3.2 Natural Conditions

To the western north of the Northern Region is the country's border with Libya and Egypt, to the north of the eastern area are hills ranging 500 to 800 m in elevation, in the central part is the low level area of peneplain less than 500 m in height through the middle of which the Nile river flows with a large curvature. Most of the areas are dry, even in the rainy season between July and September the annual rainfall in the northern area is nearly 0 mm, in the southern area it is 150 mm. The land available for agriculture is only the flood plain formed by the narrow strip of land on both sides of the Nile river which can be irrigated by the Nile river water.

To the west of the Nile river, most of the area is dry desert area, and Nubian sandstone of the middle and lower part of the Mesozoic Era covers a wide area with outcrops of basaltic lava in many spots. And the Nile provinces (eastern area) are covered widely by Precambrian basement rocks.

3.3 Socioeconomic Conditions

According to the country's census in 1985, the population was about 1 million but since most of the people had settled down on the narrow flood plain (2 $\sim$ 4 km) on both sides of the Nile river, practically the population density may be considered in the area around the Nile river to be 60 persons per square kilometer.

The land usage is 9.5% for agriculture, 49% for pastures, 2% for forest land and the remaining 40% of land is unused.

3.4 Conditions of the Infrastructure

3.4.1 Roads and Transportation

Paved roads exist only in the big capital city of Khartoum and outside the city they become roads covered with sand; going beyond the city of Ad Damar in the Northern Region, excluding the roads through communities, there are no proper roads linking the colonies which are scattered around the Nile river, therefore, it is common to follow the vehicle tire tracks left behind on the sand. Even in the southern part of the Northern Region if rainfall continues, the roads become soft and muddy, and several areas may be seen where the passage of big vehicles becomes impossible.

To go from Atbara in the Nile province which is at the center of the National Railway to Marawi, Donqola in the Northern province, excluding airplanes, the easiest way to travel is by crossing the desert. Even for doing this, the roads are not fixed. So there is no way other than following vehicle tracks left behind on the sand.

From Atbara to Karima the tracks of the National Railways have been laid but regular services are in disorder.

As for bridges crossing the Nile river (or tributaries), other than the one between Atbara and Ad Damar (common with the railroad), further downstream none have been erected and the only way to cross over is by ferry boat.

3.4.2 Electric Power, Others

Electric power supply stations are restricted to Shandi and Matamma on the opposite bank of the Nile. Further north of these places, the dependence is on only medium and small scale diesel engines for domestic power generation.

Consequently, for small-scale water yards, usage of electric power is not possible, and the reality is that other than depending on the power generated by the diesel engines as the power source for pumping machines, there is no other alternative.

The permanent residents of the Northern Region are practically restricted to the narrow belt on either side of the Nile river, and the communities have a population of a few hundreds, a few thousands and in some cases ten thousands, too. In medium-size communities, public facilities such as elementary schools and secondary schools exist. However, doctors and dispensaries are very few. Communities with traveling health nurses are also limited.

CHAPTER 4 PROJECT CONTENT

CHAPTER 4 PROJECT CONTENT

4.1 Objectives of Project

The objectives of this Project are as follows:

1) The restoration of the water supply and living conditions of the rural inhabitants by construction of new water supply facilities at safe areas for migrating inhabitants and rehabilitation of existing water supply facilities in the Northern Region which were seriously damaged by heavy rainfall and flooding of the Nile River in August to September, 1988.

2) Maintenance and servicing of the existing construction equipment, reinforcement of the construction and maintenance system of the NCDRWR for improvement of the rural water supply condition which is being executed based on the 7th 4-year Salvation Recovery and Development Programme.

To achieve the objectives mentioned above, the supply of the following equipment and materials is being examined and planned:

1) Materials for rehabilitation of existing water yards and water supply facilities using surface water in the Northern Region

2) Materials for construction of new water supply facilities (water yard and water supply facilities using surface water)

3) Construction equipment and materials for water supply facilities

4) Replenishment of spare parts needed for operation and maintenance for equipment such as drilling rigs, servicing machines, pumps, vehicles which were distributed in the Northern, Central, Kordofan, Darfur and Eastern Regions by the rural water supply projects under the Japanese Grant Aid executed in 1982/83.

4.2 Examination of Content of Request

4.2.1 Outline of Content of Request

The request of the Government of the Sudan is mainly composed of the following items for restoration of the existing water supply system in the Northern Region damaged by the floods in August and September of 1988.

(1) Rehabilitation of Existing Water Yards and Water Supply Facilities Using Surface Water at 130 locations (including construction of 20 new wells)

(2) Construction of New Water Yards at 30 Locations

(3) Construction of New Water Supply Facilities Using Surface Water at 20 Locations

(4) Spare Parts Needed for Equipment Supplied in 1982/83 Distributed in the Northern, Central, Kordofan, Darfur, and the Eastern Regions.

Each of the above-mentioned items is needed to be executed urgently but in the present Project cooperation shall be possible in the following:

(1) Rehabilitation of Water Yards, and Water Supply Facilities Using Surface Water at 57 Locations.

(replacement of water wells at 14 locations, rehabilitation of water yards at 31 locations, rehabilitation of water supply facilities using surface water at 12 locations)

(2) Construction of New Water Yards at 10 Locations Construction of 10 New Wells Included

(3) Construction of New Water Supply Facilities Using Surface Water Flow at 10 Locations

(4) The Same Amount of Spare Parts as Requested

With the execution of the Project, a total of 68 locations (actual plan of executing sites - in case of plural rehabilitation of facilities, calculated one site) in the Northern Region will have water supply facility operating. The remaining 103 locations would be implemented under the emergency measures of the Government of the Sudan.

For the well construction, considering the time period for construction of new wells (14 + 10), and the travelling time between the widely dispersed well sites, at least several drilling machines will be necessary.

The Regional office of the NCDRWR in the Northern Region at present has 3 drilling machines in total which are available: one machine (rotary type) which was donated in 1982/83 under Japanese Grant Aid, and 2 other machines. However, the office is responsible for the construction work of many wells for water supply in an entire regional area where the area is very wide (1.3 times as large as Japan). Therefore, to assign all these machines continuously for the Project is unrealistic over a long period. Consequently, the

consideration mentioned above will leads to the necessity of at least one more drilling machine and its accessories in addition to the 3 machines available owned by the NCDRWR.

Also, the Project shall be carried out urgently for the restoration of existing water supply facilities that suffered damage due to floods.

The village water supply systems which use groundwater as the main source of water supply will continue to be constructed by the Government of the Sudan even after accomplishment of the Project.

For the above, the engineers of the NCDRWR shall be familiar with operation, repair and maintenance of equipment and materials. Therefore, adequate technology transfer within the framework of the Project, including the construction of wells using drilling machines, is indispensable.

For this reason, it is considered that adequate training must be given, and it would be most appropriate that the equipment be used by the local personnel as a result of technology transfer. For the personnel to receive the technology transfer, the Northern Region, Regional office of the NCDRWR will deal with the selection of the trainees. Also, the qualified employees in the regional office will respond adequately to the required technology transfers under this Project.

For the above mentioned technology transfer, the required Japanese engineering personnel are as listed below:

(1) Mechanical engineer

(2) Well drilling engineer

(3) Hydrogeologist

In the policy of the Sudan Government, the Regional office of the NCDRWR would receive the equipment and materials for the restoration of flood damage in the Northern Region, and even after accomplishment of the Project, the equipment would continue to be used at the Northern Region by the Regional office for the construction of water supply facilities.

For the improvement of rural water supply conditions of the Sudan, the contents of equipment and materials supplied by the Japanese Government in the past, distributed areas, and operating conditions are as listed below:

Equipment	Q'ty (No.)	Distributed area	Operating conditions
Well drilling machines Rotary type (TRD-300S)	2	Northern and Central Region, one each	Due to fault in parts, both machines need to be repaired.
Well drilling machines Percussion type (SM-22T)	2	Central, Eastern Region, one each	In operation
Well drilling machines + Compressor Percussion type (SM-26T/C)	2	Kordofan, Darfur Region, one each	In operation
Servicing machines (MK-10SC)	4	Central, Kordofan, Eastern, Darfur Region, one each	In operation

The majority of the equipment is operational but, in practice, due to insufficient spare parts, other substitute parts are used and the equipment is operated. If the spare parts are not available in the near future there is a likelihood that operations will cease altogether. The replenishment of spare parts for the equipment which is in operation is necessary. The contents of the spare parts in the request are for the operation and maintenance of already supplied equipment (well drilling machines, servicing machines, submerged pumps, generators, pumps, vehicles, etc.).

Also, these spare parts are to be stored in the main office (Khartoum) of the NCDRWR.

4.2.2 Examination of Content of Request

(1) Project Period for the Reconstruction Work

As described in the World Bank's report (Emergency Flood Reconstruction Program, October 1988), the flood reconstruction plan in the Northern Region must be implemented as soon as possible for the program's strategy to restore damage caused from the disaster. Therefore, the Project period for the construction work will be limited to within two years.

(2) Optimum Construction Period per Year

As for the period for constructing water supply facilities by Sudan after equipment and materials are supplied, it will be reasonable that the period of construction is 6 months from December to May in consideration of the rainy season in the Republic of the Sudan, delivery of equipment and materials, and the period of technology transfer including trial operation.

(3) Executive Organization of Project

When this project is carried out, one project manager will be selected from among directors of the Headquarter of the NCDRWR (Khartoum), and he will be responsible to carry out the project.

Under this project manager, the Regional Office in the Northern Region of the NCDRWR will form a drilling group (3 teams), a water yard construction group (3 teams), and a construction group for water supply facilities that use surface water (3 teams).

The composition of each team shall be as follows:

Drilling team: 17 persons
(Mechanician, driller, geologist, driver, laborer, etc.)

Water yard construction team: 12 persons
(Mechanician, builder, mason, welder, driver, laborer, etc.)

Construction team for water supply facilities that use surface water: 15 persons
(Civil engineer, foreman, mason, driver, laborer, etc.)

If there is not enough personnel at the Regional Office in the Northern Region, they will ask other branch offices to send prsonnel in order to carry out the project.

The number of regular staff at the NCDRWR Regional Office in the Northern Region is 1,031.

Of this number, 620 are engineers. If the number of drivers and laborers is insufficient, they will temporarily hire them as required.

Judging from the above, the NCDRWR Regional Office in the Northern Region has a sufficient number of engineers and a well-established administrative system.

(4) Plan for the Construction Work

By taking into consideration the optimum construction period per year cited in (2) and the executive organization of the Project cited in (3), the number of sites for carrying out the Project will be determined according to the type of improvement plan of water supply facilities.

1) Construction Plan of Water Wells

As for drilling machines, one unit which is to be supplied by the project shall be used. Two of the three units owned by the NCDRWR Regional Office in the Northern Region will be allocated to this project.

The 3 teams of the drilling group will each use one drilling machine. The operational days per month are estimated to reach 26 (Fridays are a holiday).

Accordingly, the number of wells which can be constructed is calculated as follows:

$$\text{One unit} \times \frac{\text{Period of construction: 6 months} \times \text{26 days/month}}{\text{Days of construction: 36 days/well}}$$

$$= 4.3 \text{ wells/team/year}$$

Consequently, 4 wells can be drilled by one team in a year.

The number of wells to be drilled in two years will be: 2 years x 3 units (3 teams) x 4 wells/team/year = 24 wells.

According to the water supply improvement plan in the Northern Region by the NCDRWR Regional Office, a) the planned site number of substitute wells at existing water yards to be constructed is 20, and b) the planned site number of new water yards to be constructed as inhabitants migrate from the village is 30. New wells must be constructed at 50 sites in total. However, it is necessary to reduce the number of wells to 24.

In this case, the 26 sites must be divided between a) the planned number of substitute wells at existing water yards and b) the planned number of construction of new water yards, respectively.

Paragraph a) construction of substitute wells at water yards is an exchange of a part of equipment in the existing water supply system, but paragraph b) construction of new wells at water yard includes the whole system with elevated tanks, pump houses, etc. In this case, paragraph a) the construction of substitute wells at the existing water yards will be more effective with a small amount of investment than paragraph b) the construction of the wells at the new water yards.

Therefore, the plan will put more emphasis on paragraph a) than b). Thus, the number of well construction sites for paragraph a) will be planned to be 14 and for paragraph b) to be 10.

At the 10 sites of paragraph b) construction of the new water yards, water supply facilities except for water wells (pump & engine, pump house, elevated tank, etc.) shall be constructed by the construction team.

2) Construction and Replacement of Water Supply Facilities, Except for Water Wells (pump, engine, pump house, elevated tank, etc.) - Rehabilitation of the existing water yards and construction of the new water yards for migrating inhabitants (10 sites).

The construction group (3 teams) will be assigned to this work. The construction work for fences (barbed-wire is attached to a steel frame) and pump houses (corrugated plate is attached to a steel frame) is simple and easy. Although some work such as installation and exchange of buried pipe requires a considerable number of days, the term of construction per site is estimated to be 16 days including all construction work.

Accordingly, the total number of sites where construction work can be done is estimated as follows.

$$\text{One team} \times \frac{\text{Period of construction: 6 months/year} \times 26 \text{ days/month}}{\text{Days of construction: 16 days/site}}$$

$$= 9.5 \text{ sites/team/year}$$

The planned number of sites in a year is: 1 year x 3 teams x 9.5 sites/team/year = 28 sites

3) Rehabilitation of the Water Supply Facilities Which use Surface Water and Construction of New Water Supply Facilities Which use Surface Water for Migrating Inhabitants

The term of construction becomes long due to concreting on the sedimentation basin and the filter basin, and installation of pipes. It is estimated to be 31 days per site including all construction work.

The number of sites where construction is possible is estimated as follows.

$$\text{One team} \times \frac{\text{Period of construction: 6 months/year} \times 26 \text{ days/month}}{\text{Days of construction: 31 days/site}}$$

$$= 5 \text{ sites/team/year}$$

The planned number of sites in a year will be: 1 year x 3 teams x 5 sites/1 team/year = 15 sites.

The maximum number of facilities to be constructed in a year will be 1) 12 water wells, 2) 28 sites for the rehabilitation of water yards and construction of new water supply facilities (including water yards at 10 sites) for migrating inhabitants, and 3) 15 sites for the rehabilitation of water supply facilities which use surface water and construction of new water supply facilities which use surface water for migrating inhabitants.

The number of sites is the maximum number of sites where construction can be done in a year. Since the preparation for accommodating machines and materials in the Northern Region has to be done, the Project reduces the number of sites to be constructed in the first phase so that the maximum number of sites could be achieved in the second phase.

The construction plan of the facilities is divided in the first phase and second phase as shown in the table below.

Rehabilitation of Water Supply Facilities and New Construction Sites

Item \ Phase	First phase (number of sites)	Second phase (number of sites)	Total (number of sites)
1) Water yard substitute wells (14 wells) Water yard, new wells (10 wells)	12 wells	12 wells	24 wells
2) Rehabilitation of water yards New water yard (except water well) (shift of the village which was damaged by the flood) [Details] Rehabilitation: Pumping machine at water yard (pump and engine) Elevated tank Construction (except water well)	13 9 1 3	28 17 4 7	41
3) Rehabilitation of water supply facilities which use surface water Construction of new water supply facilities which use surface water (shift of the village which was damaged by the flood) [Details] Rehabilitation: Pumping machine (pump and engine) Elevated tank Transmission and distribution pipe Construction	7 2 1 1 3	15 3 1 4 7	22

Note: The number of sites indicates the number of sites depending on construction work and may be duplicated.

CHAPTER 5 BASIC DESIGN

CHAPTER 5 BASIC DESIGN

5.1 Policy of Basic Design

We note the emergency which lies behind this request. Design standards basically conform to those of other facilities. However, where there are marked problems, they are improved. Weather conditions, traffic conditions, and operation and maintenance systems are taken into consideration when selecting equipment and materials.

In particular, roads other than national roads which constitute trunk roads become unusable in the rainy season. Attention must be paid to this point. Therefore, we selected vehicles that can run under this condition.

This plan consists of the following:

1) Rehabilitation of the Water Supply Facilities Damaged by Flood

2) Construction of the New Water Supply Facilities at Safe Areas for Migrating Inhabitants

3) Replenishment of Spare Parts Required for Operation and Maintenance of Equipment and Materials Held by the NCDRWR.

The detailed contents are as follows:

1) Rehabilitation of the Water Supply Facilities (57 sites)

   - Rehabilitation of the water yards (45 sites)
     (Detail)
     o Pump (26 sites)
     o Elevated tank (5 sites)
     o Water well (14 wells)

   - Rehabilitation of the water yards using surface water (12 sites)
     o Pump (5 sites)
     o Elevated tank (2 sites)
     o Pipe, pipe fittings (5 sites)

2) Construction of the New Water Supply Facilities (20 sites)
   o Construction of the new water yards (10 sites)
   o Construction of the new water supply facilities using surface water (10 sites)

3) Replenishment of Spare Parts

The above number of sites are counted by classification of work, however the actual number of sites is 68, which is less than the 77 sites of the total amount because the replacement of plural equipment at one (1) site is included.

5.2 Examination of the Conditions for Basic Design

5.2.1 Equipment and Materials Owned by the Regional Office of the NCDRWR in the Northern Region

The NCDRWR Regional Office in the Northern Region owns the following drilling machines and vehicles:

Item	Contents	Q'ty	Current condition
1. Drilling machine	Bomack (West Germany)	1	Operating
	Mathamqe (Italy)	1	Operating
	Tone Boring (Japan)	1	Repair is necessary (wait for arrival of parts).
2. Vehicles	Truck (12 tons) (Sweden)	2 3	Operating Repair is necessary.
	Truck (7 tons) (Yugoslavia)	6 1	Operating Repair is necessary.
	(Japan)	2 1	Operating Repair is necessary.
	Truck (5 tons) (England)	9 1	Operating Repair is necessary.
	Pick up (Round rover) (England)	8 13	Operating Repair is necessary.
	Pick up (Round cruiser) (Japan)	2 2 2	Operating Repair is necessary. Scrapped
	Pick up (Hilux) (Japan)	8	Operating
	Tank truck (Denmark)	1	Operating
	Workshop car (Denmark)	1	Operating
	Station wagon (Round rover) (England) (Corona) (Japan)	 1 1	 Operating Operating

Among the drilling machines, one unit of Tone (Japan) waits to be repaired due to failure of machine parts in the repair factory at the NCDRWR Headquarters in Khartoum. It can be repaired by the spare parts which are supplied this time.

The vehicles other than drilling machine are used to transport machinery and materials for operation and maintenance of water yards and laborers.

The NCDRWR is involved not only in the development plan of the Corporation but also in the supply of technology, including construction work, upon request by the National Urban Water Corporation (NUWC), Regional Local Governments, and other organizations. Consequently, the drilling machines which can be used in this project will be two units among three which are owned by the NCDRWR Regional Office in the Northern Region.

5.3 Basic Design

5.3.1 Basic Plan of Water Supply Facilities

(1) Water Source

The depth of the wells will be 240 meters based on the field conditions. The diameter of the wells will be 6 5/8 inches, a size used at most of the existing wells to facilitate interchangeability of pumps and casing pipes.

The length of the screen will be estimated to be 10% of all well depths by taking into consideration the ratio of the length of between all the layers and aquifers in the field based on existing boring data.

The diameter of the well will be 9 5/8 inches, the same as new wells in the Northern Region.

1) Rehabilitation of Water Yards and Water Supply Facilities Which use Surface Water.
In rehabilitation sites of existing water yards and water supply facilities which use surface water, replacement wells shall be needed to be sunk in the 14 rehabilitation sites.
The necessary amounts of casing pipe and screen to be used for new wells are as follows:

Casing pipe (6 5/8 inches)		
6 m x 504 pcs =	3,024 m	216 m/hole
Screen (6 5/8 inches)		
6 m x 56 pcs =	336 m	24 m/hole
Centralizer (per 15 meters)		
	224 pcs	16 pcs/hole

2) Construction of the New Water Yards
For the 10 wells which are included in new construction of water yards at 10 places, the necessary amounts of casing pipe and screen are as follows:

Casing pipe (6 5/8 inches)		
6 m x 360 pcs =	2,160 m	216 m/hole

Screen (6 5/8 inches)

6 m x 40 pcs	=	240 m	24 m/hole

Centralizer (per 15 meters)

	160 pcs	16 pcs/hole

(2) Pumping Machines (deep well pump and engine)

1) Rehabilitation of Water Yards

The pumps to be installed at water yards comprise the following three types.

a) Submersible pump
b) Soccer rod type (reciprocating pump)
c) Vertical turbine pump

It is considered reasonable to exclude submersible pumps from this project from the viewpoints of electric power source, operation and maintenance.

Vertical turbine pumps are widely used in East Africa. The newly installed water supply facilities in the Sudan also use this type. This type of pump is widely used at many sites in the Northern Region, which had suffered flood damage, and the same type is used among the pump engines which require rehabilitation (replacement) and the existing pump engines. For the pumps at 26 sites which were damaged severely by the flood in the Northern Region, we decided to include the 26 pumps and 4 spare pumps (30 units in total) in the framework of the Project.

Consequently, it is considered reasonable to use the soccer rod type or the vertical turbine pump in this project. These two types are compared below.

Item	Reciprocating type	Vertical type
Pump efficiency	Low	High
Difficulty of installation	No difference	
Durability	No difference	
Operation and maintenance	No difference	
Price	x 1.7	x 1
Cost of fuel	High	Low
Procurement method	Imported	Domestic product
Record of use in the Sudan	Used in old facilities	Used in new facilities

As a result of the comparison, we decided to adopt the vertical turbine pump by taking the procurement conditions, recent trend in the Sudan, price, and cost of fuel (operating cost) into consideration.
Regarding the specifications, we conform to the pump specifications which are used in the existing facilities. Also, as for the driven and transmission system, we use the belt system. They are used as the standard specifications in this project.

a) Pump specifications:
Q = 20 ∿ 25 m^3/hr (330 ∿ 415 ℓ/min)
H = ∿ 60 m
HP = ∿ 14 HP 30 units

b) Engine specifications:
Horizontal type, water-cooled, 4 cycle
HP = 14 HP
N = 1,800 rpm 30 units

c) Pipes, joints, and other accessories:
30 sets

2) Construction of New Water Yards
In the same way as the above, the vertical turbine pump is adopted as the pump engine which will be installed at 10 water supply facilities (water yards). The pump specifications which are used in the existing facilities will be used, and the drive and transmission system adopts the belt system as the standard specifications.
The pumps to be installed at four places are added as spare pumps.

a) Pump specifications:
Q = 20 ∿ 25 m^3/hr (330 ∿ 415 ℓ/min)
H = ∿ 60 m
HP = ∿ 14 HP 14 units

b) Engine specifications:
Horizontal, water-cooled, 4 cycle
HP = 14 HP
H = 1,800 rpm 14 units

c) Pipes, joints, and other accessories:
14 sets

(3) Pumping Machines (water-intake and water-supply pumps and engine)

1) Rehabilitation of Water Supply Facilities (water supply facilities which use surface water)

We decided to plan to rehabilitate five pumps and one pump (spare) which received great damage due to the flood in the Northern Region. (The number of pumps for which rehabilitation was requested is 10.)
As for the specifications, we will use the pump specifications which are used in the existing facilities and the belt system as the drive and transmission system as the standard specifications.

a) Pump specifications:
Q = ∿ 50 m^3/hr (∿ 830 ℓ/min)
H = 40 ∿ 60 m
HP = ∿ 20 HP 6 units

b) Engine specifications:
Horizontal, water-cooled, 4 cycle
HP = 20 HP
N = 1,800 rpm 6 units

c) Pipes, joints, and other accessories:
6 sets

The pipes which extend from the water-intake yard to the distributing reservoir over 2 kilometers were damaged due to the flood. We will exchange the pipes at five places and one place (spare) among the 10 places requested. The existing pipes are 4 inches in diameter and are made of zinc plated steel pipes. In the Project, however, vinyl chloride pipes having the same diameter will be used from the viewpoints of a reduction of the term of construction, work efficiency, and rustproofing.

The joints which are needed in piping are included in the materials to be planned for the Project.

2) Construction of New Water Supply Facilities Which use Surface Water

The inhabitants in the villages which were damaged by the flood of the Nile River started to move to alluvial sandhills of 4 to 5 meters. For this reason, we decided to plan water supply facilities which use surface water at 10 places and 3 places (spare). (The number of the facilities they requested is 20.)

For the rehabilitation of water supply facilities which use surface water, the pumps of two different types per one supply system are needed; a water-intake pump and a booster pump which sends water to an elevated tank. Concerning the specifications of the water-intake pump, we conform to the request to install the water supply facilities on higher land than the existing facilities (to prevent damage by a flood). As for the specifications of the booster pump, we also conform to the request by taking the height of the elevated tank into consideration (24 feet = 7.2 meters). The belt system is also adopted as the drive and transmission system.

A. Water-intake pump (centrifugal pump)

a) Pump specifications:
Q = ∿ 50 m^3/hr (∿ 830 ℓ/min)
H = 80 ∿ 100 m
HP = ∿ 31 HP 13 units

b) Engine specifications:
Horizontal, water-cooled, 4 cycle
HP = 31 HP
N = 1,800 rpm 13 units

c) Pipes, joints, and other accessories:
13 sets

We decided to adopt vinyl chloride pipes as the pipes which extend from the water-intake yard to the distributing reservoir over 2 kilometers which enable a reduction of the term of construction, and excel in work efficiency and rustproofing based on the request. The quantity used shall be 10 sets and 3 sets (spare).
The joints which are needed in piping are included in the materials to be planned for the Project. 13 sets

B. Booster pump

a) Pump specifications:
Q = 20 ∿ 25 m^3/hr (330 ∿ 415 ℓ/min)
H = 20 ∿ 25 m
HP = ∿ 6 HP 13 units

b) Engine specifications:
Horizontal, water-cooled, 4 cycle
HP = 6 HP
N = 1,800 rpm 13 units

c) Pipes, joints, and other accessories:
13 sets

(4) Elevated Tank

The tank shall be the elevated one specified by the Republic of the Sudan which is of the FRP panel system with a capacity of 50 m^3 and a height of 24 feet (= 7.2 meters) above the ground. The tank will be 5 meters x 5 meters x 2 meters.

The pedestal will be a steel prefabricated type which will enable a reduction of the term of construction and has excellent durability.

1) Rehabilitation of Water Yards and Water Supply Facilities Which use Surface Water

a) Rehabilitation of water yards
We decided to plan to rehabilitate the elevated tanks which received great damage due to the flood, 5 units and 1 unit (spare), according to the Project.
6 units in total

b) Rehabilitation of water supply facilities which use surface water
For the same reason as the above-mentioned rehabilitation, elevated tanks for which we paln are 2 units plus 1 unit (spare). 3 units in total

2) Construction of New Water Yards
According to the project, we can plan elevated tanks including fence, pump house, and piping of 10 units plus 4 units (spare).
14 units in total

The piping materials and joints which connect the deep well pump, elevated tanks, and other facilities of the same number as the above-mentioned elevated tanks (14 units) are necessary, 10 sets and 4 sets (spare).
14 sets in total

The pump house is of prefabricated type as a result of a reduction of the term of construction being taken into consideration. 10 sets plus 4 sets (spare) of pump houses including fences which is the same number as the above elevated tanks (14 units), are necessary. 14 sets in total

3) Construction of New Water Supply Facilities Which use Surface Water
In the same reason as 2) in Item (3), the number of elevated tanks for which we can plan according to the Project is 10 units plus 3 units (spare). 13 units in total

(5) Deep Well Construction Machines

1) Well Drilling Machines

The land in the Northern Region for which the project is applied mostly consists of composite layers including Nubian sandstone and alluvium. Since the ground is soft, the mud circulating method is suitable for this land as the well drilling method.

Consequently, the specifications of existing wells, that is, a diameter of 9 5/8 inches and depth of 240 meters, are adopted as the standard specifications. The rotary table type which can give apply rotating force is adopted as the well drilling machine.

Also, the well drilling machine is of the truck mounted type which can move quickly in the whole Northern Region and allows quick construction. The drilling machine to be loaded on the truck can drive the rotary table, draw work, sand reel hydraulic mast, and hydraulic system via the power take off (P.T.O.) using the diesel engine of the truck.

Tools and accessories sufficient to install 14 substitute wells and 10 new wells will be included in the materials to be planned for the project.

a) Specifications of drilling machine

Type: Truck mounted type rotary, one set

Capacity:

3 1/2 inches (drill pipe) x 300 meters

Method of construction:

Mud circulating method

Truck: 6 x 4 1 unit

b) Standard accessories for drilling machine: 1 set

c) Drilling tools and accessories: 1 set

d) Fishing tools: 1 set

e) Casing tools: 1 set

f) Tools for well development 1 set

2) Machines and Materials for Bore Hole Test

These machines and materials are used to conduct the test for electric logging in the bore hole after completion of drilling work, and the pumping test after completion of the casing work.

a) Electric logging system

The items for measurement include normal specific resistance (25, 50, 100 cm), temperature, difference of temperatures, and spontaneous potential. The accessories needed for measurement are included in the materials to be planned for the Project. Depth at which measurement is done will be 300 meters or more, and an electric winch, generator, and weight shall be included. All of the equipment and accessories will be mounted in a wagon car of van type which will facilitate moving between installation sites. One unit

b) Deep well pump used for pumping test

Amount of pumping: 25 m^3/hr (415 ℓ/min)

Pump head: 100 m

One set of accessories (electric wire, pumping pipe, etc.) is included.

1 unit

Generator (for use in deep well pump)
Output: 30 kVA
Voltage: Three phase, 220 V
Frequency: 50 Hz
One set of standard accessories is included. 1 unit

The above-mentioned deep well pump used for the pumping test and the generator will be truck-mounted to facilitate moving between construction sites.

c) Water level measurement equipment
Built-in handy type dry cell, depth for measurement: 200 meters (max) 1 unit

d) Electrode protection pipe of water level measurement equipment
Zinc plated steel pipe, ø: 3/4 inches, connected to socket 200 m

e) Electric-conductivity meter
Built-in handy type dry cell
Scope of measurement: 0 to 19.99 ms/cm
Digital display 1 unit

f) pH meter
Built-in handy type dry cell
Scope of measurement: 0 to 14 pH
Digital display 1 unit

3) Equipment and Materials for Well Development

To develop the inside of bore holes having a depth of 200 meters or more, a high pressure compressor having the following specifications is necessary. It will be truck-mounted to facilitate moving between installation sites.

a) Truck-mounted type air compressor
Type: Rotary screw type
Volume of air to be discharged:
21 m^3/min or more
Pressure to be discharged:
17.5 kgf/cm^2 1 unit

b) Air lift system for well development
Air lift pipes will be inserted in the water well by the depth of 200m, and the pipe system consists of two kinds of pipes: lift pipe of 3 inches in diameter, and air pipe of 1 inch in diameter.
One set of accessories which constitute the air lift system shall be included.
1 set

4) Bentonite

When the diameter of the well is 9 5/8 inches and its depth is 240 meters, the necessary amount for 14 substitute wells and 10 new wells (24 wells in total) is as follows:
145 tons

5) Bit (size 9 5/8 inches)

When the depth of the well is 240 meters, the necessary amount for 14 substitute wells and 10 new wells (24 wells in total) is as follows:
36 sets

(6) Welding Machine, Generator and Engineering Tools

The welding machine, generator, and standard tools are necessary for repairs, improvement, and exchange work at each site in the Northern Region. These items are loaded on a truck (4 x 4, pick up-type, etc.) to facilitate moving between location sites of water supply facilities which were damaged by the flood. Two sets of each of these are to be allocated for the drilling team group (3 teams), the water yard construction team group (3 teams) and the construction team group of water supply facilities which use surface water (3 teams).

1) Welding Machine and Generator

Welding section

Range of current:	50 to 270 A
Arc voltage:	30 V or more
Output:	8 kW or more

Generator section

Frequency:	50 Hz
Output:	10 kVA

One set of expendable supplies such as welding rods is included as accessories.

6 sets

2) Engineering Tools

One set of standard tools such as wrenches and screw drivers are included in a tool box.

6 sets

(7) Vehicles

The vehicle plan in the Northern Region is as follows:

	Pick up	Truck (7 to 8 tons)	Truck (12 to 15 tons)	Crane truck (10 to 15 tons)	Water tank truck (9,000ℓ)	Fuel tank truck (4,500ℓ)
1. Drilling team			1	1	1	1
D-1	1	*1				
D-2	*1	*1				
D-3	*1	*1				
2. Water yard construction team				1		
WY-1	1	1				
WY-2	1	1				
WY-3	*1	1				
3. Construction team of water supply facilities which use surface water			1			
SW-1	1	1				
SW-2	1	1				
SW-3	*1	1				
4. Belong to Maintenance Center in the Northern Region (at 8 places)	*14	*6	*2			*1
Total	23 (*18)	15 (*9)	5 (*2)	1	1	2 (*1)
5. Others	Station wagon *2, truck (5 tons) *8, workshop car *1					

The number with asterisk (*) indicates the number of vehicles owned by the NCDRWR and its Branch Office in the Northern Region.

According to our project, the work is carried out by 9 teams including the drilling group (3 teams), the water yard construction group (3 teams), and the construction group (3 teams) for water supply facilities which use surface water.

Accordingly, one pick up-type light vehicle is allocated to each team (9 units in total) to transport personnel, equipment and material to the site. (The number of units requested is 5.) As for the shortage of 4 vehicles, pick up-type light vehicles owned by the NCDRWR Regional Office in the Northern Region are applied.

Concerning 7 to 8 ton trucks and 12 to 15 ton trucks, one 7 to 8 ton truck is allocated to each team (9 trucks in total) to transport equipment and material from the Maintenance Center to the construction sites. (The number of requested trucks is 6 units.) 7 to 8 ton trucks owned by Regional Office in the Northern Region will be used to meet the shortfall.

Also, as for 12 to 15 ton truck, one truck is allocated to the whole of the drilling group, water yard construction group, and construction team of water supply facilities which use surface water (3 trucks in total). (The number of requested trucks is 3 units.)

The 10 to 15 ton truck (with crane) is used for loading and transportating equipment and materials (drilling tools, etc.).

The water tank truck is used to transport water for use in well construction, and the fuel tank truck is used to transport fuel for construction. One vehicle of each is allocated to the entire drilling group. (The number of requested vehicle is one unit.)

(8) Spare Parts

1) Spare Parts for Planned Equipment and Materials
The quantity will be that necessary for operation and maintenance during two years. In the first phase, 10% of the price of the main body is appropriated, and in the second phase, 20% of the price of the main body is appropriated.

2) Spare Parts for Equipment and Materials which are Already Supplied Under the Japanese Grant Aid
Spare parts which are specified by the Republic of the Sudan shall be included upon request.

5.3.2 Plan for Equipment and Materials

The equipment and materials required for carrying out the Project in the first and second phases are as follows:

Item \ Phase	First phase (Quantity)	Second phase (Quantity)
(1) Rehabilitation of water yards, and water supply facilities which use surface water		
[Water yards]		
1) Casing pipe and screen for newly constructed well (14 wells)		
Casing pipe: ø6 5/8 inches	1.512 m	1.512 m
Screen: ø6 5/8 inches	168 m	168 m
Centralizer	112 sets	112 sets
2) Replacement of pumping machine (deep well pump and engine) 25 m^3/H x 60 m	9 sets	21 sets
3) Replacement of elevated tank 50 m^3 x 7.2 m (24 feet)	1 set	5 sets
4) Vehicles		
Pick-up: 4x4	1 unit	1 unit
Truck: 4x2, 7-8 tons	1 unit	-
Truck: 6x4, 12-15 tons	1 unit	-
5) Truck mounted type welding machine, generator, standard tools 50-270A . 8 kW, 10 kVA	1 unit	-
[Water supply facilities which use surface water]		
1) Replacement of pumping machine (water-intake pump and engine) 50 m^3/H x 60 m	2 sets	4 sets

Item \ Phase	First phase (Quantity)	Second phase (Quantity)
2) Replacement of elevated tank 50 m^3 x 7.2 m (24 feet)	1 unit	2 units
3) Replacement of transmission and distribution pipe (PVC) ø4 inches . 2,000 m	1 set	5 sets
4) Vehicles		
Pick-up: 4x4	1 unit	1 unit
Truck: 4x2, 7-8 tons	-	1 unit
Truck: 6x4, 12-15 tons	-	1 unit
5) Truck mounted type welding machine, generator, standard tools 50-270 A . 8 kW, 10 kVA	-	1 unit
(2) Construction of new water yards		
1) Casing pipe and screen (for 10 wells)		
Casing pipe: ø6 5/8 inches	1,080 m	1,080 m
Screen: ø 6 5/8 inches	120 m	120 m
Centralizer	80 sets	80 sets
2) Pumping machine (deep well pump and engine) 25 m^3/H x 60 m	3 sets	11 sets
3) Elevated tank and piping material (steel pipe) 50 m^3 x 7.2 m (24 feet)	3 sets	11 sets
4) Pump house and fence Standard type	3 sets	11 sets
5) Vehicles		
Truck: 4x2, 7-8 tons	1 unit	1 unit
6) Truck mounted type welding machine, generator, standard tools 50-270 A . 8 kW, 10 kVA	1 unit	1 unit

Item \ Phase	First phase (Quantity)	Second phase (Quantity)
(3) Construction of new water supply facilities (water supply facilities which use surface water)		
1) Pumping machine (water-intake pump and engine) 50 m^3/H x 100 m	4 sets	9 sets
2) Pumping machine (pump for water supply and engine) 25 m^3/H x 25 m	4 sets	9 sets
3) Elevated tank 50 m^3 x 7.2 m (24 feet)	3 units	10 units
4) Transmission and distribution pipe (PVC) ø4 inches . 2,000 m		
5) Vehicles		
Truck: 4x2, 7-8 tons	1 unit	1 unit
6) Truck mounted type welding machine, generator, standard tools 50-270 A . 8 kW, 10 kVA	1 unit	1 unit
(4) Equipment and materials required for construction of deep well		
1) Truck mounted type drilling machine (rotary type) ø3 1/2 I.F x max. 300 m	1 unit	-
2) Vehicles		
Truck: 6x4, 10-15 tons (with crane)	1 unit	-
Water tank truck: 6x4, 9,000 ℓ	1 unit	-
Fuel tank truck : 4x2, 4,500 ℓ	1 unit	-
Pick-up: 4x4	1 unit	-
Truck: 6x4, 12-15 tons	1 unit	-

Item \ Phase	First phase (Quantity)	Second phase (Quantity)
3) Vehicle mounted type electric logging system Depth of measurement: 300 meters or more	1 unit	-
4) Vehicle mounted type pumping test unit 25 m^3/H x 100 m	1 unit	-
5) Water-level measurement equipment (with electrode protection pipe) Depth of measurement: Max. 200 meters	1 unit	-
6) Electric-conductivity meter: Handy type	1 unit	-
7) pH meter: Handy type	1 unit	-
8) Truck mounted type air compressor 17.5 kgf/cm^3 x 21 m^3/min	1 unit	-
9) Air lift pipe, tools for development	1 set	-
10) Bentonite	60 tons	85 tons
11) Rock bit ø9 5/8 inches	15 pcs	21 pcs
(5) Spare parts required for operation and maintenance		
1) Spare parts required for the equipment and materials to be newly supplied	1 set	1 set

Item \ Phase	First phase (Quantity)	Second phase (Quantity)
2) Spare parts required for the machines and materials which were already supplied Drilling machine (rotary): TRD-300S Drilling machine (Percussion): SM-22T Servicing machine: MK-10SC Submersible pump: PMU Generator: DCA40A1 Generator: NEG-101-N0109BC P & G crane: T220 Cargo truck: TK-80G Engine: TS-155CE Pump: 3-140KS	1 set	1 set

CHAPTER 6 PROJECT EXECUTION PLAN

CHAPTER 6 PROJECT EXECUTION PLAN

6.1 Execution Plan

6.1.1 Execution System

Before executing the Project, the Mechanical Section of Research/Water Resources Department, and the Workshops/ Manufacturing Department in Khartoum city's headquarters of the NCDRWR will take the initiative on the Project execution and select a project manager from among the headquarter's officers as a person in charge on the Japanese project to execute the Project after discussion with the NCDRWR's director general and executive director. The organization of the national corporation is shown in Fig. 3. To execute the work under the project manager for the disaster restoration plan on existing water supply facilities in the Northern region, the regional office will organize well drilling teams (3 in number), facility construction teams (3) and water supply facilities teams using surface water (3), respectively as the teams specialized in construction and in executing the Project. The NCDRWR Regional Office located in Atbara of the Northern Region will be responsible for the actual control of materials/ machinery, the materials supply for the Provincial Office of the National Corporation in the Northern/Nile Province, and the decision on the Project sites and the dispatch of engineers/laborers belonging to the maintenance center.

However, the replacement of the spare parts required for the operation and maintenance of the machinery (well drilling rigs, servicing machines, pumps, vehicles and so on) already supplied by economical cooperation will

be controlled through the Supply Department of the National Corporation headquarters.
The Supply Department will supply directly the spare parts to the National Corporation Regional Office of each region. The Regional office, moreover, will supply the spare parts of their holding machinery to the provincial offices.

6.1.2 Execution Plan

The Project is executed by division into the first and second phases owing to the Project scale.
The Project has to supply equipment and materials needed for executing the Project, and materials available in the Sudan shall be procured all within the Sudan, and all of other equipment and materials are contained in the Project planning. After the equipment and materials shall be unloaded and passed through the customs at an international trade port (Port Sudan City) which is located in the Eastern Region and faces on the Red Sea, the ones for the disaster restoration plan on existing water supply facilities in the Northern Region shall be transported by trucks from Port Sudan City to Atbara City by land and shall be delivered at the Regional Office of the NCDRWR in Atbara City. And, the spare parts for operating and maintaining the machineries already supplied will be transported by trucks from Port Sudan to the National Corporation headquarters in Khartoum City and kept in the headquarter's storage house and yards.

6.1.3 Execution Schedule

The execution of the Project will begin with the conclusion of the Exchange of Notes (E/N) between the Japanese Government and the Sudanese Government and end on the delivery of equipment and materials through the process, including Detailed Design, Tender, procurement of equipment and materials, overseas transportation, customs clearance, inland transportation from Port Sudan to Atbara in the Northern Region (the equipment and materials for the disaster restoration plan on existing water supply facilities in the Northern Region) and from Port Sudan to the headquarters in Khartoum City (spare parts for operation and maintenance of equipment previously supplied).

The Project shall be executed through each similar process for the first and second phase. The Detailed Design, after the conclusion of E/N between the two countries, shall be entered into contract and between a Japanese consultant and the Sudanese Government, the Detailed Design Documents including the determination of the detailed specifications required for equipment and materials supply, and that of the detailed executive plan by the Sudanese Government itself and so forth will be prepared.

On the Tender, Contract and Supervising work, after the conclusion of E/N between the two countries, the Supervising work shall be contracted between such consultant and the Sudanese Government, the consultant approved by both governments will invite to bid the contractors for the Project. The successful bidder will put the plan into practice after the signing of the contractor's contract with the Sudanese Government and the subsequent verification on contract by the Japanese

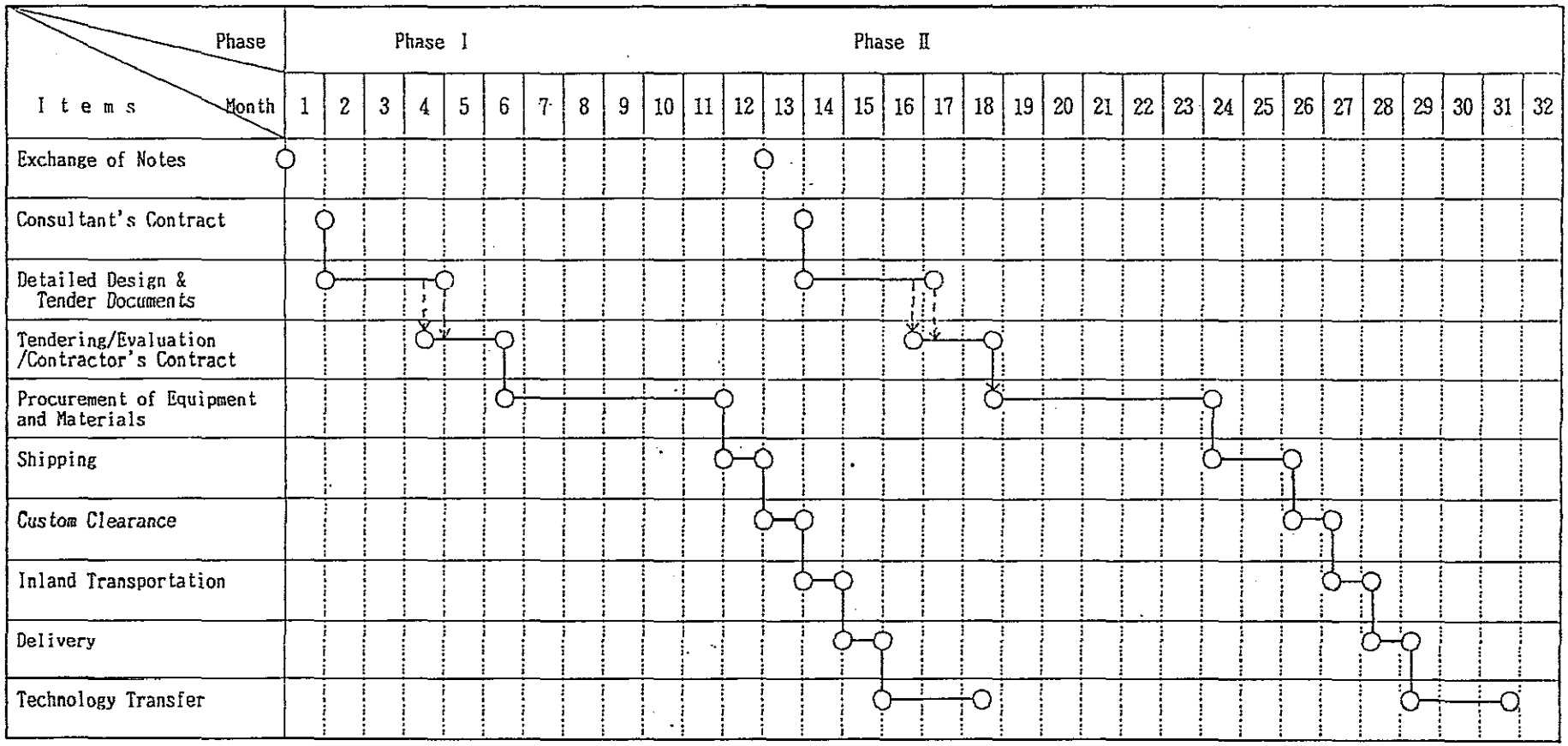
Government. The Sudanese Government shall perform such procedures as Custom Duties and Sales Tax and varieties of tax exemptions for Japanese corporations and Japanese nationals before the arrival of the equipment and materials transported to Port Sudan.

It is estimated that Detailed Design Study requires a period of 3 months, Tender/Contractor's contract about 1.9 months and the procurement to delivery of equipment and materials about 9.5 months, respectively.
The total execution schedule for the Project which these were taken into consideration is shown in Fig. 6.

6.2 Estimated Project Cost

After the plan is executed and equipment and materials are delivered, the execution agency of the Project (NCDRWR) shall execute the rehabilitation of existing water supply facilities for the disaster restoration in the Northern Region or the new construction of the water supply facilities with equipment and materials supplied. In this case, the salaries for engineers employed (civil engineers, mechanics, welders, drivers and laborers, etc.), the fuel charge for power supply (diesel oil), other expendables, the general management expenses and so forth will be the burden of the Sudanese Government's operational expenses.

Fig. 6 Implementation Schedule of the Project for the Improvement of Rural Water Supply after E/N (Plan)



The construction costs are shown as follows:

(1)	Construction of water well	LS 52,500/well (¥1,499,400)
(2)	Contruction of water yard	LS 57,500/facility (¥1,642,200)
(3)	Replacement of pump/engine for water supply facility	LS 7,850/place (¥224,196)
(4)	Replacement of pipe/pipe fitting	LS 28,500/place (¥813,000)
(5)	Replacement of elevated tank	LS 18,600/place (¥531,216)
(6)	Construction of water supply facility utilizing surface water	LS 209,000/place (¥5,969,040)

The Sudanese Government's share needed for the execution of the Project, therefore, in accordance with the Sudanese Government's executive plan is shown in the following table.

The Sudanese Government's Share needed
for the Execution of the Project

Items \ Phase	First phase	Second phase
(1) Construction of water well substituted for water yards (#14) Construction of new water yard water well (#10)	12# (LS 630,000) (¥17,992,800)	12# (LS 630,000) (¥17,992,800)
(2) Rehabilitation of water yards Construction of water yards (except water well) (Shift of villages damaged by floods) Details Water yards	13 places (LS 261,750) (¥7,475,580)	28 paces (LS 610,350) (¥17,431,596)
Replacement of pumps/ engines	9 places	17 paces
Replacement of elevated tanks	1 place	4 places
Construction of water yards (except water well)	3 places	7 places
(3) Rehabilitation of water supply facilities using surface water Details	7 places (LS 689,800) (¥19,700,688)	15 places (LS 1,619,150) (¥46,242,924)
Replacement of pumps/engines	2 places	3 places
Replacement of elevated tanks	1 place	1 place
Transmission and distribution pipes	1 place	4 places
Construction of water supply facilities	3 places	7 places
Total	LS 1,581,550	LS 2,859,500
	¥45,169,068	¥ 81,667,320
Ground total	LS 4,441,050	
	¥126,836,388	

The costs to be borne by the Sudanese Government for the execution of the Project are (LS 1.58 million: ¥45.17 million) for the first phase and (LS 2.86 million: ¥81.67 million) for the second phase, and these expenses are considered a sufficiently small amount of budget scale compared with the development budget (1988/89, LS 136 million: ¥126.84 million) of NCDRWR described in (2) the financial conditions of the second chapter 2.2.2 operation state and financial conditions and within the development budget bearing capacity of the Sudanese government.

6.3 Technology Transfer Plan

The technology transfer plan will be enforced to guide how to operate and maintain machinery after the delivery of the equipment and materials to the Sudanese Government. The assignment for technical guidances will be a total of three persons, a mechanical engineer (one person, 1.0 month), a well drilling engineer (one person, 1.5 months) and a hydrogeologist (one person, 1.5 months). After the delivery of equipment and materials supplied accompanied by the execution of the Project to the Sudanese Government is completed, the mechanical engineer will guide local engineers and workers for a period of one month on the methods of operation and maintenance of such machinery as well drilling machines, compressors and generators. After that, with the start of the construction work using equipment and materials supplied to local engineers, the well drilling engineer and hydrogeologist will guide the methods of well drilling and treatment of equipment for well logging in the construction site for a period of 1.5 months. The dispatched engineers, however, will not be directly responsible for the enforcement/progress on the construction work and will be dispatched only for the technical guidance. The consultants will stay on the

field for a period one month after the delivery of materials and machinery, coordinate between the dispatched engineers and NCDRWR, and also guide the engineers to the field site in the Northern Region. The term of the technology transfer is shown in the working schedule on the Detailed Design and Supervising of Fig. 6.

CHAPTER 7 OPERATION AND MAINTENANCE PLAN

CHAPTER 7 OPERATION AND MAINTENANCE PLAN

7.1 Operation and Maintenance System

The equipment and materials for the disaster restoration plan of existing water supply facilities in the Northern Region after the delivery of the equipment will be managed jurisdictionally by the NCDRWR Regional Office. The Regional office of the National Corporation holds eight maintenance centers (Yugoslavian loan project, 1979 ∿ 88) in the Nile Province/the Northern Province, and each center takes charge of the maintenance of the holding machinery and existing water supply facilities in the territorial jurisdiction.

For the typical example, the Al Matamma maintenance center in the Shandi District of the Northern Region has technical employees comprising senior engineers (3), foremen (5), technicians (10) and laborers (50), holds repair equipment containing a generator with diesel engine (90 kVA, 1), sawing machine (1), lathe (1), milling machine (1), radial drilling machine (1), compressor (7.5 ∿ 10.5 kgf/cm^2, 1), and grinder (1). The other maintenance centers, moreover, hold presses (hydraulic), shapers, drilling machines, welders, cutting machines and cranes (indoor large and small type), have the system matching almost the requirement on machining/repairing of machinery.

And, each maintenance center, although there are differences due to the territory, controls 40 to 70 of the water yard facilities/water supply facilities using surface water and has water yard operators (in Al Matamma, 85 operators). Each center, moreover, because of a manpower shortage by only the national corporation's employees, selects operators from among applicants of

village inhabitants, conducts the education of operation and maintenance and has them undertake operation and maintenance of water supply facilities in villages.

And each maintenance center holds considerable numbers of trucks, pick up, and jeeps or the like for the operation and maintenance of water yards and the transport of materials/machineries/laborers.

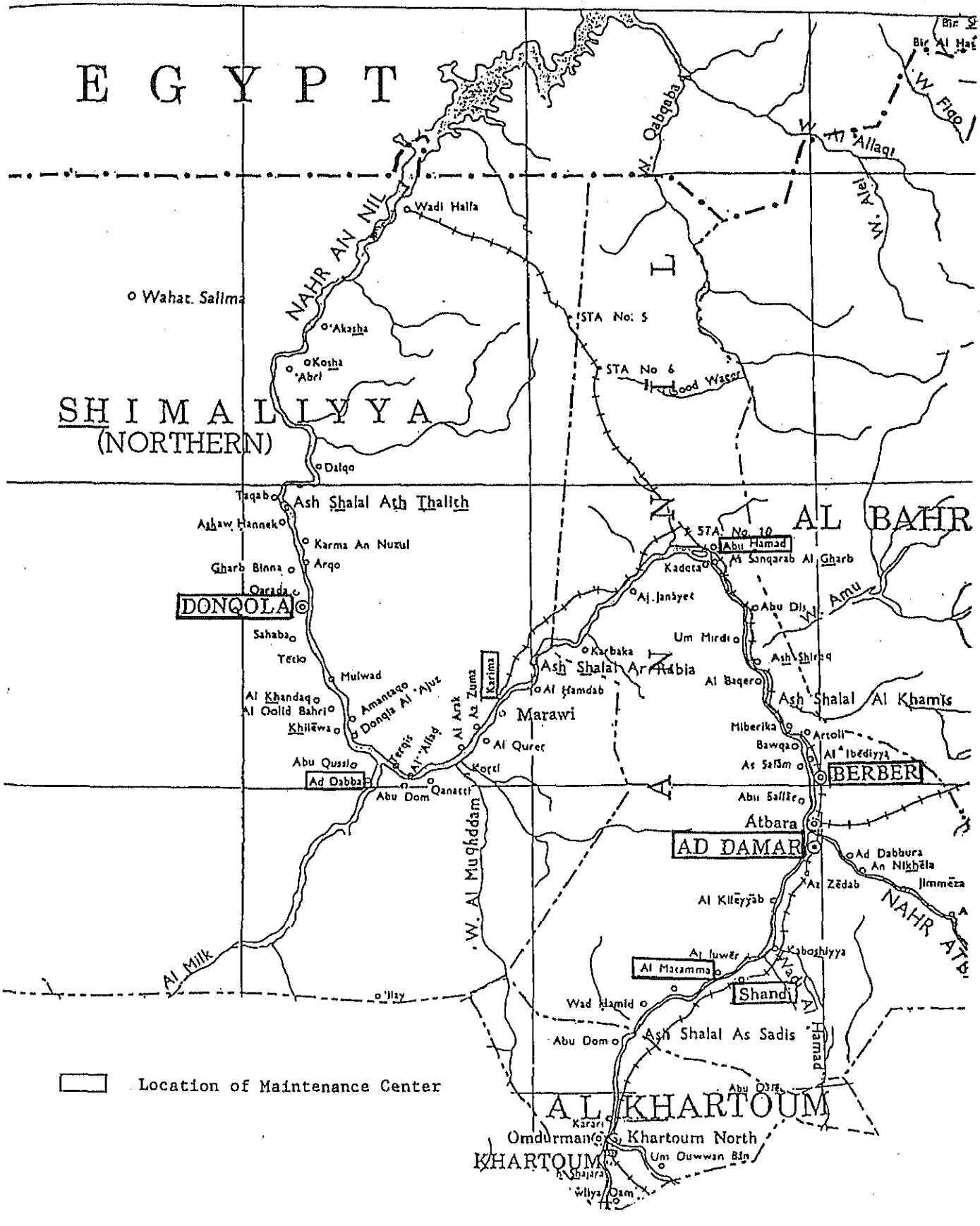
The maintenance centers' locations in the Northern Region are shown in Table 5 and Fig. 7.

Table 5 The Maintenance Centers' Locations in the Northern Region

Name of province	Maintenance centers' location
Nile province	Shandi
	Matamma
	Ad Damar
	Berber
	Abu Hamad
Northern province	Karima
	Ad Dabba
	Donqola

In region-level maintenance centers, on the repair of machinery, although the conventional scale repairs including replacement of spare parts and overhauls are treated, on the larger-scale repair and rebuilding of machinery, damaged machinery are carried to a workshop attached to the NCDRWR headquarters located in Khartoum City and repaired.

Fig. 7 Location Map of Maintenance Center, NCDRWR in Northern Region



The headquarters' repair shop is installed with headquarters' office buildings and materials/machinery yard in an extensive site and composed of a large scale processing/assembly plant and welding plant. The center has 28 personnel including senior engineers (8), general engineers (18) and other technicians/laborers. And the processing/assembly plants equipment for machining/assembling/repairing includes lathes (8), milling machines (3), boring machines (4), shaper (1), shearing machines (2), drilling machines (2), sawing machine (1) and 50 tons crane (2), and are machining drill collar screws (pin) for well drilling and engine cylinder bores. And the welding plant has four sets of welders and was building the water tank part of an elevated tank of 50 m^3 with steel sheets and steel materials.

After the supply of materials was enforced, the maintenance of water supply facilities completed shall be managed by the maintenance system as mentioned above.

The maintenance system in the Central, Kordofan, Darfur and Eastern regions, where the replenishment of spare parts for the operation/maintenance on existing machineries is planned, is also identical to the case of the Northern Region.

7.2 Operation and Maintenance Expenses

The operation/maintenance expenses for existing water supply facilities in the Northern Region are not collected normally and the total amount is born by the NCDRWR or the Regional Local Government. The operation of water supply facilities including water yards is conducted by three persons: a clerk, an operator, and a guard. The labor cost for these persons and fuel charge are the main

maintenance expenses, the labor cost is some LS 12,000/year (about ¥340,000). The fuel charge varies with the specifications of water intake or booster pumps used at each water supply facility. The pump specifications and fuel charges at each water supply facilities are as follows:

(1) Water Yards (substituted water well construction sites/new construction sites)

1) Deep well pump, engine

Pump specifications	Engine specifications
Q = 25 m^3/hour	H = 60 HP
H = 60 m	N = 1,800 rpm
HP = 14 HP	

Fuel charge = LS 12,045/year

Maintenance expenses = Labor cost + fuel charge

= LS 24,045/year, facility x 48 sites

= LS 1,154,160

= ¥32,974,351

(2) Water Supply Facilities Using Surface Water (rehabilitation)

1) Intake pump, engine

Pump specifications	Engine specifications
Q = 50 m^3/hour	H = 20 HP
H = 60 m	N = 1,800 rpm
HP = 20 HP	

Fuel charge = LS 26,098/year

Maintenance expenses = Labor cost + fuel charge

= LS 38,098/year, facility x 10 sites

= LS 380,980

= ¥10,884,598

(3) Water Supply Facilities Using Surface Water (new)

1) Intake pump, engine

Pump specifications	Engine specifications
Q = 50 m^3/hour	H = 31 HP
H = 100 m	N = 1,800 rpm
HP = 31 HP	

Fuel charge = LS 40,953/year

2) Booster pump, engine

Pump specifications	Engine specifications
Q = 25 m^3/hour	H = 6 HP
H = 25 m	N = 1,800 rpm
HP = 6 HP	

Fuel charge = LS 4,818/year

Maintenance expenses = Labor cost + fuel charge
= LS 57,771/year, facility x 10 sites
= LS 577,710
= ¥16,505,174

Total maintenance expenses = LS 2,112,850
= ¥60,364,124

These maintenance expenses are equivalent to about 16% of LS 13,000,000 (¥371.28 million), NCDRWR's operation and maintenance budget in 1988/1989. These expenses are born by the NCDRWR/the Regional Local Government.

CHAPTER 8 PROJECT EVALUATION

CHAPTER 8 PROJECT EVALUATION

8.1 Beneficiary

A total of 68 sites (number of executing sites) will benefit from the Project: (1) the rehabilitation sites (48 sites) for existing water supply facilities damaged by flood, and distributed in Shandi, Ad Damar, Berber, Seedon, Karima, Donqola, Abri, and Dulgu Areas in Northern Region, (2) the newly settled sites (20 sites) of water supply facilities accompanied by the evacuation of flood-damaged villages.

The population benefitting from the Project is 387,000 (the total population of the villages planned for the Project). This is shown in Table 6 in detail. And, as for the spare parts replenished for the operation and maintenance of materials already supplied, the reinforcement of the construction systems on water supply facilities by the NCDRWR is the main focus for the execution of the Project.

Table 6 Beneficiary of the Project

Number of Project sites	Beneficiaries	
	(1)	(2)
(1) Rehabilitation of existing water supply facilities (Water yards/replacement of pumps, elevated tanks etc. of water supply facilities using surface water)		
43 sites	207,000 people	95,520 people
(2) Rehabilitation of existing water supply facilities (Construction of water wells substituted for water yards)		
14 sites	95,000 people	27,860 people
(3) Construction of water yards		
10 sites	63,000 people	19,900 people
(4) Water supply facilities using surface water		
10 sites	22,000 people	22,000 people
Total	387,000 people	165,280 people

Note: In the beneficiary,

(1) The total population of Project sites

(2) As described in "Chapter 2, 2.3 Damage Caused by the Heavy Rain and Flood, 2.3.1 Damage of Water Supply Facilities and Necessity of Reconstruction, (2) Necessity of Reconstruction", the beneficiaries are calculated from the water supply capacity of facilities.

The population for water supply facilities using surface water was calculated from the capacity of intake and booster pumps.

8.2 Appropriateness and Feasibility of Executing the Project

The area damaged by floods covers all districts in the Northern Region as shown in Fig. 5. Eighty-two (82) sites (containing two new sites to the 80 sites noted by the World Bank Report) corresponding to about 38% of the 214 existing water yard facilities in the Northern Region were badly damaged by floods. The Project consists of the following construction items: (1) the construction of wells substituted for water yards, (2) the replacement of pumps and elevated tanks, (3) newly constructed water yards, (4) construction of new water supply facilities using surface water.

At the sites where these water supply facilities were damaged by floods, mainly shallow groundwater of traditional hand dug wells or dirty water of the Nile (including clay/organic matters) is used. As described in the item "Chapter 2, 2.3.1 the damage of water supply facilities and the necessity of reconstruction, (2) the necessity of restoration", the water supply will still be deficient even after the execution of this Project. In many villages, however, facilities capable of supplying safe drinking water are completed and even a small amount of water volume will come to be supplied.

In the selection of equipment and materials included in the Project, attention was paid so as to have high adaptability regarding to the specifications of existing water supply facilities in the NCDRWR, the designs of standard facilities and the natural conditions such as topography, geology, and groundwater in the field.

CHAPTER 9 CONCLUSION AND RECOMMENDATIONS

CHAPTER 9 CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

The heavy flooding caused by the overflowing of the Nile that hit the Northern Region of the Republic of the Sudan in August to September 1988 damaged the whole residential area distributed only along the Nile. The inhabitants, even in the term when we surveyed the field for the Basic Design, cannot recover from the flood disaster by themselves and are forced to camp out with houses and existing water supply facilities remaining damaged. In villages with existing facilities damaged, the inhabitants use the Nile's dirty water and shallow groundwater of traditional hand dug wells subject to contamination by the infiltration of polluted water from the ground surface. And, parts of villages damaged by floods are already shifting to the hills in the desert zone behind alluvial low lands on the Nile's river bank for fear of another flood disaster in the future. Therefore, urgent implementation of the restoration plan for the flood disaster is necessary.

The Project focuses on supply equipment and materials needed for rehabilitation and construction of water supply facilities, and for the restoration plan of existing water supply facilities damaged in the Northern Region. In this case, the Sudanese Government comes to conduct the construction of water supply facilities using the equipment and materials supplied. In the judgement of the feasibility for execution of the Project, the following points of view shall be the most important key point: the capability of the organization and system for execution of the Project and the maintenance ability by the Government. Concerning these points, the NCDRWR office in charge of executing the Project has a considerably steady

organizations, enforcing ability, and maintenance ability. And, the execution agency's cost for the execution of the construction work after the delivery of equipment and materials is borne by the National Corporation and the Regional Local Governments, the amount is concluded to be sufficiently capable to be borne, judging from the budjet scale for the development of the National Corporation.

Construction machinery and transportation vehicles are supplied through this Project, and the Sudanese Government's system for constructing water supply facilities will be greatly reinforced. And, 68 sites of water supply facilities are to be rehabilitated and newly established, the population benefitted will reach 387,000 (the total population of projected sites), and the Project's enforcement will bring great effects.

From the matters mentioned above, the enforcement of this Project is considered sufficiently valid and effective.

9.2 Recommendations

In execution of the Project, the following are recommended for the efficient and smooth implementation of the Project:

(1) Owing to the natural conditions in the Northern Region, the terms capable of constructing facilities by the Sudanese Government are limited to about six months of the winter season (generally December to May). Therefore, the procedures such as customs clearance, inland transportation, and delivery of the equipment and materials after its arrival at Port Sudan need to be conducted smoothly for saving the period until the implementation date of the construction work, and also, it is necessary that

the preparation for the construction work be carried out quickly, efficiently and systematically. Moreover, strong assistance of Port Sudan City's Branch Office of the NCDRWR for smooth customs clearance is necessary. And, both of the national corporation's headquarters and the Regional Office must closely communicate with each other and form a strong system for executing the Project.

(2) In this plan for equipment and materials, spare parts for about two years of operation are estimated to be needed. Spare parts volume for two years of operation is of the minimum level-range necessary.

Moreover, for the operation and maintenance of the machinery after the achievement of the construction work, necessary spare parts must be replenished in the future. During the surveying period for the Basic Design, the Team founded many cases of which machinery owned by the NCDRWR was in a non-operating conditions due to a shortage of spare parts. Therefore, especially, the emphasis is put on the replenishment of spare parts which will be needed during a long period in the future.

(3) At present, each village in the Sudan usually owns only one or two water supply facilities, of which the capacity for water supply per facility is limited to less than 2,000 persons. However, most of the villages have a much larger population in comparison to the water capacity. Therefore, the general water supply condition is still in the low-supply level.

Consequently, the further improvement of the rural water supply condition is hoped to be conducted also in the future in the Central, Kordofan and Darfur, and Northern Regions. Therefore, the new projects subsequent to the Project for improvement of the rural water supply are desired to be created and planned. For the realization of the new Project, the strong assistance of the Japanese Government in the future will be necessary.

APPENDIX

Appendix 1 Members of the Study Team

The survey team consists of the following members:

1.	Team Leader	Takuya SATOU	Chief, Construction Office, Construction Dept, Nagoya City Water Supply Bureau
2.	Water Supply Planning	Tamio KOTAKA	Nippon Jogesuido Sekkei Co., Ltd.
3.	Water Supply Facilities	Kenji TAKAYANAGI	Ditto
4.	Equipment and Material Planning	Susumu SAKURAI	Ditto

Appendix 2 Itinerary of Field Survey

The itinerary of the study team is shown in Table 1 attached herewith.

Itinerary of Field Survey

No.	Month/Date	Day	Place	Activities	Remark
1	Jan/25	Wed	Inflight	Departure, Tokyo Arrival, Paris	
2	26	Thu	Inflight	Departure, Paris	
3	27	Fri	Khartoum	Arrival, Khartoum	
4	28	Sat	Khartoum	Coutesy Call to Japanese Embassy, MFEP	
5	29	Sun	Khartoum	Meeting with NCDRWR	
6	30	Mon	Khartoum	Meeting with NCDRWR	
7	31	Tue	Khartoum	Meeting with MIWR & NCDRWR	
8	Feb/ 1	Wed	Khartoum	Meeting with NCDRWR	
9	2	Thu	Khartoum	Discussion on Minutes	
10	3	Fri	Khartoum	Inner meetng of Team, arrangement of data	
11	4	Sat	Khartoum	Explanation of Minutes to the Japanese Ambassador	
12	5	Sun	Khartoum	Singing of Minutes	
13	6	Mon	Central R	Trip from Khartoum to center R Visit of Regional office (Wad Madani), NCDRWR	
14	7	Tue	Central R	Trip from Khartoum to Central R Visit of Provincial offce in Nile Province (Sinnar)	
15	8	Wed	Khartoum	Inner Meeting of Team	
16	9	Thu	Northern R	Trip from Khartoum to Northern R, Visit of Shandi Maintenance Center	
17	10	Fri	Northern R	Trip from Shandi to Atbara, Visit of Matamma Maintenance Center	
18	11	Sat	Northern R	Visit of Northern Regional Office (Atbara)	
	12	Sun	Northern R	Trip from Atbara to Marawi	
20	13	Mon	Northern R	Survey on Existing water Supply Facilities damaged by flood	
21	14	Tue	Northern R	Trip from Marawi to Korti	
22	15	Wed	Northern R	Trip from Korti to Khartoum	
23	16	Thu	Khartoum	Meeting with NCDRWR	
24	17	Fri	Khartoum	Inner Meeting of Team	

No.	Month/Date	Day	Place	Activities	Remark
25	18	Sat	Khartoum	Meeting with NCDRWR & MFEP, Reporting the result of survey to Japanese Embassy	
26	19	Sun	Kordofan	Trip from Khartoum to El Obeid, Kordofan Region	
27	20	Mon	Kordofan	Visit of Regional office(El Obeid), Kordofan Region	
28	21	Tue	Khartoum	Trip from El Obeid to Khartoum, Survey of UNICEF Project	
29	22	Wed	Khartoum	Meeting with NCDRWR & MFEP, Visit of West Germany & Netherland Embassy	
30	23	Thu	Khartoum	Meeting with NCDRWR, Visit of UNICEF office	
31	24	Fri	Khartoum	Inner Meeting of Team	
32	25	Sat	Khartoum	Meeting with RCDRWR, Reporting the final result of survey to Japanese Embassy	
33	26	Sun	Inflight	Departure, Khartoum Arrival, Frankfurt	
34	27	Mon	Inflight	Departure, Frankfurt	
35	28	Tue	Tokyo	Arrival, Tokyo, Narita	

Appendix 3 List of Competent Individuals Interviewed

Ministry of Finance and Economic Planning

①	Dr. El Tigany El Tayib	Ministry of Finance State Minister
②	Mr. Omer Abdel Salam	Ministry of Finance and Economic Planning Director of Energy & Mining
③	Mrs. Elsham Abdalla	MFEP Assistant Director of Enegy & Mining
④	Mr. Mohamad Saeid Abdala	MFEP Inspector Loans and Technical Assistance
⑤	Mr. Salah Mohamed Ahmed	MFEP Inspector Sector

Ministry of Irrigation and Water Resources

⑥	Mr. Mohamed Bashier Gomaa	Minister of Irrigation & Water Resources

National Corporation for Development of Rural Water Resources

⑦	Mr. Lutfi Wohdan	NCDRWR Director General
⑧	Mr. Abbas hamza	NCDRWR Chief of Mechanical Division
⑨	Mr. M.S. Ibrahim	NCDRWR Northern Region, Regional Director
⑩	Dr. Mohamed Sharief	NCDRWR Chief of Research and Water Division
⑪	Mr. Osman Mohamed Taka	NCDRWR Advisoring Engineer

⑫	Mr. Mohamed Elfaki	NCDRWR Nothern Region, Chief of Department
⑬	Mr. Amer Ahmed Mohamed	NCDRWR Chief of Drilling Division

Embassy of West Germany

⑭	Mrs. Bogemann-Hagedorn	West Germany Embassy

Embassy of Metherland

⑮	Mr. H. Lille-lund	Netherland Embassy

United Nations

⑯	Mr. T. ekvall	UNICEF

Embassy of Japan

⑰	Mr. Hikaru Oka	Ambassador Extraordinary and Plenipotentiary
⑱	Mr. Toshio Kaneko	First Secretary
⑲	Mr. Yoshihiko Satou	Second Secretary

Appendix 4 Minutes of the Meeting

MINUTES OF DISCUSSION ON THE BASIC DESIGN STUDY ON THE PROJECT FOR THE IMPROVEMENT OF RURAL WATER SUPPLY IN REPUBLIC OF THE SUDAN

In response to the request made by the Government of the Republic of the Sudan for the Project for the improvement of Rural Water Supply (hereinafter referred to as "the Project") the Government of Japan decided to conduct a Basic Design Study on the Project, and the Japan International Cooperation Agency (JICA) sent the Basic Design Study Team (hereinafter referred to as "the Team") headed by Mr. Takuya SATOU, Chief of Construction Office, Construction Department, Nagoya City Water Supply Bureau, from January 25 to February 28, 1989.
The Team had a series of discussions with the authorities concerned of the Government of Republic of the Sudan, Headed by Lutfi M.S. Wahdan Director General of National Rural Water Corporation, and will conduct a field survey to the Northern, and Central, and Kordofan Region.

As a result of the Study, both parties have agreed to recommend to their respective Governments that the major points of understandings reached between them as attached herewith should be examined towards the realization of the Project.

Khartoum, February 5, 1989.

Takuya Satou

Takuya SATOU
Team Leader of Basic Design Study Team

Lutfi Moh. Saeed Wahdan
Director General of
National Rural Water Corporation

5.2.89. Omer Al Salam

OMER ABDUL SALAM
Deputy Undersecretary.
Ministry of Finance and Economic Plan

ATTACHMENTS

1. The objective of the Project is to improved and restore the existing water supply systems damaged by flood disaster and rainstorm and to construct new water supply facilities for Re-settlement in Northern Region.

2. The project area is in the Northern region which is shown in Fig. 1.

3. National Rural Water Corporation (NRWC) will be responsible for administration and excution of the Project.

4. A request of the Government of Republic of the Sudan listed in Annex II was submitted to the team.

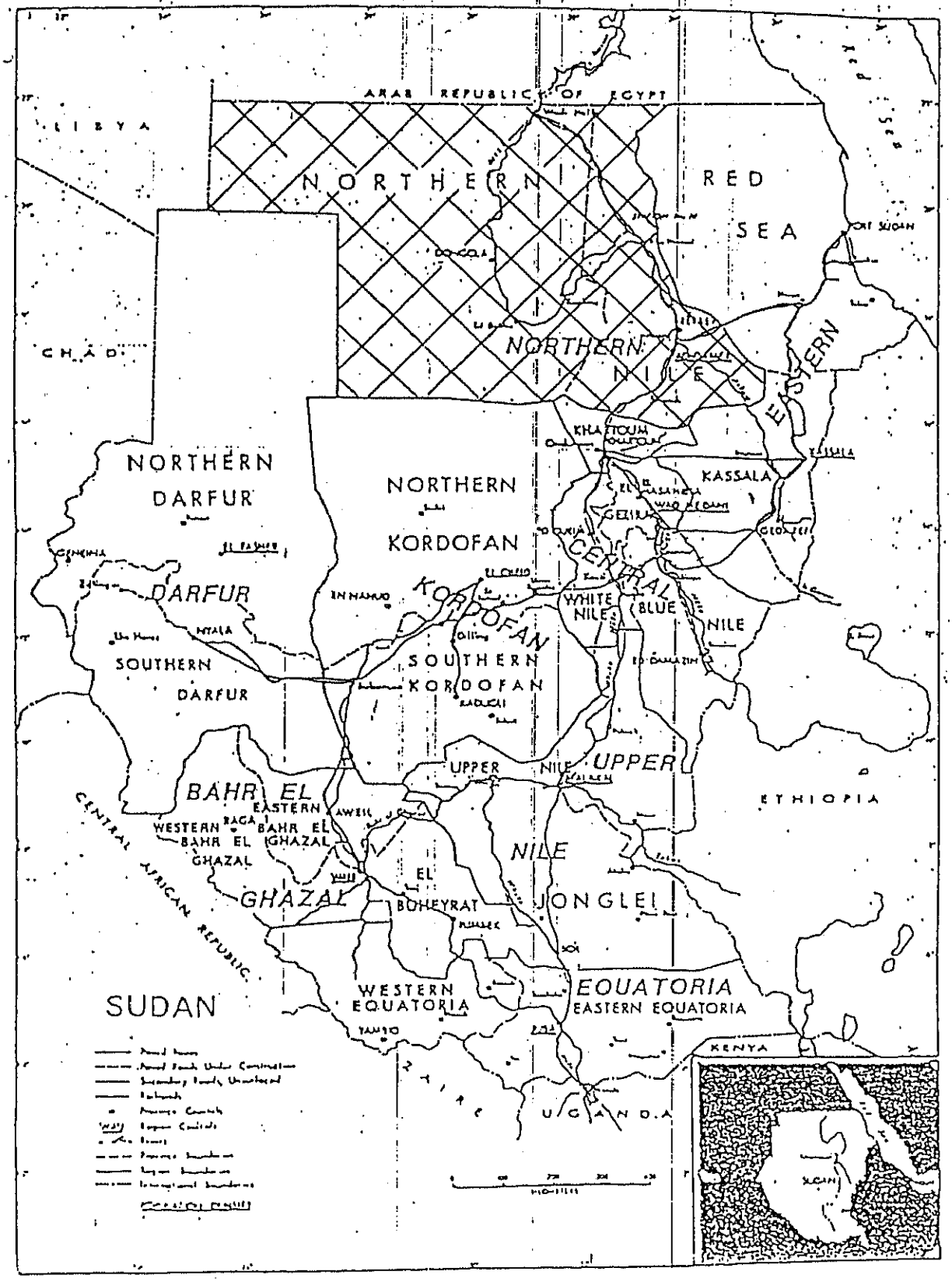
5. The Government of the Sudan understood Japan's Grant Aid System as explained by Team.

6. The Government of the Sudan will take nesessary measures listed in Annex III on condition that Grant Aid by the Government of Japan is extended to the Project.

7. Training of Sudanese tech. staff will be considered to be carried by Japanese experts in the Sudan during the execution of the Project.

ANNEX I

FIG. 1 PROJECT AREA



ANNEX II.

Major equipment & materials requested by the Government of Republic of the Sudan.

(1) Rehabilitation Equipment and Materials for Northern region.

A. Rehabilitation Equipment and Materials

1. Casing & Screen for Replacement.
2. Pump Sets
3. Water Tanks
4. Viehicles for Transportation.

B. Improvement Equipment and Materials

1. Drilling Rig
2. Viehicles for Transportation
3. Borehole Test unit and Equipment
4. Drilling Equipment and Materials
5. Development unit and Equipment.
6. Geophysical unit and Equipment

C. Construction Materials for Water Yards

1. Pump Sets
2. Water Tanks
3. Viehicles for Transportation
4. Construction Materials

D. Construction Materials for Surface Water Schemes

1. Pump Sets
2. Water Tanks
3. Construction Materials
4. Viechiles for Transportation.

(11) Spare Parts for Operation and Maintenance

A. Spare parts for :-

1. Drilling Rig
2. Servicing Machine
3. Pump Sets
4. Generating Set
5. Viehicles for Transportation

ANNEX III.

UNDERTAKINGS BY THE GOVERNMENT OF SUDAN.

1. To ensure prompt unloading, tax exemption and customs clearance at port of disembarkation and prompt internal transportation therein of the products purchased under the grant.

2. To exempt Japanese nationals engaged in the Project from customs duties, internal taxes and other levies which may be imposed in Republic of the Sudan with respect to the supply of the products and the services under the verified contracts.

3. To accord without delay to Japanese national whose services may be required in connection with the supply of the products and services under the verificed contract which may be necessary for their entry into Republic of the Sudan for the performance of their work.

4. To bear all the expenses, other than those to be borne by the grant, necessary for the improvement and reconstruction of existing water supply systems damaged by flood disaster and rainstorm, and for operation and maintenance of existing equipment and materials provided by the scheme of Japanese Grant Aid in times past.

5. To ensure necessary budget and personnel for proper and effective operation and maintenance of equipment provided under the grant.

6. To bear the commissions to the Japanese foreign exchange bank for the banking services based upon the banking arrangement.

Appendix 5 List of Collected Data

1) Sudanese Businessman Directory

2) Administrative Reforms and Developing Planning in The Sudan (1956~1975)

3) Sudan in Africa

4) The Four Year Salvation Recovery & Development Programme
(1988/89 ~ 1991/92) Copy

5) Geological Map of the Sudan (1:2,000,000)

6) Topographical Map Khartoum (1:1,000,000)

REPUBLIC OF SUDAN

MINISTRY OF FINANCE & ECONOMIC PLANNING

(PLANNING)

THE FOUR YEAR SALVATION, RECOVERY AND DEVELOPMENT PROGRAMME 1988/89 - 1991/92

VOLUME I

JULY 1988

1. OBJECTIVES

2.01. This four-year Salvation, Recovery and Development program aims to address the immense inherited problems facing the present Government in a systematic and comprehensive way. The basic objectives of the Program will be:

(i) Inspiration and stimulation of the patriotic spirit and the sanctity of work.

(ii) A GDP average growth rate not less than 5% per annum.

(iii) Provision of basic needs in respect of food, water, clothing, shelter, security, health, education, and transport.

(iv) Food security for rural and urban populations.

(v) Social justice through reduction of disparities in income and wealth.

(vi) Progress to be made towards balanced regional development, with emphasis on less developed regions.

(vii) Formulation of post-war development programme for the Southern Region taking into full consideration the extra-ordinary conditions pertaining to that region.

2.02. The attainment of these objectives will require due emphasis being given to:

(a) Vertical development and full utilization of existing capacities.

(b) Maintenance and rehabilitation of existing projects.

(c) Development of the traditional sector.

(d) Infrastructure development and maintenance, particularly energy, transport and telecommunications.

(e) Sectoral balance which would realize the optimum utilization of resources.

(f) Prevention of further environmental degradation.

(g) Steady progress to realize economic stability by encouraging savings and investments.

(h) Revitalization of the production and investment activities of the private sector, so it can play an effective role in the development process.