad Wellfield could produce water of 21,200 m^3/day, but decreased to 8,700 m^3/day at present because of the deteriorated well body and insufficient maintenance.

On the other hand, the Afgoi Wellfield has produced 38,400 m^3/day against the planned discharge rate of 42,000 m^3/day. Groundwater of the Afgoi Wellfield contains much calcium, so that the scale of this calcium has been stuck to the inside of pipes and made them clogged. For these reasons, it has been incapable to supply a sufficient quantity of water to the people. The Government of Somalia has planned to construct a treatment plant against this qualitative problem of the Afgoi Wellfield, but it has not been commenced by reason of the MWA's financial difficulties. It is estimated that the actual total discharge rate of both wellfields is 47, 100 m^3/day, and the actual supplied rate is 70 percent of the total discharge rate with taking into account leakages. In addition, the supplied amount for a person per day is 33 liters except large consumers such as

plant sand hotels. As compared to 75 liters which is the supplied amount for a person of lower class in urban area of Kenya, the present supplied amount for a person in Mogadishu is low.

From the foregoing background, the Government of Somali has established the Mogadishu Water Supply Improvement Project Phase III in order to improve water supply conditions of Mogadishu City by means of drilling new wells in the Balad Wellfield area, and requested grant aid from the Government of Japan in December 1987 for the implementation of well drilling. In response to this request, the Government of Japan decided to implement a basic design study, and JICA dispatched a basic design study team to the Somalia from August 31, 1988 to September 25, 1989. The Team had a series of discussions with the officials concerned of Somalia, carried out field surveys, confirmed the contents of the request, and collected data.

This study aimed to design the facilities to be newly constructed and rehabilitated in order to raise the discharge rate of the Balad Wellfield. The planned discharge rate has been designed on the basis of the condition of water supply in Mogadishu City, the condition of existing facilities of the Balad Wellfield and the other related facilities. The Project is not intended to entirely cover the existing water shortage in Mogadishu City but is basically intended to increase the water supply rate as an urgent relief.

The existing facilities of water supply in the Balad Wellfield consist of intake facilities, power supply facilities, water conveyance facilities, and water supply facilities. Among these facilities, the water conveyance facilities and the water supply facilities do not need rehabilitation. Therefore, the intake facilities and the power supply facilities will be rehabilitated or newly constructed. The scope of the Project has been decided on the basis of hydrogeological condition of the Balad Wellfield area and the conditions, capacity, oldness of the existing facilities. The scope of the Project is as follows:

(1) Construction of new water intake wells
(2) Partial replacement of submersible pumps of existing wells
(3) Connection of water conveying pipes for newly constructed wells
(4) Partial reinstallation of water conveying pipes
(5) Replacement of generators

(6) Replacement of operation panel

(7) Replacement of power transmission equipment

As a result of the field survey and analysis in Japan, a basic plan have been proposed as mentioned below.

Planned total water pumping rate :28,000 m^3/day

Planned water pumping rate per well (the well which is newly constructed and the well which the submersible pump is replaced) : 55 m^3/day

Number of proposed wells : 13

The Outline of the proposed facilities is as follows:

Intake Facilities		
Intake well	55 m^3/hr/well	13
Submersible pump	Head 115 m, motor 30 kw	2
	123 m, motor 37 kw	5
	128 m, motor 37 kw	6
	143 m, motor 37 kw	2
Pipes around well	dia. 150 mm, Ductile iron pipe	2 sets
Flow meter	Ultrasonic type	2
Piping		
Conveyance pipe	dia. 150 mm PVC	0.53 km
Transmission pipe	dia. 150 mm PVC	0.5 km
	dia. 250 mm PVC	0.5 km
	dia. 300 mm PVC	0.5 km
Sluice valves	dia. 150 mm	2
Power Supply Facilities		
Generators (including control panel)	339 KVA (over) X 380 V X 50 Hz	4 sets
Main transformer	150 KVA X 380 V /15 KV X 50 Hz	2 sets
Subtransformer	75 KVA X 1.5 KV X 380 V / 222 V X 3 phase X 50 Hz	11 sets
Lighting	Mercury-arc 100 W	13 sets
Staging for Transformer		13 sets
Wiring	CV cable	34.6 km
Electric pole		14 sets
Ancillary Facilities		
Fence for new well		2 sets
Rehabilitation of power plant house		1 unit

The Project is scheduled to take 12 months to complete the construction. The implementing agency for the Project is the MWA which is responsible for the waterworks of Mogadishu City. Before construction, the Somali side shall obtain a construction site and prepare approach roads.

After completion of the construction, the discharge rate of the Balad Wellfield will be increased from 8,700 m^3/day to 28,000 m^3/day, and the daily water consumption per capita also will be increased from 33 liters to 70 liters. In addition, it will be possible to supply to the high land area constantly and unnecessary to take times to secure living water. For these reasons, the existing condition of water supply in Mogadishu City will be remarkably improved. Therefore, it can be said that the implementation of the Project under the grant aid cooperation by the Government of Japan is significant and justified. The Project will be part of long-term plan of the waterworks which planned by the Government of Somalia. Furthermore, it is estimated that the MWA's receipts will be increased by 42.7 million shi. by the operation of the Balad Wellfield after the completion of construction. The MWA's budget for maintenance in 1986 was about 7 million shi., so that the increased receipts will contribute to a maintenance budget for stable water supply.

Before implementation of this Project, it is necessary that the Somali side take measures for the following items.

(1) Preparations shall be carried out without any delay within the range of undertakings of the Government of Somalia.

(2) Primarily, the Project is intended to improve the water shortage in Mogadishu City as a matter of urgency. It is possible to complement the planned water supply rate of the master plan (Stage 2B) being set up by the Government of Somalia at present, so that the MWA should review the master plan and consider effective utilization of the Project.

(3) The planned water intake rate of 28,000 m^3/day in the Project can be continued for 20 years in the future. This is because the groundwater level stabilizes with the ingress of salt water, and it is anticipated that groundwater in the Balad Wellfield will be salified in the future, so that it is necessary to check and control the water quality at all times after completion of construction.

The facilities will be maintained and operated on the basis of the Maintenance & Operation Manual prepared by the Japanese side after completion of construction, so that it is desirable to dispatch a Japanese expert in order to transfer technique of water supply for smooth maintenance and operation of the facilities. In addition, it is desirable for Somali engineers to improve the capability of maintenance & operation through training in Japan.

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Survey Photo
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ABBREVIATIONS

Organization

DAC	Development Assistance Committee
EEC	European Economic Community
GOS	Government of Somalia
IDA	International Development Association
JICA	Japan International Cooperation Agency
MMWR	Ministry of Mineral and Water Resources
MWA	Mogadishu Water Agency
UNDP	United Nations Development Programme
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WFP	UN/FAO World Food Programme

Measurement

mm	millimeter
cm	centimeter
m	meter
km	kilometer
%	percent
km^2	square kilometer
ha	hectare
l	liter
V	Volt
A	Ampere
Hz	Hertz(cycle)
W	Watt
kW	Kilowatt
kV	Kilovolt
KVA	Kilovolt-ampere
KVAr	Kilovar
PS	Horsepower
$Sh./m^3$	Shilling per cubic meter
m^3/day	cubic meter per day
m^3/hr	cubic meter per hour
m^3/sec	cubic meter per second

cm/sec	centimeter per second
mm/sec	millimeter per second
m/sec	meter per second
m/sec^2	meter per square second
$\mu S/cm$	micro Siemense per centimeter
kg/l	kilogramme per liter

Others

GNP	Gross National Product
GDP	Gross Domestic Product
F/S	Feasibility Study
EC	Electrical Conductivity
JIS	Japanese Industrial Standard
Fig.	Figure
dia.	diameter

CHAPTER 1 INTRODUCTION

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Mogadishu City, the capital of the Somali Democratic Republic, faces the Indian Ocean and has developed primarily as a harbor town. Its population was 440,000 in 1976, but increasing rapidly thereafter, it is estimated to have reached 1,000,000 as of 1988.

Living water in Mogadishu City had been supplied from more than 200 wells drilled in the city until the 1960s. However, as the water demand increased, it became difficult to secure potable water with these wells only, because of their lowered water table, polluted water and further, because of ingress of salt water into them. Thus, from the latter half of the 1960s, the Government of Somalia set up groundwater development plans and implemented development surveys in the peripheral areas of the city.

In 1973, under financing by USAID, the Balad Wellfield was constructed at points of about 9.5 km to 15 km in the northeastern parts of the city, and in 1986, under cooperative financing by the World Bank, the Arab Funds and the EEC, the Afgoi Wellfield was constructed at points of about 10 km west of the city. At present, water supply from these two well fields to the city is undertaken by the Mogadishu Water Agency (MWA).

Of these two wells, the Balad Wellfield, constructed by USAID, produced water of 24,000 m^3/day against the planned discharge rate of 28,000 m^3/day. However, it decreased to 15,600 m^3/day due to pump damage which occurred directly after its construction and damage of the well body which resulted from inadequate maintenance. The Balad Wellfield was rehabilitated from 1985 to 1986 under the grant aid by the Government of Japan. As a result of this rehabilitation work, the Balad Wellfield could produce about 21,200 m^3/day , but decreased to 8,700 m^3/day at present because of the deteriorated well body and insufficient maintenance.

On the other hand, the Afgoi Wellfield has produced 38,400 m^3/day against the planned discharge rate of 42,000 m^3/day. Groundwater of the Afgoi Wellfield contains much calcium, so that the scale of this calcium has been stuck to the inside of pipes and made them clogged. For these reasons, it has incapable to supply a sufficient quantity of water to the people. The Government of Somalia has planned to construct a water treatment plant against this qualitative problem of the Afgoi Wellfield, it has not been commenced by the reason of MWA's financial difficulties.

From the foregoing background, the Government of Somalia has established the Mogadishu Water Supply Improvement Project Phase III in order to improve water supply condition of Mogadishu City by means of grilling new wells in the Balad Wellfield area and requested grant aid from the Government of Japan in December 1987 for the implementation of well drilling.

The Japan International Cooperation Agency (JICA) dispatched a Basic Design Study Team headed by Mr. Masayuki Matsushima of the Kyoto Municipal Waterworks Bureau from August 31 to September 25, 1988 to Somalia in order to confirm the contents of the request of the Government of Somalia, survey conditions of existing facilities , and collect data. After the Team returned to Japan, further studies were carried out on the basis of the result of field survey in Somalia, and a specific basic design was formulated. In the meantime, the Team prepared the draft of basic Design Study Report on the Project for the Mogadishu Water Supply Improvement Phase III.

JICA dispatch a Draft Final Report Explanation Team head by Mr. Akira Mitamura of the Kyoto Municipal Waterworks Bureau to Somalia from December 11 to December 22, 1988. The Team had a series of discussions with the officials concerned of the Government of Somalia on the result of the study and basic conditions related with the Project. The major points that both parties agreed were summarized in the Minutes of Discussions (refer to Appendix B-4). This report presents an optimum specific basic design in consideration of comments of the Somali side on the Draft final Report.

CHAPTER 2 BACKGROUND OF THE PROJECT

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2.1 Outlines of the Somalia and National Development Plan

2.1.1. Natural Environments

The Somali Democratic Republic is located in the easternmost of the African Continent called "Horn of Africa". It ranges from 2 degree south latitude to 12 degrees north latitude. Its land faces the Gulf of Aden and the Indian Ocean, and is bounded on the north by Djibouti, on the west by Ethiopia and on the south by Kenya. The land area is 637,000 km^2. The land utilization ratio is 2% for farmland, 46% for pasture, 13% for forest, and 39% for others.

The country is divided into 18 administrative provinces, which are further divided into 87 regions. The capital is Mogadishu City in Benaadir State (Refer to the Regional Map). Topographically, the land consists roughly of northern mountain areas in excess of 2,000m above sea and plain areas on the south.

Climate as classified according to the latitude belongs to the tropical zone and subtropical zone areas. The coastal areas show high temperatures and high humidity, temperatures being around 21 degrees to 40 degrees through the year. The inland areas consist of high temperature dry zones, it being as hot as 31 degrees to 37 degrees through the year. The rainy season visits two times in the year, the precipitation being as small as about 200 to 400 mm per year, frequently causing a drought and affecting stock farming and agriculture.

2.1.2. Population and Racial Construction

The total population of the Somali Democratic Republic in 1986 was about 6,000,000 according to the announcement of the United Nations (or about 8,500,000 according to the Government of Somalia), 29% reside in the urban areas and 29% in the rural areas, and remaining 42% being nomadic tribes. The population of Mogadishu City is estimated at about 840,000 in 1986, and it is assumed to be reached at 1,000,000 in 1988 according to the Government of Somalia. The rate of

population growth is 3.1%, being rather high as compared with that of other African countries.

The infant mortality is 152/1000, the child mortality is 280/1000, and the average life expectancy is 43 years old, suggesting that the hygienic level is very low. As to the racial composition, the Somalia occupy the most part and the Danakils also live. There are also about 700,000 to 900,000 refugees from Ethiopia. Religion is Islam for about 95% of the people, and the official language is Somali. In addition, English, Italian and Arabic are also used.

2.1.3 National Economy

According to the data published by the Government of Somalia, the yearly average growth rate of GDP from 1980 is 3.5%. Regarding GDP in 1986, the primary industry including agriculture and stock breeding occupies 57%, the secondary industry 9% and the tertiary industry 33%. Especially, the stock breeding field occupies as large proportions as 32% of GDP and as 73% of the export from 1980 on. One of the most important policies targeted in the sixth Five-Year National Development Plan (1982 to 1986) was to reduce the trade deficit, but as shown in the following table, this target could not be accomplished.

Table 2.1.3 Changes in Trade from 1984 to 1986

(unit : US$ million)

	1984	1985	1986
Export	60	91	94
Import	457	392	361
Export/import	13%	26%	26%

*Source: UNDP-ANNUAL DEVELOPMENT REPORT 1986

The national economy depends to a large degree on the agricultural and stock breeding fields as seen above. These fields are liable to be affected by meteorological phenomena, and repeated droughts have made it difficult to predict production and exports accurately. Thus, economic conditions have become instable, and economic development has been impeded.

Regarding the obtainment of foreign currencies by Somalia, the money being sent back by those people who go to work in the Middle and Near East plays an important role and amounted to US$ 70 million in 1984. At present, however, with lowering of the crude oil price in recent years, employment opportunities have decreased and , the amount of money being sent back has decreased as a result.

2.1.4. National Development Plan

The national development plan of Somalia was established by the Economic Planning Ministry, and now, the Seventh Five-Year Plan (1987 to 1991) is in progress. The Seventh Five-Year Plan aims at consolidating the living ground, improving the education level, and improving the hygienic and water supply facilities. As its strategy, three points, stabilization of economy, increase of the domestic production, and raising and promotion of the commodity production fields, have been set up.

On the other hand, in order to make corrections in each year so as to suit the purpose of the Five-Year Plan, annual development plan has been set up. For example, in 1987, the auction system for imported products and the regulation on the foreign currency exchange rate were abolished. The annual development plan, 1988, includes improvement of the public sector, investment by foreigners and activation of the private sector to promote employment, and price control. Concrete measures taken include improvement of the constitution of agriculture liable to be affected by natural disasters, consolidation of the infrastructures such as transportation, communications, and water resources, and overall development programs for the southern basin of the River Juba. These programs are financed from outside the country, and at the creditors' conference (Paris Club) in 1987, financing of US $ 580 million was agreed on .

2.2 Circumstances of Waterworks in Somalia

2.2.1. General Circumstances of Waterworks

According to the statistics of 1986, the population in Somalia supplied with safe water were 31% of the whole; 65% in the urban areas and 21% in the rural areas. Potable water is supplied mostly from groundwater. In the urban areas, many houses are supplied on an individual house basis, but in the rural areas, water intake sources are deep wells and shallow wells, and water is supplied from joint-use water taps and water buying basis. In the urban areas, the water supply ratio is higher than in the rural areas, but many of their water facilities have been deteriorated or become defective and their efficiency is low.

Water consumption per capita per day is at present 50 liters in the urban areas and 20 liter in the rural areas. "Drinking Water Supply and Sanitation Decade" of Somalia says that the target of water supply ratio in 1990 is 80% in the urban areas and 50 to 60% in the rural areas, and the quantity of water supply per capita per day is set at 130 liter for the urban areas and 50 liters for the rural areas by increasing the water taps for those houses supplied on the individual house basis and the joint-use water taps. To accomplish this target, a yearly water production of 92.4 million m3 is required by 1990, and continuous maintenance, pump replacement, and construction of about 700 deep wells are being planned.

During the years from 1982 to 1986, as a result of the promoted development project, the pervasion of waterworks showed a yearly average growth rate of 15.8% which broke down into 27% in the urban areas and 11% in the rural areas.

2.2.2. Present States of Waterworks Administration

The waterworks administration of Somalia is under the control of the MInistry of Mineral and Water Resources, and actual operation and management are undertaken by the Waterworks Public Authority of each city and the Water Development Bureau governing small cities and local regions, both of which belong to the Ministry of Mineral and Water Resources. On the other hand, water resources development is undertaken independently by various ministries and agencies, such as the Ministry of Mineral and Water Resources, the Ministry of Health, the Ministry of Interior, the Ministry of Livestock, Forestry & Range, the Ministry of

Agriculture, and the Ministry of Juba Valley Development Agency.

In the Seventh Five-Year National Development Plan the government plans to establish the nationwide water source law, set up the water source overall program, integrate the private sectors, and develop the water supply management system, so as to insure supply of adequate and safe living water for habitants, stock breeding water, agricultural water, etc. at moderate costs. Concrete measures enumerated in this connection include construction of waterworks facilities, improvement of hygiene by sewage treatment, and establishment of a rationalized water resource development system.

2.2.3 Programme of Waterworks Undertaking

(1) City Waterworks

During the period of the Sixth Five-Year Development Plan, the Afgoi and Balad water source in Mogadishu City, and waterworks facilities of Joha City and Merka City were completed, and the waterworks pervasion was significantly extended. At present, water supply plans for the cities of Hargeisa, Gabili, Borama, Sheku and Lugh are in progress. Waterworks facilities for five local cities such as Berbera and Kismayo are now being planned.

(2) Local Waterworks

In the Sixth Five-Year Project, construction of 250 deep wells around the country were planned, but actually only 110 of them were completed, falling short of the expectation. According to a wide-area groundwater development plan, hydrological and geological surveys were made in the coastal area and the central stock breeding zone, and 49 production wells and 55 survey wells were constructed. In addition, groundwater development plans for Koreori City and Bakoi District are now in progress.

(3) Education of Personnel

Aside from waterworks development, overseas training of hydrological and geological engineers has been carried out for the personnel of the Mogadishu Waterworks Bureau with the aim of personnel education. Further, through overseas project assistance, improvement of engineering capability of the staff has been pursued.

(4) Water Rates

The water rate per m^3 was raised, in 1983, from 4.5 shillings to 10 shillings and in 1985, to 14 shillings. By the Mogadishu Water Agency, it was raised in March, 1986, to 25 shillings, and further, a proposal has been made to

raise it to 50 shillings to be balanced with the operation and running costs at present.

2.2.4 International Cooperation for Waterworks Undertakings

The DAC member countries have granted a bilateral ODA of $353.86 million in terms of the net expenditure in 1986 to Somalia, and 86.9% thereof is donation. The major assisting countries are Italy (45%) and the USA (23.2%) followed by West Germany. Japan (8.6%) is the fourth largest assisting country. The assistance from international organs is $166.82 million of ODA in terms of the net expenditure in 1986. The major assisting organs are UNHCR, IDA and WFP.

The economic and technical cooperation of the Government of Japan for Somalia began with the food assistance in the fiscal year of 1980 and has been in satisfactory progress, achieving records of a yen loan of Y6.5 billion and a grant aid of about Y9.45 by December, 1987, contributing to the development of Somalia in various fields, such as food assistance to overcome poverty and starvation, consolidation of telecommunication networks, and improvement of hospital facilities to improve the sanitary conditions.

Records of assistance from various countries and international organs for waterworks undertakings are shown in Table 2.2.4.

Table 2.2.4 Technical Assistance and Funding Sources
(In Million of US$ at Current Prices)

	STARTING DATE	ENDING DATE	CONTRIBUTIONS 1986	CONTRIBUTIONS TOTAL	GOVERNMENT AGENCY
TA for Water Resour.Devpt.	1980	1989			M.M.W.R
Germany			.79	3.20	
to be funded			.00	1.00	
Project Total			.79	4.20	
Comprehensive Groundwater	1979	1987	1.38	10.73	M.M.W.R
U.S.A			1.38	10.73	
Project Total			1.38	10.73	
National Water Center	1986	1989			M.M.W.R
U.S.A			.28	.70	
UNDP			.23	1.10	
GOS			.00	.10	
Project Total			.51	1.90	
TA Municipal Sewer.Dept.	1986	1987			M.W.A
GOS			.00	.10	
To be funded			.00	.40	
Project Total			.00	.50	
Mogadishu Water Supply I	1986	1987			M.W.A
EEC			.30	.60	
Project Total			.30	.60	
Storm Water Drainage	1984	1986			M.M.W.R
Germany			.40	2.00	
Project Total			.40	2.00	
Emergency Water Relief	1985	1987			M.M.W.R
UNDP			.30	.90	
Project Total			.30	.90	
N.W. Community Water	1985	1988			
UNICEF			.21	.77	M.M.W.R
Project Total			.21	.77	
Middle Shabelle Water	1986	1988			M.M.W.R
Oxfarm			.04	.12	
UNICEF			.16	.50	
Project Total			.20	.62	

Source : UNDP-ANNUAL DEVELOPMENT REPORT

2.3 Present Conditions of Water Supply Facilities and Waterworks Undertakings of Mogadishu City

2.3.1 Water Supply Facilities

In and before the 1960s, Mogadishu City was supplied with water from about 200 wells installed in the city. However, owing to the increased salt concentration and lowered water levels of groundwater, it became difficult to secure groundwater in the city area. Then, 1963, water source development surveys in the peripheral areas of the city were carried out and the Balad wellfield was developed from 1986 to 1972 with the USAID loan. The waterworks of Mogadishu City at present are operated by the Mogadishu Water Agency (MWA).

The water supplied is groundwater produced at two points, Balad wellfield and Afgoi wellfield. The water supply area in the city is divided into five zones: the Shek Muhidin Reservoir zone is supplied from the Balad wellfield, and Tower zone, Milk factory zone and Northeast zone are supplied from the Afgoi wellfield. (Refer to Fig.2.3.1.)

(1) The Balad Wellfield System

The Balad Wellfield has 21 existing wells. The groundwater pumped up is conveyed through 600 mm asbestos pipes to the Shek Muhidin Reservoir installed on a hill in the eastern part of the city, from which water is supplied by gravity to the water supply zone. Moreover, from public fountains at three points installed near the Balad wellfield, water is supplied to the neighboring habitants. It is assumed that actual rate of water consumption for this supplied area is 6,000 m^3/day according to the actual pumping rate, 8,700 m^3/day. The water supply in highland area has been suspended continuously, and it has taken times for people in this area to secure the living water. A chlorine disinfection facility is installed by the reservoir, but this facility is not in use at present because of the equipment failure and the difficulty in chlorine obtainment.

(2) Afgoi water source system

The Afgoi wellfield has 32 existing wells. The groundwater is once collected in the collection well installed in an electric power plant, from which water is conveyed by gravity to a reservoir in the city. The Southwest zone and

Northeast zone are supplied from this reservoir directly by gravity, but the Milk Factory zone is supplied through a reservoir. The Tower zone is at a high altitude and cannot be supplied by gravity, and hence a booster pump is used to pump up water into an elevated tank. The Afgoi Wellfield has produced water of 38,400 m^3/day, but groundwater in the Afgoi Wellfield contains much calcium. The scale of this calcium has been stuck to the inside of pipes and made them clogged, so that it is incapable to supply sa ufficient quantity of water to the people. The MWA replaced these clogged pipe to new pipe several times. A chlorine disinfection facility is installed in the power plant of the Afgoi Wellfield but is not in use due to same reason of the Balad Wellfield.

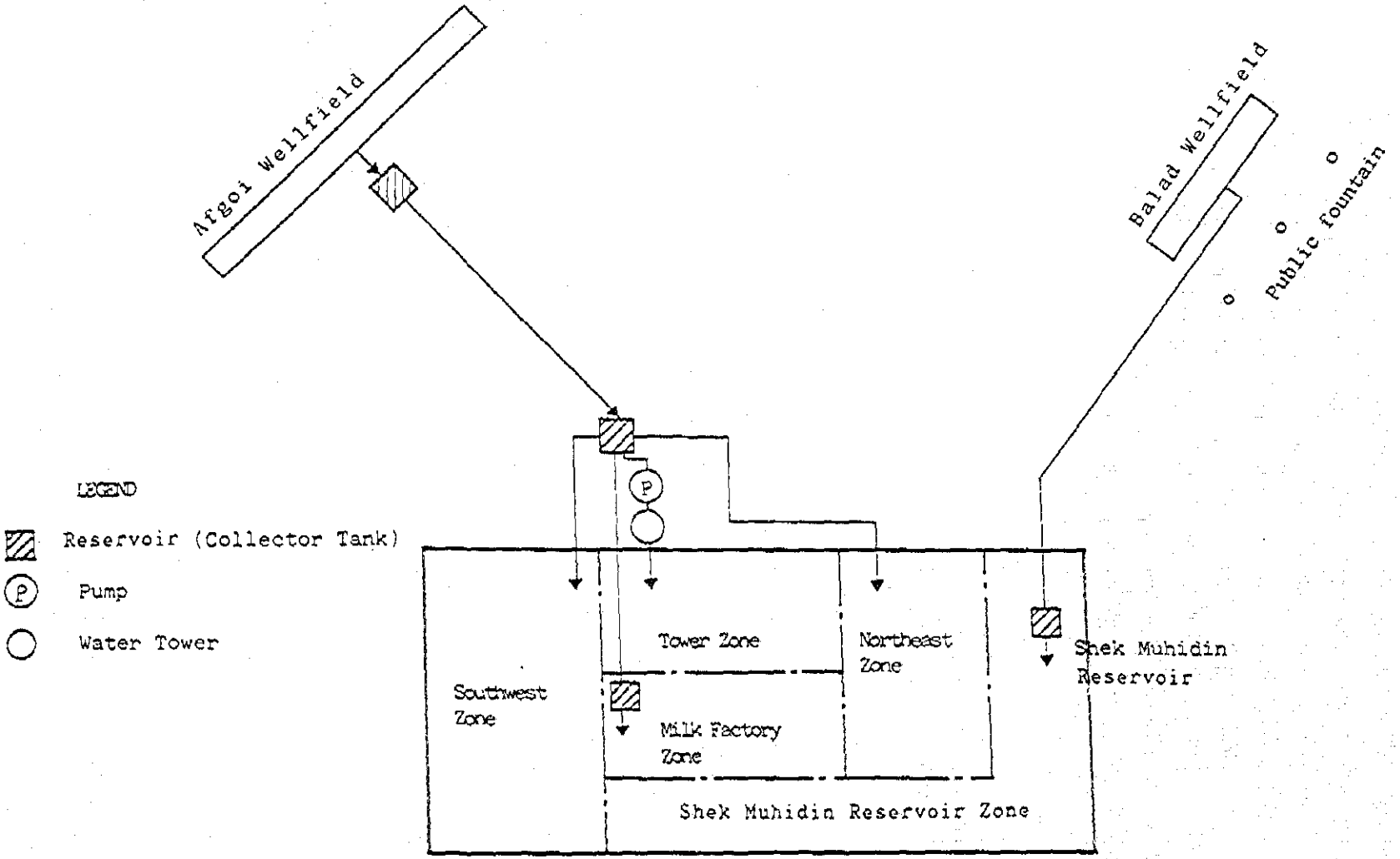


Fig. 2.3.1 Schematic Flow of Water Supply in Mogadishu City

2.3.2 Condition of Water Supply

Water supply in the city is accomplished on an individual-house water supply basis and a public fountain basis. At present, about 40,000 individual-house water taps and about 250 public fountains are registered. The water charge is collected in accordance with the quantity of water used. It is 25 shilling for individual-house basis per cubic meter. To collect the water charge, a metering system is applied for the individual-house basis water supply, a bill is issued monthly, and a collector goes to each house to collect it. In the case of public fountains, a manager is assigned for each water tap, and he delivers 50% of the sales amount to the MWA and earns remaining 50% as his (or her) income.

As of September 1988, when field surveys were carried out on the well operating conditions, eight of 21 wells of the Balad water source, and 27 of 32 wells of the Afgoi water source were in operation, and the possible water intake rate was about 8,500 m^3/day for the Balad wellfield and 38,400 m^3/day for the Afgoi wellfield. The total water intake rate from these two wellfields was 46,900 m^3/day, but the actual water supply to the habitants in the city is estimated to be about 70% of this water intake rate if water leakage and large water consumption in hotels, factories, etc. are taken into consideration. Thus, on assumption of the population of 1,000,000 in Mogadishu City, the water supply rate per day per capita is about 33 liters.

2.3.3 Waterworks Undertakings

In 1973, with the USAID loan, the Balad wellfield was developed and the water supply system to the city was consolidated. However, in order to cope with the increased water demand, F/S surveys for Mogadishu Water Supply Expansion were carried out in 1976 under the financing by the World Bank. Based on this F/S, a development plan including the existing Balad wellfield was designed and its execution was started in 1980. This plan was executed in two stages; Stage 1 and Stage 2. Stage 2 is subdivided into Stage 2A and Stage 2B. As of the present time, the plan up to Stage 2A has been completed. The contents of work in these stages are as follows.

Stage 1 (1980-1982):

1) Construction of eight production wells and three observation wells in the Afgoi wellfield
2) Consolidation of electric power and machine facilities (Afgoi wellfield) well pumps, electric power transmission lines, three generators.

Stage 2A (completed in 1987):

1) Construction of 24 production wells in the Afgoi wellfield
2) Distributing reservoir, remote control system, control panel
3) Four Generators and electric power distribution equipment
4) Civil engineering and architectural work

Stage 2B (under planning at present)

1) Installation of additional distributing reservoirs in the Afgoi wellfield
2) Installation of additional distributing reservoirs, and piping in the Balad wellfield
3) Construction of 23 wells in the Garas Bintow* wellfield
4) Water collecting boxes and water conveying pipelines in the Garas Bintow wellfield

*: Refer to the Fig. 2.3.3.

As to the execution of Stage 2B, its design is completed and a request for economic and technical assistance in part is made to the Italian government, but a definite answer about the time of execution is not obtained.

Water from the Afgoi water source completed in Stage 1 and Stage 2A contains much calcium (EC 3,200 uS/cm) and is not suited for drinking. Moreover, coagulation of calcium ions causes water supply piping to be clogged and water meters to become defective frequently. For this reason, construction of softening plants is urgently demanded. However, at present, there is no certain prospect of procuring the necessary funds.

The rehabilitation project for existing wells of the Balad water source, implemented with grant aid from the Government of Japan in 1986 (Phase I, II), and the improvement project at this time (Phase III), are not included in this development plan.

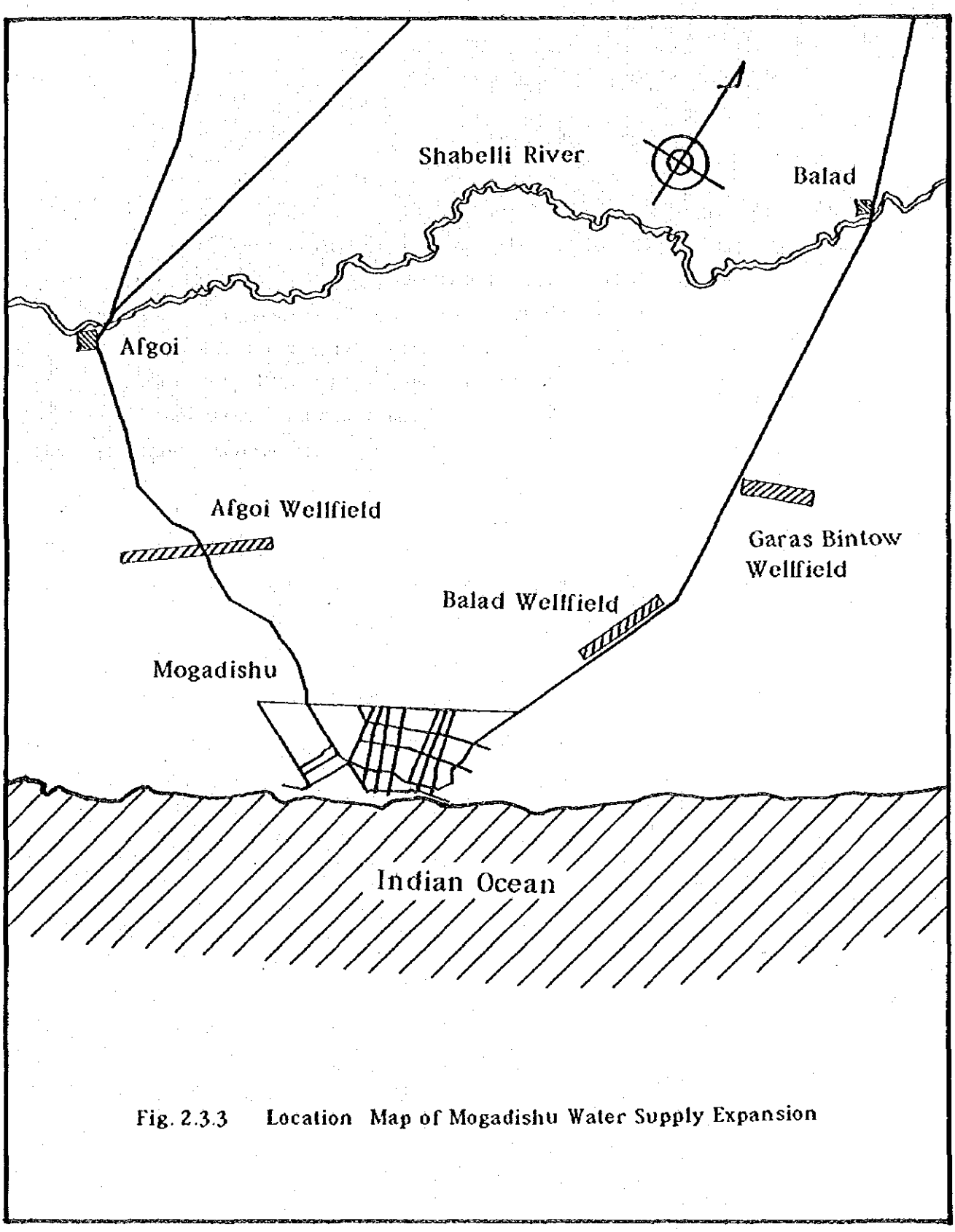


Fig. 2.3.3 Location Map of Mogadishu Water Supply Expansion

2.3.4 Finance and Foreign Assistance

(1) Finance of the MWA

The finance of the MWA is operated with subsidies from the government and with water charges.

According to the statement of accounts of 1986 and 1986 obtained from the MWA, the yearly total income is 69.30 million shillings and 133.50 million shillings, respectively, that is, the amount in 1986 is about two times that in 1985. Of this, the income from the water charge is increased from 31.50 million shillings to 95.20 million shillings, about three times that in the previous year. This is because mainly of the increased water supply as a result of completion of the Afgoi water source, raised water charge (14 shillings/m3 in 1985, 25 shillings /m3 in March, 1986), and additionally installed water meters. On the other hand, the yearly balance is in the red by 60.10 million shillings in 1985 and by 27.10 million shillings in 1986.

As shown above, the financial condition is becoming better, but is still in the red, and the MWA is now considering further raising the water charge in order to implement the facility expansion plan in the future.

Table 2.3.4 Financial condition of MWA (Unit: million shillings)

		1985	1986
Income	Subsidy	37.6	38.3
	Water charge,etc.	31.5	95.2
	Individual	20.3	89.4
	Public fountain	11.2	5.8
	Subtotal	69.8	133.5
	Carry-over	9.1	0.9
	Total	78.4	134.4
Expenditure	Fuel	52.0	85.3
	Salary	11.0	10.6
	Repair, maintenance (facility)	9.0	5.0
	Repair, maintenance (pipes)	8.1	2.6
	Electric power	1.4	1.5
	Others	4.3	6.4
	Subtotal	85.8	111.9
	Depreciation	43.5	44.2
	Loan interest	7.3	5.4
	Total	138.5	161.5

(2) Foreign assistance

Major projects by foreign assistance to the MWA are for the development of the Balad wellfield with the USAID loan implemented from 1963 to 1973, the development of the Afgoi wellfield under the cooperative financing by the World Bank, the Arab Funds and the EEC implemented from 1980 to 1987, and rehabilitation of the Balad wellfield by grant aid cooperation of the Government of Japan implemented from 1985 to 1987, and in addition, the advisor service by the World Bank.

2.4 Circumstances and Contents of the Request

2.4.1 Circumstances of the Request

Mogadishu City, the capital of the Somali Democratic Republic, has shown rapid population increases in recent years. The population, which was 440,000 in 1976, is estimated to have reached about 1,000,000 as of 1988, and it has become an urgent issue to consolidate the infrastructure of the city.

The Government of Somalia has planned a living water development plan for the city as one of the top priority projects, and regarding the rehabilitation of the existing wells which is a matter of special urgency in this plan, the government submitted a request to the Government of Japan, in 1984, for grant aid cooperation. In response to this request, the Government of Japan carried out Mogadishu City Water Supply Improvement Project Phase I and Phase II in the Balad wellfield , which is one of the two large water sources of the city during the years of 1985 and 1986, and thereby accomplished rehabilitation of 16 existing wells and construction of five new wells. Moreover, in the Afgoi wellfield, 32 new wells were constructed in 1986 under the cooperative financing by the World Bank, the Arab Funds and the EEC.

The rehabilitation work for the existing wells executed in the Balad wellfield was based on the ground surface survey alone, and so, broken well bodies, left fallen materials, etc. could not be expected and 3 of 16 wells planned at the beginning were judged and abandoned as incapable of rehabilitation. As a result, the 13 existing wells were rehabilitated. With these wells, together with five newly constructed wells, 21,200 m^3/day was secured. However, thereafter, because of rehabilitated well body breakage, well pump failures and for other reasons, the water pumping rate is decreased to about 8,700 m^3/day. On the other hand, the Afgoi wellfield started water supply in 1986, but the water has a high hardness which causes the water supply pipes to be scaled and interfere significantly with the actual water supply rate. Thus, Mogadishu City suffers a stringent shortage of water supply over the entire area. The Government of the Somali Democratic Republic is planning to construct softening plants for the Afgoi well field and to develop water resources in other areas. However, at present, there is no certain prospect of procuring the necessary funds.

From the foregoing background, the Government of Somali has established the "Mogadishu Water Supply Improvement Project (Phase III)" in order to make up for the water supply shortage by drilling new wells in the existing Balad wellfield as a matter of special urgency, to improve this water supply condition of Mogadishu City, and regarding its implementation, the government submitted a request to our country in December, 1987, for grant aid cooperation.

2.4.2 Contents of the Request

At the field survey, the Team had discussions with the Somali side and confirmed the contents of the request as shown below.

(1) The objective of the Project is to improve the present shortage of water supply in Mogadishu City as an urgent relief by means of drilling new wells in the Balad wellfield.

(2) The site of the Project is at the Balad wellfield, which is located 9 to 16 km northeast from the center of Mogadishu City.

(3) The content of the Project shown by the Government of Somalia is to construct new wells and to rehabilitate the existing water supply facilities in the Balad wellfield.

1) Construction of new wells:

New wells for relieving the present water shortage in the city.

2) Provision of materials for the construction of new wells:

Submersible motor pumps, generators, transformers, pipe materials, wiring cables, consumables, etc.

3) Provision of materials for improving the existing intake facilities:

Generators, transformers, pipe materials, wiring cables, consumables, etc.

4) Provision of equipment for operation and maintenance:

Accessories for drilling machine, equipment of workshop, tools for electrical work, etc.

CHAPTER 3 OUTLINE OF THE PROJECT

CHAPTER 3 OUTLINE OF PROJECT AREA

3.1 General Circumstances

3.1.1 Location and Topography

Mogadishu City, as the object water supply area of this project, is located at 2 degrees north latitude and 45 degrees east longitude, facing the Indian Ocean. The city area ranges 10 km along the coast and 5 km in the direction of inland, occupying about 500 ha. At present, as the population increases, the development of the peripheral area is being rapidly expanded.

About 30 km to the north of the city, the Shabelle River, which is one of the two large rivers in Somalia, runs northeast to southwest approximately in parallel to the coastal line. Since the basin area is fertile, producing a variety of agricultural products, as a food supply base for Mogadishu City. The Balad wellfield, the groundwater intake source in the Project, is located at points of about 9.5 to 15 km on the Balad Road extending toward northeast from the town area. This area has altitudes of 70 to 80 m and looks flat, but has gentle rise and fall. It presents a semidesert condition and has thorny plants grown at nearly equal intervals.

3.1.2 Population and Socioeconomic Conditions

The population of Mogadishu City is estimated as 1,000,000 at present, but its accurate figure has not been grasped since the statistical data after the census implemented in 1975 are inadequate. Mogadishu City is the economic center as the capital. At the same time, it is the maximum consuming area in the country, and therefore, owing to a rapid inflow of population from various areas of the country, its existing town area is crowded and the city area is rapidly expanding. In the dry season, moreover, the nomads moving all over the country seeking for water gather to the Shabelle River basin, resulting in temporary increase in the population of Mogadishu City.

3.2 Natural Conditions

3.2.1 Climate

Climate of Mogadishu City is of a high temperature and high humidity type showing an average temperature of 27 degrees and an average humidity of 30%.

According to the variation of precipitation, the a year is divided into four seasons: dry season (precipitation 0 mm) from January to March, the first rainy season (monthly precipitation 50 to 80 mm) from April to August, the semidry season (monthly precipitation 10 to 20 mm) from September to October, and the second rainy season (monthly precipitation 30 to 60 mm) from November to December. The yearly evaporation rate is 200 mm to 400 mm. (Refer to Fig.3.2.1-1)

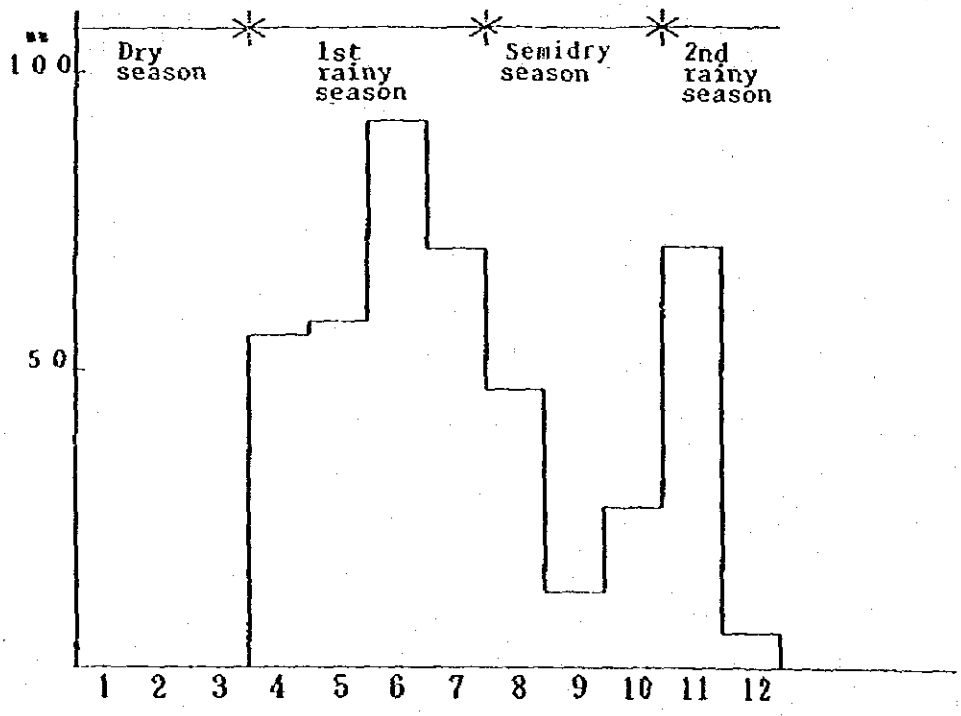


Fig.3.2.1 Monthly Mean Precipitation in Mogadishu City for 6 years from 1976 to 1984 (from Ministry of Agriculture)

3.2.2 Topographical and Geological Features

The coastal area in the southern part of Somalia including Mogadishu City is topographically divided into the following three areas, each of which is distributed in parallel with the coastal line.

(1) Coastal area:

Active plateau area of 2 km in width having a maximum altitude of 50 m.

(2) Bendana coastal plain:

Stable area consisting of red-brown sand of sand dunes of about 20 km width having an altitude of 30 to 70 m, being the highest point at about 12 to 17 km inland.

(3) Shabelle River basin:

Alluvial plain consisting of darkish clay and silt of about 60 km width, the Shabelle River repeatedly meandering until it reaches a marsh zone at the mouth of the river.

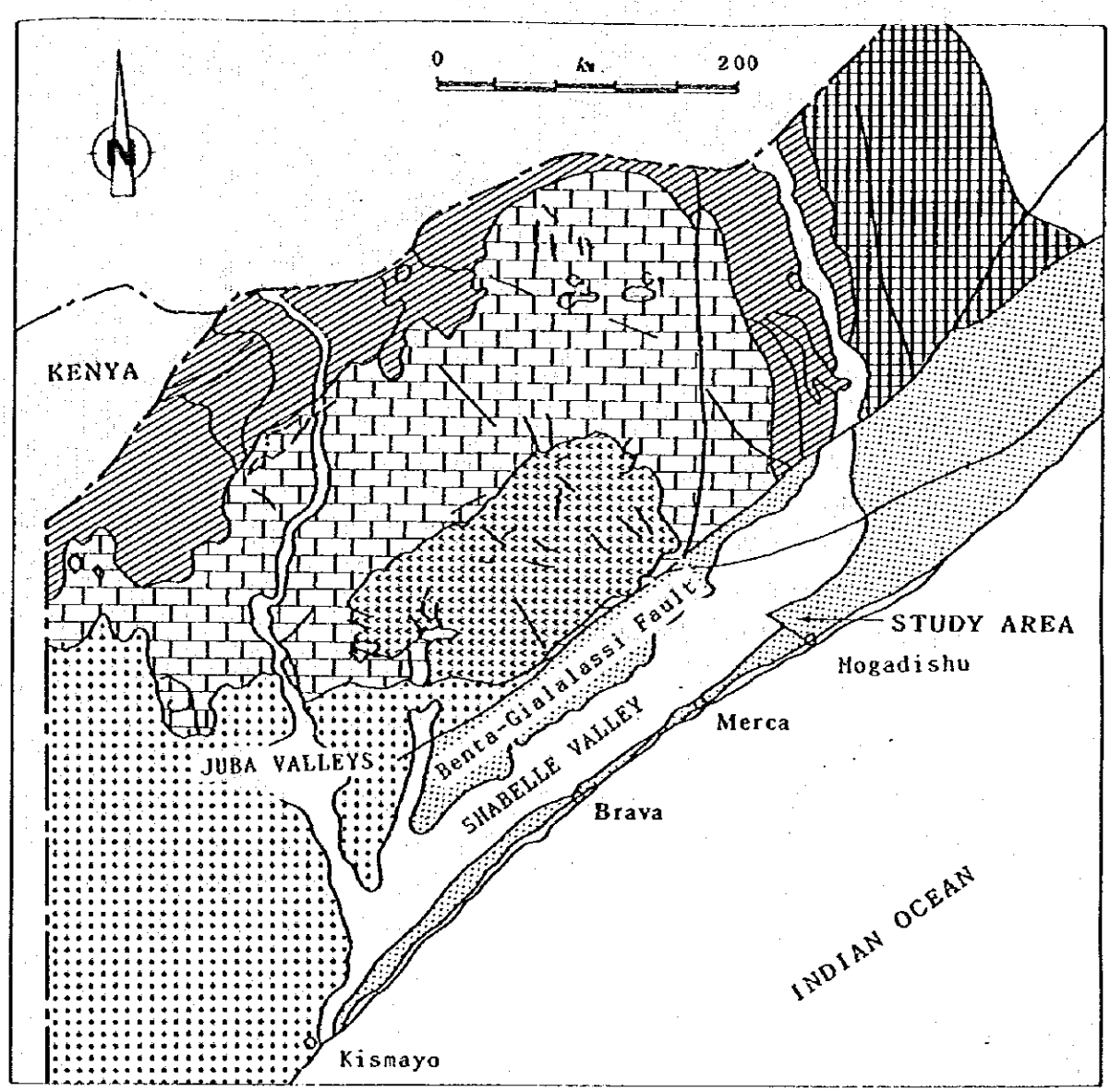
Fig.3.2.2 shows geology of the southern part of Somalia. It is divided into two provinces, coastal province and inland province, which are sectioned by the Benta Gialalassi fault and show quite different properties from each other. The geological structure of each province is as follows.

Coastal province:			
Cenozoic	Tertiary	----------	Tertiary sedimentary rocks (sandstone, clay stone, limestone)
	Quaternary		
	Diluvial	----------	Diluvium (sand, gravel, clay, limestone)
	Alluvial	---------	Alluvium (sand, clay)
			Aeolian (sand)
Inland province:			
Precambrian		----------	Old bedrock such as granite, gneiss.
Mesozoic	Jurassic	----------	Sandstone, limestone, dolomite.
	Cretaceous	-------	Sandstone, limestone, dolomite.
Cenozoic	Tertiary	----------	Tertiary sedimentary rock (sandstone, limestone, dolomite)

The Balad Well Field as the planned water source of the Project belongs to the coastal province.

In the province of the Balad Wellfield, alluvial layers are rarely distributed, and in the highest part, red aeolian soil deposits are thickly distributed. In the middle part, reddish brown marine sands are distributed, but on the coastside, white and gray limestone is distributed like an interposed lens. At the Balad Wellfield, this limestone is distributed as the nonwaterbearing layer in the

part. The lower layer consists of brown and green silt or clay in a subconsolidated or consolidated condition.



LEGEND

Juba and Shabelle Valleys		Quaternary	Coastal Province
Benadir Coastal Plain		Tertiary-Quaternary	
Lower Giuba Plain		Tertiary-Quaternary	
Coastal Belt		Tertiary-Quaternary	
Oddur Border Plateau		L.Cretaceous-U.Jurassic	Inland Province
Cretaceous Border Region		U.Jurassic-Cretaceous	
Mudugh Plateau		L.Tertiary	
Bur Region		Precambrian	

Fig. 3.2.2 Geological Map

3.3 Conditions of The Social Infrastructure

3.3.2 Transportation

Regarding the main roads in Mogadishu City, four-lane roads with central separate zones have been constructed and most roads have been paved asphalt-concrete. However, in the central part of the city, there is a depression running a few kilometers in parallel with the coastal line, and because of the draining facility not consolidated, rainwater stays and interferes with traffic in the rainy season.

Toward the outside of Mogadishu City, two paved main roads, Balad Road and Afgoi Road, connecting to other areas have been constructed, and the traffic volume is comparatively large. In Mogadishu City, seaport and international airport facilities are available as the transportation means in addition to roads.

3.3.2 Electric Power

Electric power in the city is supplied from two power plants provided in the city, but because of capacity shortage and generator failures, power service is frequently interrupted. To cope with such situations, public facilities and hotels in the city are provided with independent power generating equipment.

3.3.3 Communications

The condition of communications in the city is good as a result of expansion work and improvement work executed under the assistance of Japan and cooperation of the Arab Funds and Italy.

3.4 General Condition of Construction

In the city, buildings are being constructed at many places, but all the construction materials except for aggregate are imports. The prices of the materials are always varying according to supply-demand condition.

3.5 The Condition of Existing Facilities of The Balad Wellfield

3.5.1 Intake Facilities

An outline and the present condition of the facilities of the Balad wellfield are as follows.

1) Number of existing wells: 21
   - Wells which were abandoned by Phase II Project 3
   - Wells rehabilitated by the Phase II Project 13
   - Wells newly constructed by the Phase II Project 5

2) Wells in operation at present
   - Wells rehabilitated by the Phase II Project 5
   - Wells newly constructed by the Phase II Project 3

3) Actual water pumping rate as of the time of surveys

The pumping rate of wells now in operation is as follows.

- Wells rehabilitated in the Phase II Project
  About 4,800 m^3/day (average pumping rate per well : 40 m^3/hr)
- Wells newly constructed by the Phase II Project
  About 3,900 m^3/day (average pumping rate per well : 55 m^3/hr)
- Total possible pumping rate 8,700 m^3/day
  (Refer to Table 3.5.1 List of existing wells.)

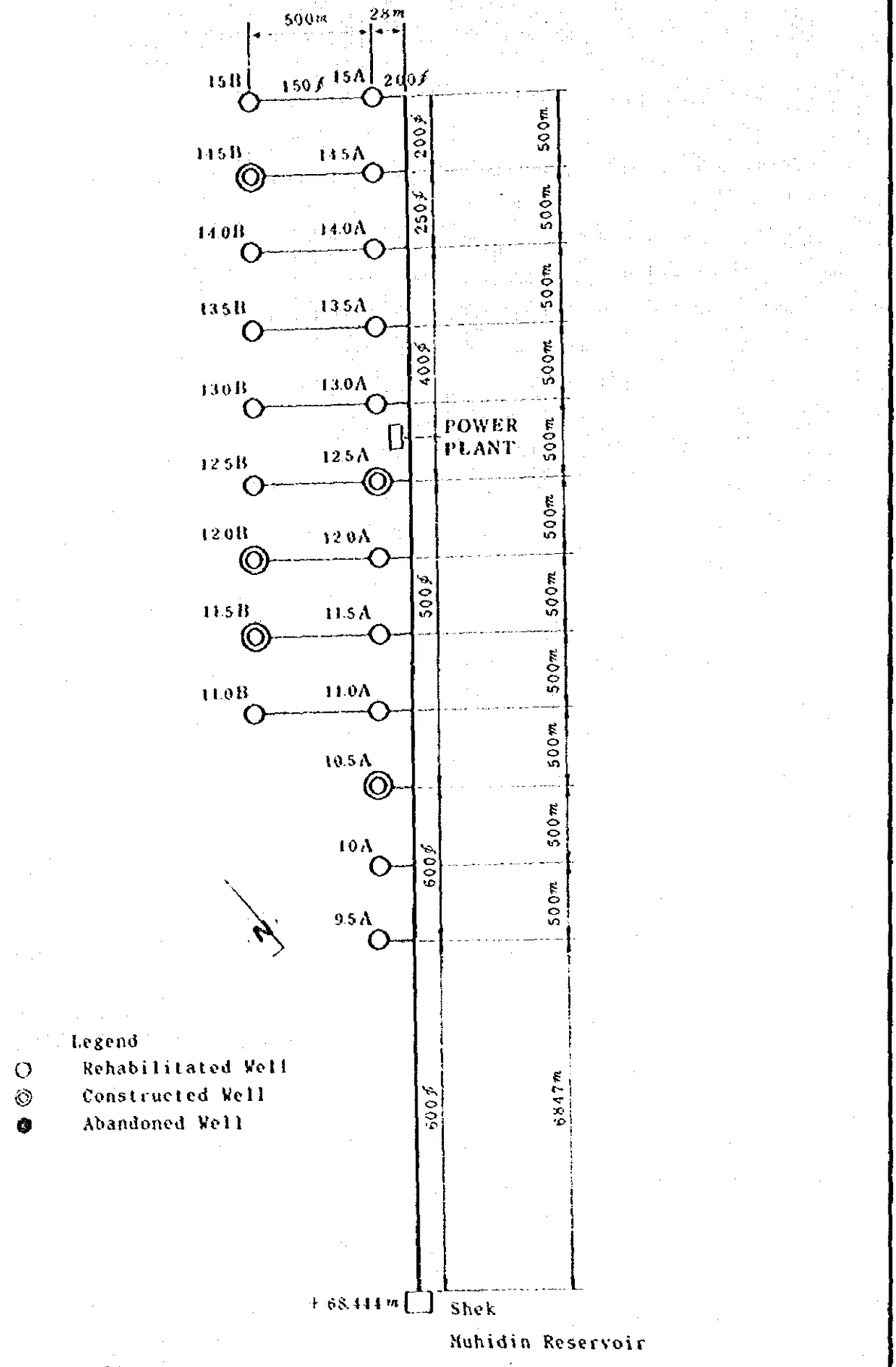


Fig. 3.5.1 Classification of Existing Wells in Phase II Project

Table 3.5.1-1 Present Condition of Existing Wells

Well	Submersible Pump	Flow meter		Remarks
9.5A	Uninstalled in Phase Ⅱ			Abandoned
10.0A	Operating	Operating		The screen of the well has been damaged.
10.5A	Operating	Out of order	○	
11.0A	Removed in Phase Ⅱ			Abandoned
11.0B	Not operating	Out of order		Previous material has been at 110 m depth.
11.5A	Removed in Phase Ⅱ			Abandoned
11.5B	Operating	Out of order	○	
12.0A	Not operating	Impossible to measure		Previous material has been at 84.7 m depth.
12.0B	Removed	Impossible to measure	○	
12.5A	Operating	Out of order	○	A pumping test was carried out.
12.5B	Removed	Impossible to measure		The screen of the well has been damaged.
13.0A	Operating	Operating		Previous material has been at 87.0m depth.
13.0B	Removed	Removed		
13.5A	Operating	Operating		Previous material has been at 84.0m depth.
13.5B	Operating	Operating		Previous material has been at 84.0m depth.
14.0A	Operating	Operating		Previous material has been at 103.0m depth. A pumping test was carried out.
14.0B	Removed	Removed		The screen of the well has been damaged.
14.5A	Out of order	Impossible to measure	○	
14.5B	Out of order	Impossible to measure		
15.0A	Removed	Impossible to measure		The screen of the well has been damaged.
15.0B	Out of order	Impossible to measure		Previous material has been at 78.0m depth.

○ :well newly constructed in Phase Ⅱ

Table 3.5.1-2 Change of Discharge Rate in Balad Well Field

Well	Discharge Rate: m³/hr			
	Mar. 1985	May 1987	Jan. 1988	Sep. 1988
9.5A	41.0	Abandoned		
10.0A	47.0	44.4	35.0	29.0
10.5A	-	60.2	55.0	(55.0)
11.0A	40.0	Abandoned		
11.0B	50.0	35.4	35.0	-
11.5A	54.0	Abandoned		
11.5B	-	66.6	54.0	(54.0)
12.0A	7.0	45.0	-	-
12.0B	-	60.2	55.0	-
12.5A	-	66.0	-	55.0
12.5B	32.0	46.2	32.0	-
13.0A	65.0	48.6	37.0	44.0
13.0B	45.0	51.6	-	-
13.5A	50.0	51.6	50.0	47.0
13.5B	27.0	37.2	35.0	37.0
14.0A	54.0	51.6	45.0	42.0
14.0B	-	19.3	-	-
14.5A	40.0	43.8	37.0	-
14.5B	-	72.0	-	-
15.0A	47.0	41.4	35.0	-
15.0B	52.0	42.0	40.0	-
Total	651.0	883.1	545.0	363.0
m³/day	15624	21194	13080	8712

3.5.2 Electric Power Supply Facilities

(1) Power generating equipment

Seven generators are installed at the exclusive power plant in the Balad wellfield and supply necessary power to each well. Six of seven existing generators installed by USAID loan were American-made, and the last one which installed in the Phase II Project is Japanese-made.

Two of the American-made generators are in operation at present. The fuel pump of the Japanese-made generator is out of order, so that the MWA is preparing to order the spare parts. Two American-made generators which are in operation have been used over ten years, so that generating vibration noises and oil leakages are noted. In addition, these two generators have produced output of about 117 KVA against original output of 250 KVA, so that it is judged that the life of these two generator almost expired. The remaining four American-made generators have been disassembled or their parts have been diverted on other generators, and it seems difficult to rehabilitate them.

The two generators in operation can drive well pumps for seven wells. The total output of two generators (existing) as of the time of surveys (September 18) is 380V, 385A, 48Hz, which corresponds approximately to the rated output of only one sound generator. On the transformers, no specific damage is noticed and there is no problem. The present conditions of the generators are shown in the Table 3.5.2.

(2) Power transmission equipment

In the hearing on power transmission equipment, examples of trouble, such as wire breakage because of deteriorated transmission lines, generation of leakage and short-circuit at porcelain insulators on the pole were mentioned. The shortcircuit at the insulators is caused by formation of water drops in the porcelain due to temperature differences between day and night times in the dry season, attachment and consolidation of salt and sand dust by tidal winds on the porcelain. The MWA is performing cleaning of the porcelain using the pump of a fire engine as needed by the trouble, but it was impossible to remove the defect completely from all insulators. Also, it was heard that the power transmission became impossible due to breakage of the shortcircuited insulator and restoration required about one day.

Table 3.5.2 Present Condition of Existing Generators

No.	Manufacturer	Capacity	Date of installation	Condition	Remarks
1	Holt Bros., U.S.A	250KVA	1972	Out of order	
2	- do -	- do -	- do -	Operating	Present Output 185A, 352V,48HZ Original Output 380A,380V,50HZ
3	- do -	- do -	- do -	Out of order	
4	- do -	- do -	- do -	Out of order	Part of the generator has been removed.
5	- do -	- do -	- do -	Out of order	
6	- do -	- do -	- do -	Operating	Output 200A,352V,48HZ
7	Denyo,Japan	- do -	1987	Out of order	Relacement of the fuel pump is necessary.

3.5.3 Piping Facilities

Water conveying pipes are 150 to 600 mm asbestos-cement pipes and concrete pipes, and it is judged that there is no need for their replacement. Piping around the pumps has been replaced in the Phase II Project and no damage is noticed. Some flow meters are defective and do not operate.

3.5.4 Chlorine Disinfecting Equipment

The chlorine disinfecting equipment has been installed to feed chlorine at the discharge port of the reservoir, but it is broken and cannot be used. There is no evidence of its being used in recent years.

The MWA personnel explained that chlorine was an imported chemical and difficult to obtain, and in the event of occurrence of a contagious disease, bleaching powder would be fed, but there had been no occurrence of such a disease since 1970 when cholera broke out.

3.5.5 Condition of Equipment and Materials Furnished in the Phase I Project

The condition, place of storage, and use of equipment, materials and vehicles furnished in the Phase I Project are as follows. The equipment and materials, maintenance rig, drilling rig, etc, kept in the stockyards and warehouses of the Balad water source were in a well managed condition.

Table 3.5.5 Use and Condition of Material and Machinery Furnished in Phase I Project

Item	Q'ty	Stored at	Condition and use
Four-wheel drive passenger car	2	MWA	Used for movement between Balad Wellfield and Afgoi Wellfield, reservoir and MWA office. In good condition.
Four-wheel drive pick-up	2	MWA	Used for movement between Balad and Afgoi Wellfields, reservoir and MWA headquarters, and transportation of materials etc. between wells. One is in good condition except for the rear winker broken and bonnet depressed. The other has no specific defect.
Eight-ton crane truck	1	MWA	Used for transportation of large-size equipment and materials to Balad and Afgoi Wellfield.
Tank lorry	1		Used for clearing of porcelain insulators in the power transmitting facility at Balad and Afgoi Wellfield and emergency water supply to public facilities in the city where water supply is badly poor.
Maintenance rig	1	Balad Wellfield	Managed in the stockyard of Balad wellfield and used for pulling-up and reinstallation of submersible pumps and water pump-up pipes.
Drilling rig	1	Balad Wellfield	Managed in good condition in the stockyard of Balad Wellfield similarly to the maintenance rig. According to the hearing from the MWA, the MWA has its own well construction plan, but it has not implemented the plan. There are no signs of the drilling rig having been used in well construction.

Item	Q'ty	Stored at	Condition and use
Generator for work	1	Balad Wellfiled	Used for emergency power supply to the MWA office because commercial power supply in Mogadishu City is instable.
Air compressor	1	Balad Wellfield	Managed in the stockyard of Balad Wellfield and used as necessary.
Spare parts and equipment mateials		Balad Wellfield	Managed in the stockyard of Balad Wellfield.
Well primary switchboards, fences (unused and removed)		Balad Wellfield	Kept in custody in the workshop at the generating facility site of Balad Wellfield (switchboards for 6 wells and fences for 5 wells).

3.5.6 Considerations on the Causes of Well Breakage and Pump Failures

The ground surface survey was only executed in the basic design study of the Phase I Project, so that the oldness of well bodies and left fallen materials were not noted. In the Phase II Project, three of 16 wells planned at the beginning judged and abandoned as incapable of rehabilitation. As a result, 13 wells were rehabilitated, and five wells were newly constructed. Eight of 13 rehabilitated wells and two of five newly constructed wells are not in operation at present. This is due to the broken well bodies and submersible motor pump failures. The probable causes are as follows.

(1) Wells rehabilitated in the Phase II Project

1) Deteriorated well bodies

Openings (holes) in the casing and the screen in excess of the tolerable size have occurred due to oxidation.

2) External physical causes

Openings (holes) in the casing and the screen in excess of the tolerable size have occurred in the rehabilitation works carried out several times in the past.

3) Submersible motor pumps have been broken due to ingress of sand or gravel through the openings (holes).

4) Sand has made ingress due to excess water pumping.

5) Submerged water pumps have been overloaded due to a voltage drop.

6) Multiplied effects of above.

(2) Wells newly constructed in the Phase II Project

Two wells at shutdown are due to a pump failure. That is, openings (holes) have occurred in the pump casing, causing pumping impossible. It is judged that due to excess pumping, a large quantity of fine sand made ingress through the opening of the screen and caused wear-out.

CHAPTER 4 CONTENTS OF THE PROJECT

CHAPTER 4 CONTENT OF THE PROJECT

4.1 Objective of the Project

The objective of the Project is to study the planned water intake rate on the Balad wellfield, set up water supply plans, and implement facilities plans of a reasonable scale as a grant aid cooperation on the basis of wellfield conditions in Mogadishu City, and the conditions of existing facilities of the Balad water source and other related facilities, in order to improve the stringent water shortage of the city.

The Project assumes that it should not address itself to the water demand of Mogadishu City at present in a total way, but it is intended to increase the water supply as a matter of urgency to cope with the present water shortage.

4.2 Study of the Contents of the Request

4.2.1 Study of the Contents of the Project

The facilities of Balad wellfield consist of intake facilities, power supply facilities, water conveyance facilities, reservoir, chlorination equipment, and distribution networks. It is judged that the facilities except intake facilities, power supply facilities, and chlorination equipment is operational.

The chlorination equipment was constructed in early 1970's under the USAID's finance at the same time that Balad wellfield was constructed and has been out of order. It will be operational by means of partial repair. However, it is difficult to procure chlorine because of its being an imported material, and MWA feeds bleaching powder into the equipment in the event of infectious disease caused by water. For these reasons, it is judged that it is unnecessary to rehabilitate this equipment .

Accordingly, it is considered that the Project achieves its objective by means of consolidation on intake facilities and power supply facilities. In addition, groundwater in the Balad wellfield has no problem quantitatively and qualitatively on the basis of the results of the field survey and study in Japan (refer to 5.2.4).

4.2.2 Study of the Contents of the Request

As mentioned in 4.2.1, it is considered that the Project achieves its objective by means of consolidation on intake facilities and power supply facilities. It is judged that the contents of the request from the Government of Somalia corresponds with the objective of the Project., because the contents of the request are mainly to supply equipment and materials for intake facilities and power supply facilities and to construct those facilities. The basic study team and the officials concerned of the Government of Somalia discussed and agreed that the item and quantity of equipment and materials listed in the request is altered according to the result of study in Japan.

On the other hand, one foreman, four mechanics, two electricians, and three well maintainer are stationed as the staff for operation and maintenance of Balad wellfield. It is judged that those staff are quantitatively enough to manage the operation and maintenance after completion of the Project.

CHAPTER 5 BASIC DESIGN

CHAPTER 5 BASIC DESIGN

5.1 Basic Design Policies

In this chapter, the scale and specification of the facilities required for this area will be determined on the basis of the contents of the Project described in CHAPTER 4. The basic design policies are as follows.

(1) As a rule, the design conditions for waterworks facilities shall be in accordance with the "Design Guideline for Waterworks Facilities, Explanatory Descriptions (1977)" compiled under the supervision of the Ministry of Health and Welfare of Japan, and in addition, the circumstances at the site will be taken into consideration in determining particular design conditions.

(2) The applicable standards for furnished equipment and materials shall be JIS standards on assumption that these products are made in Japan. However, if it is judged that the procurement from a third country is preferable in respect of the price, the standards of the producing country shall be used.

(3) The allowable stress of materials shall be in accordance with the standard specifications determined by the Institute of Civil Engineers of Japan, but the values shall be reduced at a proper rate by considering the properties of execution at the site.

(4) The technical capability, existing machines and other circumstances at the site shall be taken into consideration, and a method of execution, materials, equipment, etc. which produce the least hindrance in operation and maintenance shall be selected for the design.

5.2 Basic Plan

5.2.1 Supplied Area

In the present water supply system of Mogadishu City, the Shek Muhidin Reservoir zone is supplied from the Balad Wellfield, and other four zones are supplied from the Afgoi Wellfield, and these five zones are connected with each other through connecting pipes. Therefore, groundwater pumped up in the Balad Wellfield shall be supplied mainly to the Shek Muhidin Reservoir zone and also be supplied through the connecting pipes to other zones as necessary.

5.2.2 Target Rate of Water Intake

As described in 4.2.2 "Study of the Contents of the Request", it was agreed with the MWA after discussions that the planned water intake rate in the Project shall be within the capability of the existing water conveying main pipes and these main pipes shall not be replaced. The existing water conveying main pipes are asbestos cement pipes with a diameter of 600 mm and their water conveying rate at the economic flow speed is 54,000 m^3/day to 30,000 m^3/day (refer to Fig.5.3.2), and the planned water intake rate in the Phase I Project and the Phase II Project was 28,000 m^3/day. Therefore, the planned water intake rate shall be set at 28,000 m^3/day to secure the same water supply rate as before. If the water supply rate per capita per day is set at 70 liter which is the same as determined after discussions in the Phase II Project, the number of beneficiaries will be 400,000.

5.2.3 Water Intake Plan

As described above, the water pumping rate in total of eight wells which are in operation at present among the existing wells in the Balad Wellfield is about 8,700 m^3/day (refer to Table 3.5.1-1). Regarding two wells which were constructed in the Phase II Project and not in operation at present, it is judged from the condition of their pumping rate in the past that an average water pumping rate of about 55 m^3/hr each should be possible after pump replacement. However, regarding the wells which were rehabilitated in the Phase II Project and at shut-down at present, it should be judged that their useful lives have already expired and it should not be attempted to increase the water pumping rate through rehabilitation of them. Therefore, in the Project, the possible water pumping rate of the existing wells including pump replacement shall be incorporated into the planned water intake rate, and shortages shall be made up for by newly constructed wells.

The possible water pumping rate of the existing wells is about 11,340 m^3/day.

8,700 m^3/day + (55 m^3/hr X 24hr X 2 wells) = 11,340 m^3/day