Chapter 2. Contents of the Project

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2-1 Basic Concept of the Project

2-1-1 Objectives of the Project

The government of Egypt planed to improve and to strengthen the domestic agricultural structure in the purpose of improving food demand-and supply balance of the country and increasing agricultural production.

The agriculture in Egypt totally relies on the Nile River as an irrigation water resource, but the irrigation facilities are deteriorated by aging and aren't able to provide sufficient irrigation water. Therefore, the government has prepared the long-term rehabilitation plan, which plans to modernize the irrigation facilities.
The upper Egypt region has a high potential for increasing agricultural productivity, where the government focuses on the development. In the New Valley region, the largest agricultural land reform project in the country, whose area is 210,000 ha, is implemented.

This project are to improve and rehabilitate five floating pomp stations in the upper Egypt, which require urgent implementation, to provide a maintenance barge in order to supply irrigation water with stability, to increase the irrigated area from 7,620 feddan to 10,400 feddan, to expand cropping area, and to augment 18% of farmers' income in the area.

2-1-2 Outline of the Project

The project will be implemented in Asfun area of Aswan Governorate and Luxol area of Quena Governorate in the Upper Egypt to achieve the targets mentioned above. The following five (5) floating pump stations will be improved and rehabilitated.

- Sahel Alakaba Kebli pump station (Aswan)
- Al Rakikin Sahel pump station (Aswan)
- Blowkher pump station (Aswan)
- El Ghorera (Luxor)
- El Biadiea El Ollia (Luxor)

The project components are composed of providing equipments necessary for replacement for the five (5) floating pump stations, and also providing fund to procure a maintenance barge.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Planning Design to Natural Conditions

(1) Considerations on Climate

Considerations for High Temperature and Storm

The maximum temperature reaches 51℃ in summer in the region. Moreover, sandstorm occurs between April and May. The following considerations are to be given:

1） wall material with heat insulation nature,
2） adequate ventilation, and
3） equipment to be shaded from direct sunshine.

All pump stations under Phase (Ⅰ) and Phase (Ⅱ) are designed paying due consideration on the above matters. Therefore, Phase (Ⅲ) project will also apply the same considerations.

2-2-1-2 Considerations on Flow Regime of the Nile River

Considerations for Fluctuation of Water Level

Discharge of the Nile varies by season, and its water level fluctuates largely by season. Water level difference between the maximum and the minimum water levels reaches as much as 4m. Pump head therefore has to be designed in consideration of fluctuation of water level.

Considerations for Floating Weeds

Plenty of weeds are flowing down in the Nile River. Pumps are to be protected from these weeds.

Consideration for Surges

Large-scale passenger boats frequently navigate in the Nile River. These boats cause surges to the floating pump stations. Surges become larger when ship route gets close to the pump station. It is necessary to anchor the barge as stable as possible, while joint pipe between the discharge pipe and the discharge tower designed is fixed to be flexible.

2-2-1-3 Social Conditions

In the project sites, floating pump stations should be rehabilitated urgently, since they are the only irrigation water supply facilities available in the area. However, it is necessary to avoid the frequent or long time suspension of pump operation. Fortunately, each pump station is located along the Nile River, are easily accessible from the nearest trunk road. However, as some pump stations have only narrow access from the trunk road, heavy trucks or equipment cannot pass or access to the sites.

2-2-1-4 Floating Pump and its Specifications

(1) Type of Pumping Facilities

The type of pump to be rehabilitated will be either of floating type or fixed type. Floating type can correspond to fluctuation of water level, its investment cost is lower, it does not require the land for installation and it is easy to be maintained. Therefore, floating type has more advantages than fixed pump as shown in the following table. Floating pump type shall, therefore, be selected for the Project.

Table 2-2-1 (1) Types of Pump Facilities

Item	Requirement	Floating Type	Fixed Type	Remarks
Fluctuation of Water Level	Max. 4.1m	good	poor	Barge adjustable for floating pump.
Construction	Economy	good	poor	Lower investment cost for floating pump.
Land Acquisition	Installation land	good	poor	Narrower land for floating pump.
O&M	Availability of maintenance institution	good	poor	Barge movable to workshop.
Sediment	Dredging in front of stations	good	poor	Easier dredge for floating pump.
Overall evaluation		good	poor	Floating type is much better than fixed type

(2) Necessity for renewing pumping facilities

The results of survey on the status of facilities in each pumping station show that the proposed pumping stations should be rehabilitated as early as possible.

Control Panels of pump stations are also of very old type, manufactured by outdated standards, less conscious of safety measures. Some of them are equipped with bare cable and mounted without adequate backdoor. Surface of panels are damaged and paint is peeled off as well as corrosion is fast advancing. Therefore, all equipment and materials for pump stations should be rehabilitated including replacement of control panels.

(3) Type and Capacity of Pump

Based on the monthly water requirement and monthly water level of the Nile River, type and capacity of pump should satisfy the following requirements:

1） Function against water level variation as much as 4m(maximum 4.1m) of the Nile River,

2） Water discharge adjustable to the minimum requirement,

3） High suction capacity for loading on barge,

4） To cope with narrow installation space and transportation, the pump height must be designed as low as possible,

5） Stand-by pump is not considered because of more than one pump will be installed, and

6） Standards applied are Japan Industrial Standards (JIS), the Standards of the Japanese Electrical Committee (JEC), the Standards of Japan Electrical Manufacturers Association (JEM) and Rules of Nippon Kaiji Kyokai (Rules for the Survey and Construction of Steel Ships, Steel Barges). However, German Standards (DIN) shall be applied for flanges of connection pipe as the same is applied for the flanges of the existing discharge towers.

(4) Calculation Criteria of Total Head and Required Power

Based on the results of the survey for natural conditions and water level data from the MED, total head and required power of pump are calculated adopting the following formula:

1） Calculation of Total Head

$$H=Ha + H1 = Ha + h1 + fn \cdot V^2/2g$$

$$h1 = f \times \frac{L}{D} \times \frac{V^2}{2g}$$

$$f = \frac{134}{C^{1.85}} \times \frac{1}{D^{1/6} \cdot V^{0.15}} \quad \text{……Hazen\&Williams formula}$$

Where、

H： Total head (m)

Ha： Actual head (m)

H1： Total head loss (m)

h1： Head loss of discharge pipe (m)

L： Overall length of discharge pipe (m)

D： Diameter of discharge pipe (m)

V： Velocity of water flow (m/s)

g： Acceleration of gravity (m/s^2)

C： Constant which varies with pipe conditions

fn： Coefficient value of various head losses

2） Calculation of Required Power

Calculation of Shaft Horsepower

$$L = \frac{0.163 \cdot Q \cdot H \cdot \gamma}{\eta / 100}$$

Where,

L： Shaft Horsepower (kW)

Q： Capacity (m^3/min)

H： Total head (m)

γ： Specific weight of pumped liquid
(Natural water: specific weight= 1.0)

η： Pump efficiency (%)
(Pump efficiency estimated from the diameter: 75～85%)

Power Required for Prime Mover

$P = L(1+A)/\eta t$

Where,

P： Power required for prime mover (kW)

L： Pump horsepower (kW)

A： Excess (Excess of motor is usually used 0.1 - 0.15.)

ηt： Transmission efficiency (Direct coupling is usually used 1.0.)

(5) Specifications of equipment

Pump

The following considerations are to be taken for determining the specifications of pump.

1） Capacity of pump shall satisfy the monthly water requirements,

2） From viewpoints of O & M, compatibility of equipment and spare parts between stations including those of the rehabilitated ones shall be considered to the full extent in phase I and phase II,

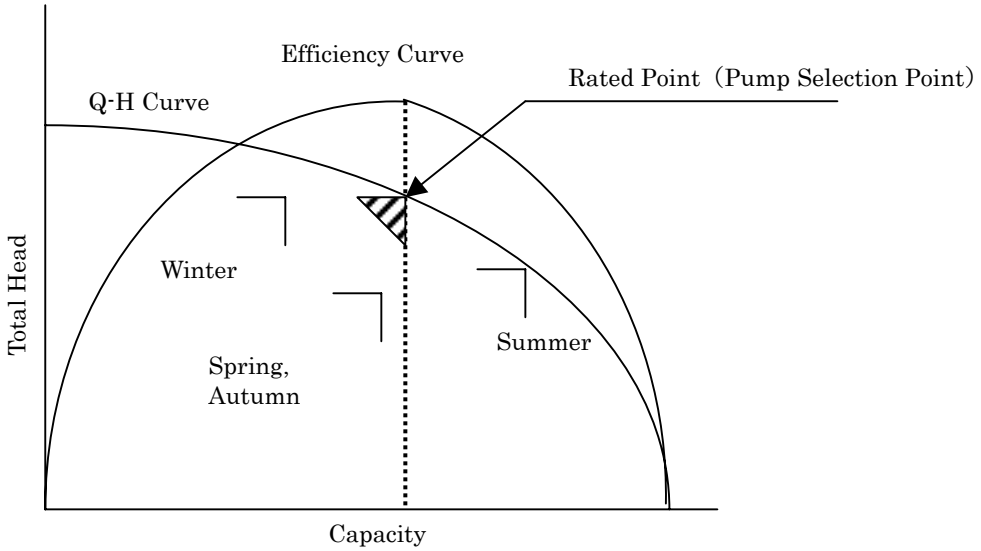
3） Considering the above (2), various pumps of per-unit capacities and total head shall be grouped into a number of typical pumps with standardized specifications,

4） Considering the wide change in seasonal water requirements and securing the pump operation, two units shall be installed per barge.

5） Pump shall be of typical type as possible.

6） Considering that water requirement is high but total head is low in summer and water requirement is low but total head is high in winter, pump specifications shall satisfy the seasonal water requirements. The rated point on the performance curve is found as follows:

Figure 2-2-1 (1) Pump Performance and Rated Point



Prime Mover

The followings shall be considered for determining specifications of prime mover:

1） As the existing pump stations have been operated by the electricity since 1989, electrical motors shall be used taking into consideration the easier operation and maintenance,

2） Considering that the motor would be loaded on barge, smaller and shorter motor shall be selected,

3） Higher speed of typical motor shall be selected,

4） For low head and low speed pump, number of poles shall be increased. Reduction gear shall not be used because of much difficulty for operation and maintenance. Pump and motor shall be stationed on the same base with direct coupling, and

5） Motor insulation and frame type shall be determined, considering that the proposed sites are high in temperature and have heavy storm with sand.

Barge

The following considerations are to be taken for determining the barge specifications:

1） Size of Barge

Required spaces of equipment (pump, motor, valves, control panel and others) and for operation and maintenance shall be a basis for determination as follows:

- Operation space
- Maintenance space ---------- Approx. 1m in front and sides.
- Desk work space
- Walk space ---------- Approx. 0.7m in width
- Space for hoist and bollard ---------- Approx. 1m in operation side

2） Depth of Barge

Depth of Barge (H) = Freeboard (h) + Draft (d)

a. Freeboard (h) -----Height of gunwale above water

The followings are to be considered for determining the freeboard:

- The maximum flow velocity (0.5m/s) in the Nile and wave height (1.0m) by boats in the Nile,
- Hydraulic inertia by suction and discharge as well as rotational reaction, and
- Allowance for other factors (0.2m)

b. Draft (d) ----- Depth of barge bottom below water surface

Followings are to be considered for determining the draft:

- Draft height by buoyancy calculation,
- Draft height to secure buoyancy equivalent to the total weight of equipment and materials on the barge, and
- The center of gravity be lowered till the water line so as maintain the stability and to be durable against water, flow velocity and winds.

c. Structure of Barge

The “Rules for the Survey and Construction of Steel Ships, Steel Barges by Nippon Kaiji Kyokai” shall be applied for the criteria for structure of barge.

Pump House

Pump house on the barge shall be designed taking into account the followings of installation methods and policies:

- Pump house shall be provided with a roof and walls to protect the equipment from wave splash, sand storm, etc.,
- Prevention of heat rise in the house and equipment from direct sunshine into the house,
- Natural ventilation,
- Manual hoist shall be equipped above the floor for maintenance of pump, motor, etc.,
- The structure of the house equipped with the hoist shall be of steel frame to bear the weight of pump, motor or etc.,
- The structure of supporting frame for connection pipe shall be of steel frame to bear the weight of connection pipe,
- Walls shall be of water-proof plywood with protection paint,
- Roof materials shall be of slate for light weight,
- Lighting system shall be equipped with inside and outside the house for night-time working, and
- Hanger board for maintenance tools shall be equipped.

2-2-1-5 Policy for Maintenance Barge

Considering the suitable maintenance and time available for maintenance and repairing, maintenance barge shall be procured. Repairing, assembling, disassembling, transporting spare parts, inspecting the pump facilities, etc shall be conducted with the maintenance barge. Policy of designing for maintenance barge shall include the followings:

Barge

The following considerations are to be taken for determining the barge specifications:

1） Size of Barge

Required spaces of loading and unloading and those of equipment (spare shelves, tables, tools shelves, generator, welder, hand truck, etc.) and those for assembling and disassembling a pump or motor shall be a basis for determination as follows:

- Spare shelves, tools shelves ---------- Approx. 1m in front.
- Working table, generator, welder ---------- Approx. 1m in front and sides.
- Desk and hand truck space ---------- Approx. 1m in front
- Loading and unloading space ---------- Approx. 3m in width
- Walk space ---------- Approx. 0.7m in width
- Space for hoist and bollard ---------- Approx. 1m in operation side

2） Depth of Barge

Depth of Barge (H) = Freeboard (h) + Draft (d)

a. Freeboard (h) -----Height of gunwale above water

The followings are to be considered for determining the freeboard:

- The maximum flow velocity (0.5m/s) in the Nile and wave height (1.0m) by boats in the Nile,
- Hydraulic inertia by suction and discharge as well as rotational reaction, and
- Allowance for other factors (0.2m)

b. Draft (d) ----- Depth of barge bottom below water surface

The followings are to be considered for determining the draft:

- Draft height by buoyancy calculation,
- Draft height to secure buoyancy equivalent to the total weight of equipment and materials on the barge, and
- The center of gravity be lowered till the water line so as maintain the stability and to be able to endure against water, flow velocity and winds.

c. Structure of Barge

The “Rules for the Survey and Construction of Steel Ships, Steel Barges by Nippon Kaiji Kyokai” shall be applied for the criteria for structure of barge

House

House on the barge shall be designed taking into account the followings of installation methods and policies:

- House shall be provided with a roof and walls to protect the equipment from wave splash, sand storm, etc.,
- Prevention of heat rise in the house and equipment by direct sunshine into the house,
- Natural ventilation,
- Manual hoist shall be equipped above the floor for maintenance of pump, motor, etc.,
- The structure of the house equipped with the hoist shall be of steel frame to bear the weight of pump, motor or etc.,
- The structure of A frame for loading and unloading shall be of steel frame to bear the weight of them,
- Walls shall be of water-proof plywood with protection paint,
- Roof materials shall be of slate for light weight, and
- Lighting system shall be equipped inside and outside the house for night-time working.

Equipment and Tools for Maintenance Barge

Based on the purpose of the maintenance barge, equipment and tools shall be equipped with the barge as follows:

(a) General Equipment and Tools,
(b) Grinding Equipment and Tools,
(c) Assembling and Disassembling Equipment and Tools,
(d) Checking and Measuring Equipment and Tools,
(e) Hanging Equipment and Tools,
(f) Equipment and Tools for Electricity,
(g) Measuring Equipment and Tools, and
(h) Supporting Equipment and Tools.

2-2-1-6 Policy on Operation and Maintenance

(1) As each existing pump station has 8-9 staff and they have enough experiences for maintaining the pump facilities, they will also maintain the pump facilities to be procured,
(2) Large-scale maintenance shall be conducted at maintenance institution and dock located in Aswan. For emergency, institution in Luxor shall be used,
(3) Daily checking, maintenance, adjustment of pump facilities shall be conducted in each pump station. However, periodical checking, replacing the moving parts for pump and motor shall be conducted in the maintenance barge to be procured,
(4) Considering that it is difficult to repair or apply high technology machining for the parts of pump and motor with the existing workshop equipment. However considering that MED has many experiences for operation and maintenance, adequate spare parts shall be selected, and
(5) Spare parts to be procured shall also be selected taking into account the conditions of spare parts usage of Phase-1 and Phase-2 projects.

2-2-1-7 Policy of Subject Equipment and Settings

(1) Subject equipment

Floating pump facilities

Equipment and materials to be procured by this Project shall be from pumping station up to connecting pipe as the same style as the Phase-1 and Phase-2 Projects as follows:

- Pump facilities: Main pump, main motor, vacuum pump, valves, suction pipe, delivery pipe, control panel, connecting pipe (incl. ball joints)
- Barge: Main body, pump house, hoist facilities, anchor facilities.

Maintenance Barge

Maintenance barge shall be equipped with hoist facilities for loading & unloading equipment to be repaired, anchor facilities and maintenance tools.

(2) Policy on equipment settings

- Connecting the pipe to the tower can be adjusted by changing the connecting position to meet the seasonal fluctuation of water levels. Connecting pipe with ball joints, which have elasticity and flexibility, can meet the daily fluctuation of water levels. To protect against the possibility of inner pipe from slipping off, strength of stopper shall be increased and caution color paint shall be painted,
- Number of anchor facilities for each barge is to be increased to four for protecting the effect to the connecting pipe by waves. Wires for anchors shall be larger by one class,
- To counter measure against waterweeds plugging strainer at pump suction, washer pump shall be equipped. Supporting materials to the outlet pipe shall be supplied so that it is easier for operator to operate the pipe outlet, and
- To set the accurate operation and maintenance time for all of the operators, a clock shall be equipped in the pump house.

2-2-2 Basic Plan

2-2-2-1 Plan of Irrigation

(1) Service area

Proposed service area for each pump station is as follows:

Table 2-2-2(1) Proposed Service Area

No.	Pump Station	Area Requested (Feddan)	Existing Service Area (Feddan)	Reversion Area (Feddan)	Extension Area (Feddan)	Total Service Area (Feddan)
22	Sahel Alakaba Kebli	250	250	—	50	300
23	Al Rakikin Sahel	150	150	—	—	150
24	Blowkher	1,500	2,000	—	400	2,400
25	El Ghorera	1,600	1,000	1,450	—	2,450
26	El Biadiea El Ollia	1,700	4,220	—	880	5,100

＊1Feddan=0.42ha

To reclaim the extension area, it is important to include provision of irrigation facilities such as secondary canals by the governmental support (MED and/or ID) due to extensive area. Accordingly, as a basic concept, inclusion of the extension area in the service area will be determined in the case that certain intention will be given in the minutes of discussion to provide the budget and to construct the irrigation facilities by the Irrigation Department.

The reasons of including the extension area are mentioned as follows:

As one of solution to alleviate the poverty in Upper Egypt, the increasing of agricultural production becomes important issue in today. Then, horizontal expansion, means expansion of area for cultivation, also is needed together with vertical expansion such as enhancement of technique for cultivation, stable supplement of irrigation water, effective water management and so on. According to the results on field survey, the average cultivable area holding by each farmer in this area is little compare with the number of whole Egypt one. It is very important purpose for this project to improve this situation. Then, the project includes the extension area considering the characteristic of each area.

a. Sahel Alakaba Kebri (50 feddan)

This expansion area has already been reclaimed in some portion due to be irrigated by grand water up to twenty years ago. If the irrigation water will be supplied to this area, this area will be able to use immediately as cultivating area with simple pump. Then, it is available to include this expansion area as total service area in the project.

b. Blowkher (400 feddan)

The expansion area lies along the south side of the Abadhy drain. the topography is terrace with from 95 to 100 m of elevation. This area consists of sandy soil. In some area beside the drain is cultivated as upland field using little drainage water. However, it seems to be cultivated in winter season only because of the shortage and the pollution of drainage water in summer season. If the irrigation water will be supplied to this area enough, this area will be able to cultivate. To convey the irrigation water from Nile River, it needs to construct the siphon, small pump and small canal on the field for crossing the Abadhy drain. Concerning this, it is be able to judge to be constructed these facilities by farmers themselves, then it is available to include this expansion area as total service area in the project. However, because the area where is over 100 m of elevation undulates much, it needs a large amount of investigation to reclaim this undulated area and to engage it as development project lead by government. Therefore, where the over 100 m area of elevation does not include to the project.

c. El Biadeia El Ollia (880 feddan)

Almost of the expansion area lies on flooding area and the topography is flat. Therefore, if the irrigation water will be supplied to this area enough, it will seem to be cultivated easily. In except the flooding area, the area of under 95 m elevation forms terrace of the Nile River, the are of over 95 m elevation is rock hill or desert. The reclamation by farmers progresses up to the area under 95 m of elevation. In the area covered by higher canal of elevation almost area has a few area, the remaining area is 250 feddan due to be reclaimed already in the almost area. On the other hand, in the area covered by lower canal of elevation has already reclaimed up to 90 or 91 m of elevation by pumping irrigation and in the some portion where is up to around 95 m also has reclaimed. Therefore, it is available to include the area of up to around 95 m of elevation to this project. However, the over 95 m area will not include this project with the reasons as mentioned follows: There is possibility to develop the over 95 m area in future. Then, it needs a large amount of investigation to reclaim this area, because there is 10 m difference of elevation from main canal and the distance reaches over 1 km. To develop this area, it needs the development project as the government basis.

(2) Cropping Schedule

While farmers freely decide the selection of the crops, the existing cropping pattern of each service area is considerably influenced by the average size of farmland owned by farmers and by accessibility to the market. These matters are significantly characterized by existence of the sugarcane cultivation in the area as well. In the area without sugarcane (No.22 Sahel Alakaba Kebli, No.23 Al Rakikin Sahel), there are many small-size farmers comparatively who earn their livelihood by income from livestock auction and migrant working as well as self-consumption of their products. In the above area, increment of planting area is expected for cash crops such as vegetables.

On the other hand, farmers have strong inclination toward enlargement of sugarcane production in the area where sugarcane is currently cultivating as large as more than 50 to 60% of the existing area (No.24 Blowkher, No.25 El Ghorera, No.26 El Biadiea El Ollia). Accordingly, increase of planting area for the sugarcane is expected in the cropping schedule in these areas.

Wheat, which is the major crop in the winter season, is applied to the self-consumptive crop for the livelihood of farmers in all areas. Since the percentage of planting area for wheat to meet with the quantity for self-consumption is estimated about 18 to 20% of the service area in average, the said percentage is basically applied to the proposed cropping area of wheat with some adjustment taking account of the average size of the farmland owned by farmers by each area.

As the maize and corn in summer are the secondary crops of the berseem in winter, cropping areas for these crops are estimated to balance each other.

Accordingly, the following cropping schedule is proposed for each service area in accordance with the above consideration.

Table 2-2-2(2) Proposed Cropping Pattern

Season	Crops	Unit	No.22 Sahel Alakaba Kebli 1.2feddan/houshold	No.23 Al Rakikin Sahel 0.3feddan/houshold	No.24 Blowkher 2feddan/houshold	No.25 El Ghorera 1feddan/houshold	No.26 El Biadiea El Ollia 1feddan/houshold	Average & Total
	Area	Fedn.	300	150	2,400	2,450	5,100	10,400.0
Winter Season (10～4)	Wheat	%	20	5	13	18	17	16.2
		Fedn.	60.0	7.5	312.0	441.0	867.0	1,687.5
	Broad Beans	%	4	10			4	2.2
		Fedn.	12.0	15.0			204.0	231.0
	Clover	%	8	15	6	4	5	5.2
		Fedn.	24.0	22.5	144.0	98.0	255.0	543.5
	Berseem	%	8	10	6	4	5	5.2
		Fedn.	24.0	15.0	144.0	98.0	255.0	536.0
	Onion	%	5	10				0.3
		Fedn.	15.0	15.0				30.0
	Garlic	%	5	5				0.2
		Fedn.	15.0	7.5				22.5
	Vegetables	%	30	25	5	4	4	5.3
		Fedn.	90.0	37.5	120.0	98.0	204.0	549.5
Summer Season (5～9)	Maize	%			11	22	9	12.1
		Fedn.			264.0	539.0	459.0	1,262.0
	Sugarcane	%			65	60	60	58.6
		Fedn.			1560.0	1470.0	3060.0	6,090.0
	Banana	%				5		1.2
		Fedn.				122.5		122.5
	Sesami	%			8		8	5.8
		Fedn.			192.0		408.0	600.0
	Vegetables	%	30	25	5	4	4	5.3
		Fedn.	90.0	37.5	120.0	98.0	204.0	549.5
	Corn	%	42	40			9	6.2
		Fedn.	126.0	60.0			459.0	645.0
Nile Seasons	Vegetables	%	30	25	5	4	4	5.3
		Fedn.	90.0	37.5	120.0	98.0	204.0	549.5
	Fruits	%	20	20	5	5	5	5.6
		Fedn.	60.0	30.0	120.0	122.5	255.0	587.5

(3) Consumptive use of crops

Consumptive use of water estimated by the Irrigation Department (Table 2-2-2(3)) is basically applied to the Project.

As for consumptive use of water for the sugarcane, six (6) data are found from the data obtained in the last site survey and in the past project. Out of them, three (3) data are almost the same figures. The data based on the research result in 1994 by the Water Management Research Institute which has been introduced to the Phase 2 Project is applied to this Project as the most appropriate one among them through the comparison studies including the comparison with the estimation result by the modified Penman method.

Table 2-2-2(3) Consumptive Use of Crops in Upper Egypt

Season/Crops	Consumptive Use of Water of Each Month (m³/month/feddan)												Total
	Winter Season				Summer Season					Winter Season			
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
Winter Season													
Wheat	450.0	458.0	460.0	452.0							249.0	520.0	2589.0
Broad Beans	362.0	368.0	533.0	100.0							620.0	618.0	2601.0
Clover	809.0	920.0	860.0	820.0	900.0	950.0	930.0	500.0	910.0	800.0	600.0	590.0	9589.0
Berseem(Fodder)	275.0	402.0									245.0	275.0	1197.0
Onion	550.0	551.0	568.0	515.0							373.0	426.0	2983.0
Garlic	390.0	388.0	413.0	364.0						655.0	874.0	995.0	4079.0
Vegetables	650.0	726.0	108.0							358.0	390.0	493.0	2725.0
Summer Season													
Maize						423.0	805.0	749.0	859.0	459.0			3295.0
Sugarcane	154	240	254	350	792	892	1,239	1,344	1,144	930	699	371	8408.1
Banana	160.0	245.0	260.0	360.0	800.0	900.0	1240.0	1350.0	1150.0	1000.0	700.0	380.0	8545.0
Sesame					350.0	603.0	636.5	602.0	424.75				2616.3
Vegetables	550.0	556.0	1090.0	1186.0	1345.0	1122.0	203.0						6052.0
Corn					686.0	904.0	1154.0	565.0					3309.0
Other Plants					214.2	596.4	646.8	638.4	529.2				2625.0
Nile Seasons													
Vegetables								1429.0	1836.0	1720.0			4985.0
Fruits	250.0	220.0	225.0	308.0	376.0	497.0	484.0	469.0	440.0	425.0	308.0	303.0	4305.0

Data Source: irrigation Department Aswan

Notes: Above table shows consumptive use of crops, which are not incuding any losses such as conveyance and application.

(4) Irrigation efficiency

Overall irrigation efficiency is estimated at 0.5 based on the standard irrigation efficiencies by FAO and ICED. Interpretations of irrigation efficiencies applied are as follows:

Conveyance efficiency Ec

Conveyance efficiency Ec = 0.90 is applied because of the following conditions.

- In general, rotational irrigation method with partition into 2 blocks at interval of about 7 days is dominantly carried out in the service area.
- During 7 days, water flow is always maintained in the irrigation canal.
- It is judged from the above conditions that the canal flowing corresponds with "continuous supply with no substantial change in flow" that gives the conveyance efficiency at 0.9.

Field canal efficiency Eb

Field canal efficiency Eb = 0.70 is applied because field blocks feeding by the field canal unlined is less than 20 ha in size that gives the field canal efficiency at 0.70.

Field application efficiency Ea

Field application efficiency Ea = 0.80 is applied because irrigation method in the service area is classified as a basin irrigation method which gives the field application efficiency at 0.80.

Then, the overall efficiency is calculated as follows;

$E = Ec \times Eb \times Ea = 0.90 \times 0.70 \times 0.80 = 0.504 \rightarrow 0.5$

(5) Irrigation hour

As the same with Phase 2 Project, fourteen (14) hours per day is applied to the irrigation hour based on the following aspects.

- Hours of sunlight at the project area is about 14 hours in the summer season in which the maximum volume of irrigation water is required
- Farmers have a custom to work while there is day-light because of fear of existence of poisonous snakes when it is dark.

(6) Village water

Village water is estimated at 10% of irrigation water for garden and others.

(7) Irrigation water demand

Proposed daily demand of irrigation water is calculated by the following equation:

Daily irrigation water demand = ∑ (Cropping area x Daily consumptive use of water) / Overall efficiency 0.5

Proposed irrigation water demand (m^3/s) is calculated as follows adding village water (10%) and converting 24hours consumption to 14 working hours.

Proposed irrigation water demand (m^3/s) = Daily irrigation water demand x (1 + 0.10) x (24 / 14) / 86,400

Irrigation water demand calculated for each month is shown in the following table 2-2-2(4).

Table 2-2-2(4) Proposed Monthly Irrigation Demand

Unit : m^3/sec

Description	Area (feddan)	Winter Season				Summer Season					Winter Season		
		Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Total Requirement	250	0.17	0.20	0.14	0.23	0.28	0.30	0.23	0.28	0.26	0.26	0.14	0.17
Ex. Pump Capacity	0 m^3/s x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Required Pump Capacity		0.17	0.20	0.14	0.23	0.28	**0.30**	0.23	0.28	0.26	0.26	0.14	0.17
Total Requirement	150	0.10	0.13	0.10	0.13	0.17	0.16	0.13	0.16	0.15	0.15	0.09	0.10
Ex. Pump Capacity	0 m^3/s x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Required Pump Capacity		0.10	0.13	0.10	0.13	**0.17**	0.16	0.13	0.16	0.15	0.15	0.09	0.10
Total Requirement	2,000	0.76	1.07	0.83	1.19	1.92	2.20	2.76	3.18	3.03	2.28	1.66	1.13
Ex. Pump Capacity	0.85m^3/s x 2	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70
Required Pump Capacity		-	-	-	-	0.22	0.50	1.06	**1.48**	1.33	0.58	-	-
Total Requirement	2,450	0.91	1.27	1.02	1.44	2.15	2.65	3.50	3.93	3.80	2.87	2.00	1.40
Ex. Pump Capacity	0.50m^3/s x 2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Required Pump Capacity		-	0.27	0.02	0.44	1.15	1.65	2.50	**2.93**	2.80	1.87	1.00	0.40
Total Requirement	4,220	1.64	2.25	1.85	2.42	4.06	4.74	5.96	6.41	5.76	4.31	3.44	2.46
Ex. Pump Capacity	1.30m^3/s x 2 +2.0m^3/s x 3	2.60	2.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	2.60	2.60	2.60
Required Pump Capacity		-	-	-	-	-	-	-	-	-	**1.71**	0.84	-

:I Biadiea El Ollia, the Fixed Pump (2.0m^3/s x 3units) can't operate during winter from Oct. to Feb. due to low water level of the Nile.

(8) Proposed floating pump capacity

Existing floating pump facilities at the No.22 Sahel Alakaba Kebli and No.23 Al Rakikin Shahe will be entirely replaced by new floating pumps. While, existing fixed pump facilities and a part of floating pumps at the three (3) stations, i.e. No.24 Blowkher, No.25 El Ghorera and No.26 El Biadiea El Ollia, are found still able to operate further based on the remaining life and good maintenance of pump facilities. Then the proposed floating pump capacities of those pump stations are determined by subtracting available existing pump capacities from the irrigation water demand at each pump station.

Available capacity of existing fixed pump is estimated by the following concepts.

a. All of fixed pump stations are equipped with three or four units of pump. Among the units of pump in each station, one unit is always kept as a stand-by pump. Accordingly, one unit of fixed pump is regarded as a stand-by pump and eliminated from available capacity of existing fixed pumps.

b. At No.22 El Biadiea El Ollia pump station, the existing fixed pumps can not be operated due to the cavitations when the water level of the Nile is low in winter and irrigation water is supplied by the floating pump only which is installed by the Phase 1 Japan's Grant Aid Project. Although irrigation water required would be satisfactory fed by the remaining existing pumps in summer, shortage of irrigation water will arise in winter. Therefore, the proposed floating pump capacity is determined in winter to fulfill such shortage.

   The period that the existing fixed pumps can not be operated due to low water level in the Nile is when the discharge of the Nile is less than 120MCM/day (approximately 1,390m^3/s). Referring to the water release schedule of Aswan High Dam, the release discharge during the period from October to February is below 120MCM/day. Therefore, it is judged that the fixed pumps cannot be operated from October to February in the year generally. According to the above conditions, the pump capacity required to the new floating pump in Biadiea El Ollia will rise to its maximum in October.

Accordingly, the monthly capacities required to the new pumps are calculated as shown in the Table 2-2-2(5) .

Table 2-2-2(5) Monthly Pump Capacity Required

Unit : m^3/sec

Pump Station	Description	Area (feddan)	Winter Season				Summer Season					Winter Season		
			Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
No.22 Sahel Alakaba Kebli	Total Requirement	300	0.20	0.24	0.17	0.27	0.34	0.36	0.27	0.34	0.31	0.32	0.17	0.20
	Ex. Pump Capacity	0 m^3/s x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Required Pump Capacity		0.20	0.24	0.17	0.27	0.34	**0.36**	0.27	0.34	0.31	0.32	0.17	0.20
No.23 Al Rakikin Sahel	Total Requirement	150	0.10	0.13	0.10	0.13	0.17	0.16	0.13	0.16	0.15	0.15	0.09	0.10
	Ex. Pump Capacity	0 m^3/s x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Required Pump Capacity		0.10	0.13	0.10	0.13	**0.17**	0.16	0.13	0.16	0.15	0.15	0.09	0.10
No.24 Blowkher	Total Requirement	2,400	0.91	1.28	0.99	1.43	2.31	2.64	3.31	3.82	3.63	2.74	2.00	1.35
	Ex. Pump Capacity	0.85m^3/s x 2	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70
	Required Pump Capacity		-	-	-	-	0.61	0.94	1.61	**2.12**	1.93	1.04	0.30	-
No.25 El Ghorera	Total Requirement	2,450	0.91	1.27	1.02	1.44	2.15	2.65	3.50	3.93	3.80	2.87	2.00	1.40
	Ex. Pump Capacity	0.50m^3/s x 2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Required Pump Capacity		-	0.27	0.02	0.44	1.15	1.65	2.50	**2.93**	2.80	1.87	1.00	0.40
No.26 El Biadiea El Ollia	Total Requirement	5,100	1.98	2.72	2.23	2.93	4.90	5.73	7.20	7.75	6.97	5.21	4.15	2.97
	Ex. Pump Capacity	1.30m^3/s x 2 +2.0m^3/s x 3	2.60	2.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	2.60	2.60	2.60
	Required Pump Capacity		-	**0.12**	-	-	-	-	-	-	-	**2.61**	1.55	0.37

Note : At No.26 El Biadiea El Ollia, the Fixed Pump (2.0m^3/s x 3units) can't operate during winter from Oct. to Feb. due to low water level of the Nile.

2-2-2-2 Plan of Pump Stations

(1) Application Standards

Floating pump stations consist of pump facilities, barges, etc. According to the aforementioned section "2-1 Basic Design of the Project", standards for application to the equipment and works shall be the current issues of the followings:

Table 2-2-2(6) Standards for Application

Equipment and Works	Standards
Material and works of pumps, motors, valves, suction and delivery pipes, control panels, connection pipes (incl. ball joints)	Japan Industrial Standards（JIS）
Electrical equipment as motors, control panels, etc.	Standards of the Japanese Electrical Committee (JEC), Standards of Japan Electrical Manufacturers Association（JEM）
Structure of barges	Rules of Nippon Kaiji Kyokai（Rules for the Survey and Construction of Steel Ships, Steel Barges）

Note: Since inlets at discharge tower are in German standards (DIN), flange joints to be connected to the inlets shall be manufactured with the same standards.

(2) Specifications of Equipment

Main Pump

Specifications of main pump shall be determined taking into account the followings:

a. Type of Pump

Taking into consideration that pump will be installed on barge, have a high efficiency, have a high suction ability and be easy to maintain, best type of pump shall be of double suction volute pump.

b. Pump Specifications

To be determined the specifications (capacity, total head and number of units) of pump, the followings shall be taken into consideration:

- Based on the irrigation plan, total capacity shall satisfy the monthly water requirements,
- Considering that it shall be irrigation pump, it is necessary to disperse the pump damages, and pump shall be installed on barge, two pumps shall be the best for one barge.
- Considering the above, specifications of two pumps on the barge shall be same. Pump specifications of various barges shall be grouped into and selected typical specifications.

Pump specifications plan are obtained after calculations of total head, required power and selection of rated points as follows:

Table 2-2-2(7) Specifications of Pumps

No.	Name of Pump Stations	Water Requirement (m^3/s)	Actual Head (m)	Head Loss (m)	Calculated Head Loss (m)	Pump Specification Plan				
						Capacity per unit (m3/s)	Total Head (m)	Number of unit	Capacity (m3/s)	Shaft Hourse power (kW)
22	Sahel Alakaba Kebli	0.24 (Apr.)	7.20	1.78	8.98	0.20	10	2	0.4	27
	(300 feddan)	0.36 (Jun.)	5.20	3.11	8.31					
	Extension 50 feddan	0.20 (Dec.)	9.30	0.99	10.29					
23	Al Rakikin Sahel	0.13 (Apr.)	5.46	1.34	6.80	0.10	8	2	0.2	11
	(150 feddan)	0.17 (May)	4.57	2.26	6.83					
	Extention: None	0.16 (Jun.)	3.90	2.01	5.91					
		0.10 (Dec.)	7.10	0.80	7.90					
24	Blowkher	0.94 (Jun.)	5.90	0.57	6.47	1.00	11	2	2.0	127
	(1,332 feddan)	2.12 (Aug.)	6.10	2.83	8.93					
	Extension 400 feddan	1.04 (Oct.)	6.99	0.69	7.68					
		- (Dec.)	7.85	-	-					
25	El Ghorera	0.44 (Apr.)	6.63	0.06	6.69	1.45	12	2	2.9	200
	(1,827 feddan)	1.65 (Jun.)	4.75	0.80	5.55					
	Extension: None	2.93 (Aug.)	5.15	2.50	7.65					
		0.40 (Dec.)	8.60	0.05	8.65					
26	El Biadiea El Ollia	- (Jun.)	17.65	-	-	1.30	28	2	2.6	419
	(2,554 feddan)	2.61 (Oct.)	19.58	6.92	26.50					
	Extension 880 feddan	1.55 (Nov.)	20.15	2.58	22.73					
		0.37 (Dec.)	21.10	0.20	21.30					

Note： 1. Pumps for No. 26 El Biadiea El Ollia pump station will be as same as that for Phase-1 Project.

2. For No. 26 El Biadiea El Ollia pump station, total head shall be 28m taking into consideration that pumps will be simultaneously operated with those for Phase-1.

Detailed determination of pump specifications and rated points are referred to Annex 8 “Pump Discharge and Require Head” attached herewith.

c. Stand-by Pump

- Generally, stand-by pump for irrigation are rarely installed.
- The survey results indicate that no pump stoppage by mechanical trouble wad found other than by power failure. Power failure was also rarely.
- MED has put much stress on operation and maintenance and established a concrete system for O&M.

Considering the above, no stand-by pump shall be installed, however, stock and supply of spare parts shall be reinforced instead.

Main Motor

Following considerations are to be taken for determining the specifications:

a. Type of Motor

- Considering that the temperature in the sites is high and sites have strong storm with sand, type of motor for best selection shall be F class insulation and total enclosed.
- Taking into account that the motors would be installed on the barge and they shall be small and short,

squirrel cage type shall be the best. It has the better features like that it is compact structure and requires narrow installation space and easy O&M as well as lower cost.

- Considering the marine freight, motors shall be of tropic and damp proof type.

b. Required Horsepower

Required horsepower shall be calculated with the pump shaft horsepower. Considering the pump size and standards type of motor, specifications of motor shall be determined as follows:

Power source will be supplied as 380V, 50Hz through transformers at the sites. However, power source 6,000V, 50Hz will be supplied at No. 26 El Biadiea El Ollia pump station.

Table 2-2-2(8) Specifications of Motors

No.	Name of Pump Stations	Pump Shaft Horsepower (kW)	Required Power (kW)	Motor Specifications			Remarks
				Power (kW)	Revolution (rpm)	Number of Pole	
22	Sahel Alakaba Kebli	27	31	37	1,450	4	Standard type
23	Al Rakikin Sahel	11	13	15	1,450	4	Standard type
24	Blowkher	127	140	150	590	10	Sub-standard
25	El Ghorera	200	220	250	590	10	Sub-standard
26	El Biadiea El Ollia	419	461	460	740	8	Sub-standard

Vacuum Pump

Double suction volute pump requires bleed equipment for priming. Therefore, vacuum pump, which generally be selected for priming, shall be installed. Following considerations are to be taken for determining the specifications:

- Similar to the main pump, vacuum pump shall be electric motor-driven and installed with common base.
- Being ready for occasional water supply for vacuum pump, a water service tank shall be equipped.
- For quick and reliable priming, standards type shall be selected.
- Capacity of pump shall be of that the air suction will be finished within two minutes for priming.

Stop Valve

Following considerations are to be taken for determining the specifications:

- Either sluice valve or butterfly valve shall be installed at delivery side of pump so as to reduce initial load to motor by closed pump operation and to maintain air tightness while priming by vacuum pump.
- Considering that valves shall be of standard type, lower cost and easy O&M, valve type of less than 500 mm diameter shall be of sluice and more than 500mm shall be of butterfly.
- Taking account of advantages in continuous operation with less disadvantageous frequent and intermittent operation and in simple on-off operation without complicated discharge control, valve shall be of hand-operated for its economy and reliability.
- Valve shall be durable to maximum pressure given by pump.

Check Valve

Following considerations are to be taken for determining the specifications:

- In order to stop reverse flow from delivery side upon emergent stoppage of pump by power failure or other causes, check valve shall be installed at delivery side of pump.
- Check valve shall be of structure not to cause intense water pressure and be of specifications durable to water pressure.

Main Pipe

Following considerations are to be taken for determining the specifications:

- On both suction and delivery sides of pump, main pipes shall serve for connecting pumps, valves, etc.
- Pipe materials shall be steel for the lightness, easy site processing and adjusting.
- For connecting pump, valves, etc., fittings such as tapers, bends, T's shape pipes shall be employed as required.

Connecting Pipe (incl. ball joints)

Following considerations are to be taken for determining the specifications:

- In order to secure expansibility and flexibility at joints between outlets of pumps and tower, ball joints on both ends of connecting pipe shall be equipped. Strength of topper shall be increased for protection of coming-off and caution color paint shall be painted at the expanding portions.
- Smaller pipe bore is favorable for its lightness but excessive flow velocity shall be avoided.

Control Panel

Following considerations are to be taken for determining the specifications:

- For protection from wave splash on barge, totally enclosed type with leak prevention shall be employed.
- For easy inspection and maintenance, a door shall be on the front face.
- For protection from sand storms, dust-proof type shall be employed.
- Specifications shall be of the tropics for damp proof during marine freight.

Barge and Pump House

Following considerations are to be taken for determining the specifications:

- Provisions presented in the Design Policy shall be referred.
- In accordance with the Rules for the Survey and Construction of Steel Ships, Steel Barges of Nippon Kaiki Kyokai, structure of barge shall be as presented in the following table:

Table 2-2-2(9) Calculation Formula for Steel Plate Thickness

Bottom Plate Thickness t1 (mm)	$t1 = 4.7S\sqrt{d+0.04L} + 2.5$	S: Interval of longitudinal ribs (m) S = 2L + 450 (mm) L: Total length (m) d: Draught (m)
Side Plate Thickness t2 (mm)	$t2 = 4.1S\sqrt{d+0.04L} + 2.5$	Minimum thickness = 0.044L + 5.6
Deck Plate Thickness t3 (mm)	$t3 = 1.47S\sqrt{h} + 2.5$	H: Deck Load (KN/m^2)
Other Plate Thickness t_{min} (mm)	$t_{min} = 6$	Minimum dimensions of members are incorporated in chap 23. of the Rules. Shell plating: Smooth water
Buoyancy d1 (tf/m^2)	D1 = W0/plane area	W0：Total hull weight (tf)

Table 2-2-2(10) Buoyancy Calculation

No.	Name of Pump Station	L(m) x W(m)	Total Weight W0(tf)	Required Draught d1(m)	Planned Draught d(m)
22	Sahel Alakaba Kebli	13 x 5.5	50	0.70	0.9
23	Al Rakikin Sahel	13 x 5.5	50	0.70	0.9
24	Blowkher	16 x 7.5	75	0.63	1.1
25	El Ghorera	18 x 7.5	100	0.80	1.3
26	El Biadiea El Ollia	18 x 7.5	100	0.70	1.1

Note： L = Length of barge (m)、 W = Breadth of barge (m)

In the above, freeboard height 0.7m is given. In order to lower the center of gravity till waterline so as to secure stable barge balance and to prevent air coming into suction pipe, draught height 0.9m to 1.3m shall be given. Sizes of barges shall be consequently as follows:

Table 2-2-2(11) Size of Barges

No.	Name of Pump Stations	Length L (m)	Breadth W (m)	Depth H (m)
22	Sahel Alakaba Kebli	13	5.5	1.6
23	Al Rakikin Sahel	13	5.5	1.6
24	Blowkher	16	7.5	1.8
25	El Ghorera	18	7.5	2.1
26	El Biadiea El Ollia	18	7.5	1.8

Size of pump house shall be determined to being taken account of the size of equipment and height of the crane. Pump house shall be durable against the supplemental loads by hoist supporting connecting pipe. Pump house shall be of steel frame with sufficient stiffness not to cause substantial distortion of the frame.

Table 2-2-2(12) Size of Pump House and Main Frame

No.	Name of Pump Station	Length L (m)	Width W (m)	Height H (m)	Size of Main Frame (mm)	Size of Main Beam (mm)
22	Sahel Alakaba Kebli	9	4	4.4	HS 150 x 150	CH 150x 75
23	Al Rakikin Sahel	9	4	4.4	HS 150 x 150	CH 150 x 75
24	Blowkher	12	6	5.7	HS 175 x 175	CH 150 x 75
25	El Ghorera	13	6	5.7	HS 200 x 200	CH 150 x 75
26	El Biadiea El Ollia	13	6	5.7	HS 200 x 200	CH 150 x 75

In accordance with the aforementioned application standards and specifications for equipment, specifications of pump facilities have been determined as shown in the following tables.

Table 2-2-2(13) Specifications for Planned Pump and Motor

No.	Name of Pump Station	Present			Specifications for Planed Pump				Specifications for Planned Motor			Revolution of Planned Pump and Motor (rpm)
		Irrigation Area (feddan)	Water Requirement (m^3/s)	Calculated Total Head (m)	Capacity per Unit (m^3/s)	Total Head (m)	Number of Unit	Total Capacity (m^3/s)	Power (kW)	Number of Unit	Total Power (kW)	
22	Sahel Alakabe Kebli	300 (Expansion: 50)	0.26 (Apr.) 0.34 (Jun.) 0.20 (Dec.)	8.98 8.31 10.29	0.20	10	2	0.4	37	2	74	1,450
23	Al Rakikin Sahel	250 (Expansion: None)	0.12 (Apr.) 0.17 (May) 0.16 (Jun.) 0.10 (Dec.)	6.80 6.83 5.91 7.90	0.10	8	2	0.2	15	2	30	1,450
24	Blowkher	1,332 (Expansion: 400)	0.85 (Jun.) 2.12 (Aug.) 1.04 (Oct.) - (Dec.)	6.47 8.93 7.68 -	1.00	11	2	2.0	150	2	300	590
25	El Ghorera	1,827 (Expansion: None)	0.39 (Apr.) 1.56 (Jun.) 2.93 (Aug.) 0.40 (Dec.)	6.69 5.55 7.65 8.65	1.45	12	2	2.9	250	2	500	590
26	El Biadiea El Ollia	2,554 (Expansion: 880)	- (Jun.) 2.61 (Oct.) 1.38 (Nov.) 0.37 (Dec.)	- 26.50 22.73 21.30	1.30	28	2	2.6	460	2	920	740

2-2-2-3 Plan of Maintenance Barge

(1) Application Standards

Standards for application to the equipment and works for maintenance barge shall be the current issues of the followings:

Table 2-2-2(14) Standards for Application

Equipment and Works	Standards
Structure of barge	Rules of Nippon Kaiji Kyokai (Rules for the Survey and Construction of Steel Ships, Steel Barges)
Electrical equipment as motor, control boards, etc.	Standards of the Japanese Electrical Committee (JEC), Standards of Japan Electrical Manufacturers Association (JEM)
Materials and works of equipment, motors, etc. as well as barge	Japan Industrial Standards (JIS)

(2) Maintenance Barge

Barge and Working House

Following considerations are to be taken for determining the specifications:

Table 2-2-2(15) Calculation Formula for Steel Plate Thickness

Bottom Plate Thickness t1 (mm)	$t1 = 4.7S\sqrt{d+0.04L} + 2.5$	S: Interval of longitudinal ribs (m) $S = 2L + 450$ (mm) L: Length (m) d: Draught (m)
Side Plate Thickness t2 (mm)	$t2 = 4.1S\sqrt{d+0.04L} + 2.5$	Minimum thickness $= 0.044L + 5.6$
Deck Plate Thickness t3 (mm)	$t3 = 1.47S\sqrt{h} + 2.5$	H: Deck load (KN/m^2)
Other Plate Thickness t_{min} (mm)	$t_{min} = 6$	Minimum dimensions of members are incorporated in chap. 23. of the Rules. Shell plating: Smooth water
Buoyancy d1 (tf/m^2)	D1 = W0/plane area	W0：Total hull weight (tf)

Table 2-2-2(16) Buoyancy Calculation

Item	L(m) x W(m)	Total Weight W0(tf)	Required Draught d1(m)	Planned Draught d(m)
Maintenance Barge	14 x 6.5	65	0.70	0.9

Note: L = Length of barge (m)、 W = Breadth of barge (m)

In the above, freeboard height 0.7m is given. In order to lower the center of gravity till water line so as to secure stable barge balance, draught height 0.9m shall be given. Sizes of barges shall be consequently as follows:

Table 2-2-2(17) Size of Barge

Item	Length L (m)	Breadth W (m)	Depth H (m)
Maintenance Barge	14	6.5	1.7

Size of house shall be determined to being taken account of the size of equipment and material and height of the crane. House shall be durable against the supplemental loads by hoist with loading equipment. House shall be of steel frame with sufficient stiffness not to cause substantial distortion of the frame.

Table 2-2-2(18) Size of House and Main Frame

Item	Length L (m)	Width W (m)	Height H (m)	Size of Main Frame (mm)	Size of Main Beam (mm)
House on Barge	8	5	4.9	HS 200 x 200	CH 150x 75

(3) Equipment and Tools for Maintenance Barge

According to aforementioned section 2-1 “Policy of Basic Design for the Project”, equipment and tools for maintenance barge shall fully be supplied meeting to the required works, but pay and attention not to be over-supplied. Main equipment shall be the followings:

a) General Equipment and Tools: Generator, Welder, Cord reel, etc.

b) Grinding Equipment and Tools: Grinder, files, etc.

c) Assembling & Disassembling Equipment and Tools: Gear puller, spanner, wrench, hammer, bearing heater, etc.

d) Checking & Measuring Equipment and Tools: Steel ruler, convex ruler, dial gauge, thickness gauge, level, etc.

e) Hanging Equipment and Tools: Wire, lever block, shackle, etc.

f) Equipment and Tools for Electricity: Clamp meter, tester, insulation resister, electric tools, etc.

g) Measuring Equipment and Tools: Vibro meter, noise meter, tachometer, etc.

h) Supporting Equipment and Tools: Tool shelf, emergency light, desk and chair, etc.

Details shall be referred to Table 2-2-2(23-1)～ Table 2-2-2(23-3) "Equipment and Tools for Maintenance Barge".

2-2-2-4 Specifications and Quantity of Equipment and Materials

Specifications and quantity of plan's equipment and materials shall be as follows

Table 2-2-2(19) Specification and Quantity of Plan's Pump Stations

No.	Name of Pump Station	Pump (m^3/s x Head x Unit)	Motor (kW x Unit)	Barge (L)m x (W)m x (D)m
22	Sahel Alakaba Kebli	0.20 m^3/s x 10 m x 2	37 kW x 2	13 x 5.5 x 1.6
23	Al Rakikin Sahel	0.10 m^3/s x 8 m x 2	15 kW x 2	13 x 5.5 x 1.6
24	Blowkher	1.0 m^3/s x 11 m x 2	150 kW x 2	16 x 7.5 x 1.8
25	El Ghorera	1.45 m^3/s x 12 m x 2	250 kW x 2	18 x 7.5 x 2.1
26	El Biadiea El Ollia	1.3 m^3/s x 28 m x 2	460 kW x 2	18 x 7.5 x 1.8

Maintenance Barge	
Hull	14(L)m x 6.5(W)m x1.7(D)m

More detailed specifications of pump stations are referred to Tables 2-2-2(21-1)～2-2-2(21-5), and maintenance barge to Table 2-2-2(20-6).

Table 2-2-2(21-1) Specifications of Plan's Pump Stations

No. 22 Sahel Alakaba Kebli Pump Station

No.	Description	Specifications	Quanity
1	Main Pump (with Main Motor)	Double suction volute pump 0.20m^3/s x 10m Suction: φ300mm, Delivery: φ250mm Totally enclosed, Squirrel cage, 37kW, 4P, 3-phase, 380V, 50Hz with common bed and coupling	2 sets
2	Vacuum Pump (with Motor)	0.3m^3/min, φ25mm with water service tank 0.75kW, 4P, 3-phase, 380V, 50Hz with common bed and coupling	2 sets
3	Sluice Valve	Manual, gate valve φ300mm	2 units
4	Check Valve	Rapid closing type φ300mm	2 units
5	Suction & Delivery Pipes	Steel pipe, with flanges φ250～φ400mm	1 set
6	Control Panel (for pump starting)	Self-standing, steel panel Pump starting circuit, Star-delta circuit Control circuit	1 set
7	Barge (inc. pump house)	Steel hull structure 13m x 5.5m x 1.6m Steel frame structure, eave height: 4.0m 9m x 4m x 4.4m	1 unit
8	Connecting Pipe (incl. ball joints)	Steel pipe, φ400mm with ball joints at both ends	1 set
9	Scouring Pump	Submersible pump, φ50mm 3.7kW, 4P, 3-phase, 380V, 50Hz with hose and nozzle	1 unit
10	Spare Parts		1 lot

Table 2-2-2(21-2) Specifications of Plan's Pump Stations

No. 23 Al Rakikin Sahel Pump Station

No.	Description	Specifications	Quantity
1	Main Pump (with Main Motor)	Double suction volute pump 0.10m^3/s x 8m Suction: φ250mm, Delivery: φ200mm Totally enclosed, Squirrel cage 15kW, 4P, 3-phase, 380V, 50Hz with common bed and coupling	2 sets
2	Vacuum Pump (with Motor)	0.3m^3/min, φ25mm with water service tank 0.75kW, 4P, 3-phase, 380V, 50Hz with common bed and coupling	2 sets
3	Sluice Valve	Manual, gate valve φ250mm	2 units
4	Check Valve	Rapid closing type φ250mm	2 units
5	Suction & Delivery Pipes	Steel pipe, with flanges φ200～φ300mm	1 set
6	Control Panel (for pump starting)	Self-standing, steel panel Pump starting circuit, Star-delta circuit Control circuit	1 set
7	Barge (incl. pump house)	Steel hull structure 13m x 5.5m x 1.6m Steel frame structure, eave height: 4.0m 9m x 4m x 4.4m	1 unit
8	Connecting Pipe (incl. ball joints)	Steel pipe, φ300mm with ball joints at both ends	1 set
9	Scouring Pump	Submersible pump, φ50mm 3.7kW, 4P, 3-phase, 380V, 50Hz with hose and nozzle	1 unit
10	Spare Parts		1 lot

Table 2-2-2(21-3) Specifications of Plan's Pump Stations

No. 24 Blowkher Pump Station

No.	Description	Specifications	Quantity
1	Main Pump (with Main Motor)	Double suction volute pump 1.0m^3/s x 11m Suction: φ700mm, Delivery: φ600mm Totally enclosed, Squirrel cage 150kW, 10P, 3-phase, 380V, 50Hz with common bed and coupling	2 sets
2	Vacuum Pump (with Motor)	0.7m^3/min, φ32mm with water service tank 1.5kW, 4P, 3-phase, 380V, 50Hz with common bed and coupling	2 sets
3	Sluice Valve	Manual, butterfly valve φ700mm	2 units
4	Check Valve	Rapid closing type φ700mm	2 units
5	Suction & Delivery Pipes	Steel pipe, with flanges φ600～φ700mm	1 set
6	Control Panel (for pump starting))	Self-standing, steel panel Pump starting circuit, Star-delta circuit Control circuit	1 set
7	Barge (incl. pump house)	Steel hull structure 16m x 7.5m x 1.8m Steel frame structure, eave height: 5.0m 12m x 6m x 5.7m	1 unit
8	Connecting Pipe (incl. ball joints)	Steel pipe, φ700mm with ball joints at both ends	2 sets
9	Scouring Pump	Submersible pump φ50mm 3.7kW, 4P, 3-phase, 380V, 50Hz with hose and nozzle	1 unit
10	Spare Parts		1 lot

Table 2-2-2(21-4) Specifications of Plan's Pump Stations

No. 25 El Ghorera Pump Station

No.	Description	Specifications	Qunatity
1	Main Pump (with Main Motor)	Double suction volute pump 1.45m^3/s x 12m Suction: φ800mm, Delivery: φ700mm Totally enclosed, Squirrel cage 250kW, 10P, 3-phase, 380V, 50Hz with common bed and coupling	2 sets
2	Vacuum Pump (with Motor)	0.7m^3/min, φ32mm with water service tank 1.5kW, 4P, 3-phase, 380V, 50Hz with common bed and coupling	2 sets
3	Sluice Valve	Manual, butterfly valve φ800mm	2 units
4	Check Valve	Rapid closing type φ800mm	2 units
5	Suction & Delivery Pipes	Steel pipe, with flanges φ700～φ800mm	1 set
6	Control Panel (for pump starting)	Self-standing, steel panel Pump starting circuit, Reactor circuit Control circuit	1 set
7	Barge (incl. pump house)	Steel hull structure 18m x 7.5m x 2.1m Steel frame structure, eave height: 5.0m 13m x 6m x 5.7m	1 unit
8	Connecting Pipe (incl. ball joints)	Steel pipe, φ800mm with ball joints at both ends	2 sets
9	Scouring Pump	Submersible pump, φ50mm 3.7kW, 4P, 3-phase, 380V, 50Hz with hose and nozzle	1 unit
10	Spare Parts		1 lot

Table 2-2-2(21-5) Specifications of Plan's Pump Stations

No. 26 El Biadiea El Ollia Pump Station

No.	Description	Specifications	Quantity
1	Main Pump (with Main Motor)	Double suction volute pump 1.30m^3/s x 28m Suction: φ700mm, Delivery: φ500mm Totally enclosed, Squirrel cage 460kW, 8P, 3-phase, 6000V, 50Hz with common bed and coupling	2 sets
2	Vacuum Pump (with Motor)	0.7m^3/min, φ32mm with water service tank 1.5kW, 4P, 3-phase, 380V, 50Hz with common bed and coupling	2 sets
3	Sluice Valve	Manual, butterfly valve φ700mm	2 units
4	Check Valve	Rapid closing type φ700mm	2 units
5	Suction & Delivery Pipes	Steel pipe, with flanges φ500～φ700mm	1 set
6	Control Panel (for pump starting)	Self-standing, steel panel Pump starting circuit, Reactor circuit Control circuit	1 set
7	Barge (incl. pump house)	Steel hull structure 18m x 7.5m x 1.8m Steel frame structure, eave height: 5.0m 13m x 6m x 5.7m	1 unit
8	Connecting Pipe (incl. ball joints)	Steel pipe, φ700mm With ball joints at both ends	2 sets
9	Scouring Pump	Submersible pump, φ50mm 3.7kW, 4P, 3-phase, 380V, 50Hz with hose and nozzle	1 unit
10	Spare Parts		1 lot

Table 2-2-2(22) Specifications of Proposed Maintenance Barge

No.	Description	Specifications	Quantity
1	Barge (incl. house)	Steel hull structure 14m x 6.5m x 1.7m Steel frame structure, eave height: 4.5m 8m x 5m x 4.9m	1 unit
2	Equipment and Tools for Maintenance Barge	(a) General Equipment and Tools (b) Grinding Equipment and Tools (c) Assembling & Disassembling Equipment and Tools (d) Checking & Measuring Equipment and Tools (e) Hanging Equipment and Tools (f) Equipment and Tools for Electricity (g) Measuring Equipment and Tools (h) Supporting Equipment and Tools	1 lot

Note: More detailed specifications for equipment and tools for maintenance barge are referred to Table 2-2-2 (23-1) “Equipment and Tools for Maintenance Barge”

Table 2-2-2(23-1) Equipment and Tools for Maintenance Barge (1/3)

No.			Description	Quantity	Specification
	1	General Equipment and Tools			
1		1	Generator	1	Soundless Type, 3P,200V,25KVA/1P,100V,3KVA
2		2	Cord reel	2	Built in breaker, 30m, 2P, 15A, 125V
3		3	Arc welding machine	1	for 1.6-4mm, Inverter control, DC type, 3P,220V,8.3KVA, 20-200A
4		4	Color splay	1 set	cleaner, penetrating, developping; approx. 420ml each
5		5	Working table with vice	1	1800×900×740mm, load: for 3000kg
	2	Grinding Equipment and Tools			
6		1	Bench grinder	1	two-grinder tyep,150mm, 3000rpm, 100V, approx. 0.75kW, with eye shield
7		2	Portable grinder	1	dia. 100mm, 3000-11000rpm, 680W
8		3	Flap wheel with spindle	1 lot	10 kinds x 5 pcs/pack
9		4	Electric drill	1	13mm, 1400rpm, 100v, 530W
10		5	Cut files Bastard	1 set	215mm/110mm; 5pcs/set
11		6	Cut files Smooth	1 set	215mm/110mm; 5pcs/set
12		7	Sandpaper	1 lot	#30, #50, 50 sheets/each
	3	Assembling & Disassembling Equipment and Tools			
13		1	Gear puller	1 set	Working Width; 275mm, 320mm, 370mm three kinds
14		2	Gas torch	1	Handy type, auto ignition, 270g with 12 cartridges
15		3	Impact wrench	1	Battery operated, 1300kgf torque, Capacity 14AH, with battery
16		4	Doble ended wrench	1 set	11x13, 14x17, 19x21, 212x23, 23x26, 26x29, 29x32, 32x36; 8 kinds
17		5	Single ended wrench	1 set	M36,M38,M41; 3 kinds
18		6	Various wrench	1 set	13x17, 19x21, 22x27x32x35; 4 kinds
19		7	Pipe wrench	1 set	200mm for 1-1/4inches 450mm for 3 inches; 2 kinds
20		8	Monkey wrench	1 set	150mm for 20mm dia. 308mm for 34mm dia.: 2 kinds
21		9	Socke wrench	1 set	M10 ～M30, 13pcs
22		10	Hammer	2	#2 (900g)
23		11	Shhockless hammer	1 set	#3 (1.35kg), #6 (2.7kg), 1 each

Table 2-2-2(23-2) Equipment and Tools for Maintenance Barge (2/3)

No.			Description	Quantity	Specification
24		12	Screw driver （+, －）	2 sets	shaft length: 100mm, 150mm, 300mm 2 kinds each 3 pieces
25		13	Hook spaner	1 set	65/70, 75/80, 85/92, 105/115, 120/130 5 kinds
26		14	Packing tool	2	steel made, L=270mm, composed of dia. 7mm flexible shaft, cork screw and handle
27		15	Hexagon wrench	1 set	1.5, 2, 2.5, 3, 4, 5, 6, 8mm; 8 kinds
28		16	Cutting plier	1 set	L=125mm, 200mm; 2 kinds
29		17	Plier	1 set	L= 150mm, 200mm; 2 kinds
30		18	Snap ring plier	1 set	straight tip type, external 80.2-101.6mm internal 77.8-158.8mm; max. spread 36.5mm; 2 kinds
31		19	Pin punch	1 set	22, 32, 38mm; 3 kinds
32		20	Molykote Lubricants	12	splay type, 330ml, 12pcs per package
33		21	Grease gun	2	lever type, for 200ml
34		22	Bearing heater	1	size 236Hx158Wx372L, 100V, for inside dia. 20mm or over, with carrying case
	4	Checking & Measuring Equipment and Tools			
35		1	Steel ruler	1 set	JIS 1 class; L=300mm,1000mm: 1 each
36		2	Convex ruler	1 set	13mmx2M, 16mmx5.5M; 1 each
37		3	Thermometer	10	Alcohol type, 0～100℃
38		4	Dial gauge with stand	1 set	range 10mm, accuracy 0.01mm, with stand (range: 15mm-210mm)
39		5	Thickness gauge	2	L=150mm, 0.03-0.40mm, 10 sheets type
40		6	Taper gauge	2	L=160mm, range 1.0-15.0mm, accuracy 0.10mm
41		7	Crowbar	2	L=900mm, approx. 2.4kg
42		8	Portable hydraulic jack	1	for 5 ton, range: 160mm height
43		9	Shim	1 set	copper sheet□365×1200mm／5 kinds
44		10	Level	1	L=200mm, accuracy 0.02mm
	5	Hanging Equipment and Tools			
45		1	Wire rope	4	dia. 20mm×5m
46		2	Belt sling	2 sets	25mmx 5M, 50mm×5M□2 kinds
47		3	Lever block	1	for 1.5 ton, range: 1.5M

Table 2-2-2(23-3) Equipment and Tools for Maintenance Barge (3/3)

No.			Description	Quantity	Specification
48		4	Shackle	2 sets	inside width 8mm, 12mm, 18mm□3 kinds
49		5	Hand truck	1	for 150kg loading, with four casters with pedal stopper
	6	Equipment and Tools for Electricity			
50		1	Clamp meter	1	digital handy type, with case range: AC600A, AC600V,1k/10k ohm
51		2	Tester	1	digital handy type, with case range: AC or DC1000V, 42M ohm, 400kHz
52		3	Insulation resister	1	digital handy type, with case Max. measuring current: 1.2mA or less
53		4	Cutting plier	2	L=200mm
54		5	Nipper	2	L=150mm
55		6	Wire stripper	2	for 1.25-5.5mm^2
	7	Measuring Equipment & Tools			
56		1	Vibro meter	1	digital hady type, with case; range: 0.1- 999.9μmp-p, 0.001-9.999cm/s, 0.01-99.99m/s^2
57		2	Noise meter	1	digital handy type, with case range: 35-130 db
58		3	Tacho meter	1	digital handy type, with case range: 0-100,000rpm
59		4	Thickness checker	1	digital handy type, supersonic type, with case range: 0.8-100mm, accuracy: 0.1mm+1.5%
60		5	Paint thickenss checker	1	digital handy type, with case, range: 0-3.00mm, accuracy: 1μm and/or 0.01mm
	8	Supporting Equipment & Tools			
61		1	Tool shelf	1	811×556×1280, 9 drawers
62		2	Emergency light	3	Battery (C-1, 3 pcs) type, handy, with batteries
63		3	Desk & chair	1 set	900×600×600mm, steel type, with rubber cushions, with 2 chairs
64		4	Fire extinguisher	2	ABC powder type, 510mm height 3.5g chamical, weight: 6.4kg
Total		64	items		