3.8.4 Farm Management

Farm size, number of farm laborers, cropped area per farm household obtained from the Farm Economy Survey are summarized in Tables 3-3 (refer to Table F-1-19 to Table F-1-30, Annex F for the further detail). The average farm size is larger than the size mentioned earlier, because the sample farm households include joint families.

3.8.5 Farm Mechanization and Input Supply

Recently, farm mechanization has been making progress in the operation of land preparation and threshing. Other advantages were also noticed because of this mechanization. For example, farmers use the engines of agricultural machines to lift irrigation water instead of Saqia operations. And this practice is very popular in the Study Area. Moreover, the engine type sprayers are also used together with hand sprayers.

The ownership of farm machinery was calculated during the Farm Economy Survey and the results are presented below;

Ownership of Farm Machinery

Machinery Type	Number of Farm Households per Unit
Tractor	12
Powered Sprayer	2
Thresher	6
Truck	6
Pump Set	2

Source: Farm Economic Survey (1994)

According to the Farm Economy Survey it was found that the farmers in the Study Area use high yielding varieties in case of wheat, cotton and rice. However, in case of berseem, traditional/local varieties are cropped. There are many fields where the standing crops are a mixture of irregular plants because of limited usage of quality seeds.

Table 3 - 3 Estimated Cropped Area per Farm Household

Item	Amount	
1. Farm Size (ha)		
(1) Land under Annual Crops		
- Owned	1.9 ha	(4.7 feddan)
- Rented	0.3 ha	(0.8 feddan)
Sub-total	2.2 ha	(5.5 feddan)
(2) Orchard	few areas	
Total	2. 2 ha	(5.5 feddan)
2. Number of Family Members	8.7	(female 4.2)
3. Number of Labor Force		
- Self Farm	2.8	(female 0.8)
- Other Farm	0.4	(female 0.1)
- Non-Farm	0.7	
Total	3.9	
4. Crop Area		
(1) Winter Crops		
- Wheat	0.9 ha	(2.1 feddan)
- Berseem, short term	0.3 ha	(0.7 feddan)
- Berseem, long term	0.7 ha	(1.7 feddan)
- Beans	0.2 ha	(0.5 feddan)
- Vegetables and Others	0.1 ha	(0.3 feddan)
Sub-total	2.2 ha	(5.3 feddan)
(2) Summer		
- Cotton	0.8 ha	(1.9 feddan)
- Rice	0.3 ha	(0.8 feddan)
- Corn	0.6 ha	(1.5 feddan)
- Vegetables and Others	0.7 ha	(1.6 feddan)
Sub-total	2.4 ha	(5.8 feddan)
Total	4.6 ha	(11.1 feddan)

Commonly used fertilizers are nitrogen and phosphate. For cotton, the dosage of nitrogen seems to be very high, about 200 kg/ha. On the other hand, 100 kg/ha of nitrogen is used for wheat, rice, and maize. Pesticides are applied in normal doses, because they are supplied at subsidized prices by cooperative societies of MALRF. Regarding pest control in cotton fields, services like application of sex hormone substances and spraying of pesticides by helicopter are provided by MALRF.

3. 8. 6 Animal Husbandry and Inland Fisheries

1) Animal Husbandry

The majority of farm households raise cattle and water buffaloes not only for draft but also for meat and milk purposes. The main food for these cattle are berseem and corn which occupy 30 to 40 percent of total cropped area both in winter and summer seasons. Besides these crops, the straw of wheat and rice is also another important feeding source. Recently, raising of broiler and chicken for eggs on a commercial basis has been expanded in many places in the Study Area. The average numbers of livestock and poultry per farm household obtained from the Farm Economy Survey are shown below;

Average Number of Livestock and Poultry per Farm Household

Livestock/Poultry	Number per Farm Household	Remarks
Cattle	1.3	
Buffaloes	1.2	
Sheep	1.3	
Goat	0.5	
Donkey	0.5	including broilers
Chicken	13.7	
Ducks	6.3	

Source: Farm Economy Survey (1994)

2) Inland Fisheries

According to the Register Book (1993) of Mariut Lake Fishery Cooperative, there are about 5,600 fishermen who are engaged in inland fishery in Mariut Lake (water surface area is about 5,460 ha). The 1993 fish

catch was recorded as 3,440 tons, with the fish catch per fisherman and catch per hectare of water area, is 600 kg per year and 500 kg respectively. Tilapia amounts to about 74 percent of the total fish catch, followed by catfish and eel. The amount of gross production value per fisherman may be estimated at about LE4,200, applying the assumed selling price of LE7/kg. The fish catch has been decreasing since 1986, as the lake water has become polluted year by year. The fish catch has decreased from about 5,800 ton in 1986 to 1,700 ton in 1990.

However, it has started to show an increase tendency since 1992. The reason for this increase may be due to the introduction of huge amounts of drainage water from Omoum main drain into the Lake through cuts in the embankments. There is another source of fish in another lake (water surface area is only about 500 ha), which belongs to Qalla drainage block. The lake is fed by some surplus water from Mahmoudia canal. The production in this lake is managed by Egyptian Fishery Company, and fish catch per hectare of water area exceeds one ton (refer to Annex J).

Besides the above mentioned two sources of catch, fish in irrigation canals and drains are caught by local people everywhere in the Study Area, which is a source of protein for them.

3. 8. 7 Agricultural Supporting Services and Research Activities

1) Agricultural Supporting Services

Under the Ministry of Agriculture, Land Reclamation, and Fishery (MALRF), there are many agencies engaged in specific agricultural supporting activities in the Study Area. These agencies have organizations from national to local level, and their management is independent. A special arrangement is necessary to have an integrated agricultural supporting services in order to achieve a common target for specific area development. The major agencies and their activities related to the farm land improvement are as follows;

- Land improvement	One Directorate of Authority of Land Improvement is placed in Behera Governorate, providing farmers with services of land leveling, clearing of canals and drains

	at the on-farm level at a subsidized price. However, the services are not extended properly and adequately due to lack of machinery and finance.
- Supply of Qualified Seed	There is a local office of Central Authority for Seeds in Behera Governorate, which supplies quality seeds. The seeds are distributed among farmers through agricultural cooperative societies by agricultural extension staff.
- Agricultural Extension	The relevant agricultural extension staff are posted by Governorate to village level to provide the extension services on production of upland crops, vegetables, fruit trees, animal husbandry, pest control, soil and water management, and inland fisheries by MALRF.
- Farm Mechanization	Two Farm Mechanization Stations are located in Behera Governorate, where farm machinery including tractors and threshers are distributed and extend machinery operation services at subsidized operation rates.

2) Research Activities

There is a agricultural research station to conduct regional agricultural research in Alexandria Governorate. Beside this research station, Drainage Research Institute (DRI) belonging to MPWWR, has been carrying out research on the following items implementing a pilot project of 210 ha (500 feddan) in Hares drainage block;

- To evaluate the effect of tile drainage on crop production,
- To determine the most economic tile drainage intensity (spacing, depth, and length of laterals),
- To compare various locally produced synthetic envelope materials, and evaluate their effectiveness and cost,
- To evaluate the effect of using plastic collectors on implementation quality, hydraulic performance, cost and economy and maintenance requirements.

The above research work is technically oriented, but for agricultural development with drainage improvement development, the experimental activities on soil improvement, improvement of crop cultivation and so on is not included.

3.8.8 Supply and Demand for Agricultural Products

The self-sufficiency condition of food and agricultural commodities in Egypt is shown below;

Self-Sufficiency of Food and Agricultural Commodities in Egypt
(Quantity-wise)

Item	Self-Sufficiency (%)
Wheat	43
Rice	100
Cotton	100
Fresh Vegetables including Onion	100
Fruit	100
Sugar	60
Edible Oil	72
Meat	70
Dairy Products	84

Source: Second Five - Year Plan

The deficient food is supplemented by imports. On the other hand, the surplus food and other agricultural commodities such as cotton, vegetables, Irish potatoes, sweet potatoes and oranges are exported. These commodities are playing an important role earning valuable foreign currency. Living standards in some parts have risen up, and the demand for flowers and ornamental plant has also increased. There is a large potential to develop flowers and ornamental plants cultivation.

3.9 Agro-Economic Conditions

3.9.1 Variable Costs and Income of Products

It will be such ideal when farmers' cash flows can be estimated. In the absence of such data on detailed cost and income survey, indirect methods of estimating farmers' variable costs and income have been attempted. Gross income of selected major crops (rice, cotton, maize, broad beans, short and long berseem, and wheat), on-farm consumption, net farm income, and total variable costs of production are summarized below;

Income, Cost, Net Return by Major Crop, 1994

(unit: LE/feddan)

Major Crop	Gross Income	Net Income	Production Cost	Net Income
Wheat	1,566	909	1,398	168
Rice	950	467	1,463	-513
Seed Cotton	3,301	2,448	1,861	1,440
Maize	1,489	668	1,413	76
Beans	1,157	715	857	300
Berseem (long)	1,525	1,237	596	629
Berseem (short)	671	464	556	115

Source : Irrigation Improvement Project, IPP & PPD of WPWWR, Cairo, 1994 and Farm Economic Survey

Note : Gros income = derived from main and secondary product

Net income = Gross income minus farm consumption and production cost

Production cost = sum of non-yield dependent costs and yield dependent costs (machine, labor, etc.)

Net return = net income minus the production cost

The above table compares gross income, net income, production cost, and net income for each major crop. Seed cotton is more profitable than rice or maize in summer, and wheat is not more lucrative than berseem or beans. The table is based on the financial unit value multiplied by crop yield per feddan.

3.9.2 Farmers' Income and Poverty Conditions

The most comprehensive income and expenditure survey was conducted in 1990 - 1991. The survey shows that the average rural income was LE3,500. The lowest income bracket was LE1,500 or less, compared to the highest group of LE25,000 or more. The distribution of income was a bell-shaped curve.

Recent farm household survey in Hares Area reveled that the average farmer's annual income without project was LE 2,535, as compared with LE 6,922 should to farmer receive full benefit with project implementation. (For detail, see tables I-2-60).

The above income is derived from major crops such as wheat, beans, berseem, cotton, rice, maize, and vegetables. Income from citrus was not included.

The distribution of land ownership in Egypt, 1993 indicates that 94 percent of land owners own to the land of five feddans or less. (see Table F-2-9, Annex F). This situation remains unchanged in the Study Area. The representative farmer owns 4.2 feddans for a living. The most productive farmer is engaged in summer and winter crop productions. This means that crop intensity has a maximum of 200 percent. Usually a family consists of seven members with four active working members.

The poverty may depend upon the definition. What constitutes subsistence level of rural household livelihood ? If the subsistence level refers to food and drink, the rural poverty level may range between LE1,200 and LE1,500. On the other hand, when basic education and health care are included, poverty levels may jump to LE2,000. Tenant farmers who cultivate three feddans or less are below the poverty level. Their annual income is under LE1,600.

3.9.3 Marketing of Agricultural Products

Marketing is an important aspect of the cooperatives, assisting farmers to ship their products to the areas where demand exceeds supply. Most farmers sell their own products at the nearest cooperatives and local markets. Products for export are reasonably well organized. However, domestic products are not well organized due to the lack of information and institutional barriers.

This is due to legacy of long-time state-controled farm policy. It will take some time to implement marketing aspect of cooperatives although free market economy has been operating since 1990. Some consulting organization to assist the marketing of agricultural cooperatives will be needed.

3. 9. 4 Agricultural Supporting Services

Agricultural cooperative societies are generally organized at village level (Sheyakha) by the Ministry of Agriculture, Land Reclamation and Fishery (MALRF). Agricultural supporting services such as extension services as well as farm input supply of seeds, fertilizers, insecticides with subsidized prices are conducted at the village level. Up to 15 agricultural staff members including engineers and agricultural extension officers of MALRF are posted in each village agricultural cooperative office to render agricultural supporting services.

Aside from these village agricultural cooperatives, some agricultural cooperative societies in the land reformed areas are organized, and different agencies from the above mentioned MALRF office are placed to extend basically the same agricultural supporting services.

Recently, the organization of farmers' associations for on-farm operation and maintenance of irrigation and drainage systems has been to establish in some pilot areas by the Irrigation Department and the EPADP.

The following are the field survey's findings on the agricultural supporting services;

- More intensified and comprehensive agricultural supporting services to the downstream areas may be required to raise cropping intensity and crop yields.
- Accelerated and intensified improvement of on-farm operation and maintenance for both irrigation and drainage systems are required.

3. 9. 5 Farmer's Organization

The agricultural cooperatives are organized at village level. The cooperatives are made of general types, specialized types (poultry, livestock, fruits, and vegetables), and land reform cooperatives. The cooperative societies are organized by farmers with ten selected board members, provided with agricultural supporting services by MALRF.

General cooperatives provide services such as distribution of seeds, fertilizers, and other agricultural chemicals such as pesticides, herbicides, fungicides, pest control etc. with subsidized prices. The cooperatives also provide machinery service such as tractors and pumps at subsidized prices.

Some of these services in the Study Area may be summarized as follows;

Pest control : subsidized
Machinery : 15 to 20 LE per feddan for plowing and threshing
Seeds (cotton, rice, maize, wheat, and berseem) : subsidized
Fertilizer : subsidized

As regards farmers' organization for operation and maintenance of irrigation and drainage facilities at on-farm level, the Water Users' Association and the Drainage Users' Association are newly organized by both agencies of the Irrigation Department and EPADP in the selected areas. Although these two agencies have started to extend advisory services on operation and maintenance at on-farm level, the coverage of the farmers' organization and the extension of advisory services are still very limited.

3.9.6 Agricultural Credit

Agricultural credit is available at the agricultural cooperatives for all kinds of agricultural improvements. There are over 100 kinds of agricultural loans available to farmers throughout the credit banks. Each Governorate has its head office, branch offices, and village offices. In Behera Governorate, the credit bank has its head office in Damanhur, 14 branch offices and 82 village offices.

When a farmer needs a loan for a specific purpose, such as irrigation or drainage improvement, he will apply for a loan with detailed breakdown of the project cost. If the project cost is considered reasonable, the bank will normally approve approximately up to a maximum of 80 percent of the loan requested.

Terms and conditions of the loan vary according to the principal amount and the period of the expected loan. The loan has three categories,

short-term (less than one year), medium-term (one to five year period), and long-term (six to ten years). The interest rate charged by the bank will also vary between 10 and 15 percent. The interest rate is not compounded, but a simple per annum rate.

The proportion of land-owning farmers who utilize the credit bank is approximately 80 percent in Behera Governorate.

The risk factors of agricultural loans are classified into two categories; one is natural accidents such as flood and fires beyond farmer's control; the other is farmer's responsibility. In the case of the former, the bank will make all possible adjustment to the farmer in repaying the loan he has borrowed. In the latter case, the farmer has to prove why he had failed to pay back the remaining balance of the loan. In case of default, the farmer has to pay the penalty of one percent of the loan outstanding plus the normal interest charge he had incurred.

Bad loans as a percentage of total loans are approximately five percent. This includes loan default attributable to natural accidents and to personal non-payments.

The major criterion of approving a loan is whether the loan application will contribute to agricultural development such as reclamation, irrigation, tile drainage, well exploration, animal production and reproduction, projects necessary for reclamation, etc. The cost estimate has to be reasonably accurate and with detailed documentation. No co-signature will be required. Only one person or one group of responsible persons will be required for application.

3.10 Rural Infrastructure

3.10.1 Village Water Supply

Domestic water supply in the vicinity of the Study Area is undertaken by the Behera Water Supply Company, which is under the jurisdiction of Behera Governorate. The water is supplied to each consumer through pipeline systems originating from three main treatment plants, that is, Damanhur, Abu Hommos and Nubariya Treatment Plants. However, in the rural area public

supply systems (so-called "Sadaka") with four taps on a concrete structure are currently predominant, and usually provided at an interval of about 500 m on average in villages. Under this system, about 90 percent of local people benefit by those pipeline systems, and the remaining 10 percent living in the areas far away from the piped water source rely upon shallow wells or water transported by mobil tanks.

According to the information obtained from the Company, it is said that Sadaka systems are considered to be ineffective due to local people's lack to attention of local people for saving water, resulting in an increase of water losses.

An average amount of water consumption is 150 lit./day/head, while that in the rural areas is within a range of 50 - 70 lit./day/head.

3. 10. 2 Village Roads

Construction and maintenance of roads are the responsibility of the Road and Transportation Directorate of Behera Governorate. These roads can be classified into three types; provincial, union council and village roads. The union council and village roads are usually without pavement. Total road length in Behera Governorate and its density in 1991 are as follows;

- Paved roads (asphalt roads)	:	764 km (75 m/sq.km)
- Un-paved road (dust roads)	:	835 km (82 m/sq.km)
Total		1,599 km (157 m/sq.km)

In addition to the above mentioned roads, operation and maintenance roads along the irrigation canals and drains are utilized as communication roads among the villages.

3.11 Environment

3.11.1 Present Conditions

From water quality aspect, the Study Area can be divided into two zones, that is, Omoum drain area and Mariut Lake. The former is the main drain in the Study Area, which is collecting agricultural effluence from farmland of about 407,860 feddan (171,300 hecters) in total. Mariut Lake is located on the nearby estuary of the Omoum main drain, and receives all the drainage water. The Nubariya (navigation) canal water and waste water from Alexandria are also flowing into Mariut Lake. Under these conditions, quality of water flowing into Mariut Lake can be largely classified into three categories depending on its canal and outlet, as described below

Nubariya canal used for navigation purposes to Cairo has relatively clean water diverted from El-Behery Canal. The Omoum main drainage water has a high salinity, because of extracted saline water from tile and open drains. Alexandria waste water is discharged through East and West Treatment Plants (ETP and WTP) after sewage treatment, which are operated from July 1993; the high contents of nutrient salts and sediment. The treatment is primary basis. ETP discharges to the Mariut Lake through Qalla pumping station after mixing with farm drainage water, and WTP directly to the Lake.

Under this situation, although the waste water is treated to improve water quality through plants, Mariut Lake water is still polluted by this waste water. In particular, odors from the Qalla drain outlet, which is located at the entrance to Alexandria on a desert road, are emitted and impresses the visitors with a bad image of Alexandria.

1) Water Quality

A water quality survey for surface water was conducted on 20 samples in the Study Area. In addition to this survey, necessary data and information on the water quality were collected such Programmes as the Reuse Monitoring Programme Year Book prepared by the Drainage Research Institute (DRI), and data maintained by ETP and WTP. According to water quality analysis of water resources, Omoum main drain and Nubariya canal supply better water than other sources in terms of the water contents (DO, COD, BOD, T-N and

coliforn, see Annex J). On the other hand, groundwater quality was surveyed at 100 selected sites in the Study Area.

As mentioned above, main water sources for the Mariut Lake are Omoum main drain, Nubariya canal, Qalla drain and WTP, Alexandria. The annual discharges in 1994 from these drains and canals are roughly estimated as shown below;

Annual Discharges in 1994

Water Sources	Discharge	Rate
1. Omoum Main Drain	(MCM)	(%)
(Inflow to Mariut Lake)	1,435	64.2
2. Nubariya Navigation Canal	(630)	(28.2)
3. Hares Pumping Station	228	10.1
4. Qalla Pumping Station	174	7.8
5. West treatment Plant (WTP)	290	13.0
6. Wea Water Intrusion	72	3.2
7. Rainfall	20	0.9
	17	0.8
Total	2,236	100.0

Total inflow to Mariut Lake	;	(1,432)
Agricultural dischage	;	1+2+3=1,838 (82%)
City waste water	;	4+5=362 (16%)
Others	;	6+7=37 (2%)

Proportion of inflow discharges from city waste water such as ETP and WTP is relatively large with 25 percent of the total inflow discharges exclusive of released discharges directly drained from Omoum main drain to the Mediterranean Sea. COD load balance is 152,000 ton/annum of inflow and 121,000 ton/annum of outflow, resulting in accumulation of nutrient salt in Mariut Lake (refer to Table J-2-9, Annex J).

2) Environment of Mariut Lake

The water level of Mariut Lake is controlled and maintained by the El-Max pumping station. Its annual discharges in 1994 are about 2,400 MCM on average, which is equivalent to total inflow to the Mariut Lake subtracting water losses. Omoum main drain and Nubariya canal supply clean water to the Lake. If inflow to Mariut Lake are limited to Omoum main drain and Nubariya canal, Mariut Lake water quality could be preserved at an acceptable level. It

is reported that sewage from Ameriya town is released into Nubariya navigation canal, and necessary water treatment should be carried out as early as possible.

Vegetation such as reeds (booth) and cattail are grown in certain areas of the Lake, and these areas would become suitable for birds, fish and other wildlife. Furthermore, it would also preserve beautiful scenery for the local people. These facts are very important factors for a sound lake environment. The following data provide the major features of Mariut Lake.

- Alternation of Mariut Lake scale.

Year	Area		Storage Capacity	Water Depth
	(feddan)	(%)	(MCM)	(m)
1952	54,000	100	453.6	2.0
1960	36,000	66	226.8	1.5
1985	16,000	20	67.2	1.0
1993	13,000	16	54.6	1.0

Note; storage capacity of Lake in 1993:
V = 13,000 feddan × 0.42 × 1.0 m = 54.6 MCM
Data Source; General Authority for Fish Resources Development

- Water quality of Alexandria East and West Treatment Plants

	ETP	WTP
Outfall Discharge (cu.m/day)	350,000	176,000
TSS : Inflow (mg/lit.)	271.7	916.0
Outflow (mg/lit)	101.1	120.1
BOD : Inflow (mg/lit.)	188.7	560.0
Outflow (mg/lit.)	123.3	144.5

Data Source; ETP : July 1994, WTP: June 1994

- Fish production of Mariut Lake and Nozuha

Year	Mariut Lake		Nozuha	
	Production	Ratio	Production	Ratio
	('000 ton)		('000 ton)	
1985	5.83	1.00	0.23	1.00
1986	5.60	0.96	0.21	0.91
1987	4.24	0.73	0.11	0.48
1988	3.04	0.52	0.56	2.43
1989	2.14	0.37	0.25	1.09
1990	1.71	0.29	0.33	1.43
1991	1.95	0.33	0.34	1.48
1992	3.09	0.53	0.22	0.96
1993	3.44	0.59	0.11	0.48

Data Source; Undersecretary of Fish Resources

From environmental viewpoints the followings are considered important,

- There is a salinity problem in the whole catchment area of Omoum drain, but water quality problems including eutrophication are concentrated in the downstream section of the system, especially in Mariut Lake.
- North-east side of Mariut Lake can be called a eutrophic lake, due to the discharge of domestic waste water, so that necessary countermeasures should be taken as soon as possible.
- Omoum main drain connects Mariut Lake as a main water source and supplies water about 70 cu.m/sec on average. It is equivalent to 80 percent of water source share.
- Water level of Mariut Lake is controlled by the El-Max pumping station, which discharges the excess water into the Mediterranean sea.
- About 5,600 fishermen depend for their living on the Lake, and they have a keen interest in the water level of Mariut Lake, especially at the present level of (-) 2.70 m. MSL below mean sea level, which, according to them, is reasonably good for fish culture in the Lake.
- Improvement and rehabilitation plan for Omoum main drain system should consider these actual conditions.

3. 11. 2 Initial Environmental Examination

Initial Environmental Examination (IEE) for the Study Area has been drafted after deliberations with agencies concerned, based on the results, evaluation of the data and information collected.

As a result of analysis and discussion on IEE for the Farmland Environmental Improvement Project, the environmental impact envisaged by the study are summarized as follows;

Social Environment

- Changes in economic activities, and operational change and loss of job opportunities for fisheries,
- Necessity of water on fishing rights regulations and complications in adjustment.

Natural Environment

- Changes in surface and groundwater hydrology,
- Impediment of inland fisheries,
- Water pollution and deterioration of water quality,
- Water eutrophication,

In conclusion, taking into account the existing situation in the vicinity of the Study Area and tentatively proposed project components, an Environmental Impact Assessment (EIA) on the Farmland Environmental Improvement Project will have to be carried out.

3. 12 Related Projects and Studies in the Study Area

The following related projects and studies have been implemented in the Study Area.

- Subsurface Drainage Development Project
- Behera Rural Development Project (BRDP)
- Main System Management (MIS) Project

- Subsurface Drainage Design for Hares Pilot Area
- Reuse Monitoring Programme
- Omoum Drain Project
- Balaqtar Irrigation Project
- Mahmoudia Irrigation Improvement Project
- West Nubariya Agricultural Intensification Project

Subsurface Drainage Development Project;

This is a subsurface drainage projects in Egypt for target completion by the year of 2000 by means of tile drains. In the Study Area, 138,000 feddan (58,000 ha) of land has been provided with tile drains. The implementing agency is Egyptian Public Authority for Drainage Project (EPADP), Ministry of Public Works and Water Resources, financed by UNDP and the World Bank.

Regarding this project in the Study Area, about 44 percent of farmland in the upstream areas has been provided with subsurface drainage. However, it is observed that anticipated benefits are not yet being obtained in some areas due to inefficient functioning of these subsurface drainage.

Behera Rural Development Project (BRDP);

This is a rural development project covering 135 villages in Behera Governorate. Major components of the projects are; a) soil improvement, b) agricultural intensification, c) subsurface drainage design for Hares Pilot Area, d) basic infrastructure improvement, e) improvement of agricultural services, and f) project administration and coordination. The project implementation agency is the Ministry of Agriculture, Land Reclamation and Fisheries, with a financial assistance from the African Development Bank (ADB) and African Development Fund (AFD).

According to the information, progress of the rural development project in the vicinity of the Study Area is that so far 85 villages have been completed by July 1992, and the remaining 50 villages are presently under implementation.

Main System Management Project;

This is one of the ten components of the Irrigation Management System project (IMS), which intends to strengthen the capability and capacity of the Ministry of Public Works and Water Resources (MPWWR) in the aspects of planning, design, operation, management, and maintenance of the Nile River irrigation system in Egypt. Objectives of the project are; a) efficient management of the Nile River water resources, b) preparation of accurate and real-time data for the water managers, c) communication facilities to operate the irrigation system facilities. The project is being implemented by a grant from the United States Agency for International Development (USAID).

At present, three automatic water level gauges, which have been installed at the Truga and El-Max pumping stations and Kofr Boleen Regulator are recording / monitoring the data and sending them to Cairo.

Subsurface Tile Drain Design for Hares Pilot Area;

This is a pilot project for tile drains, aiming at testing technology and economy of drainage systems. The objectives of the project are; a) evaluation of effects of drainage on the crop production, b) determination of the most economic drainage intensity (spacing, depth, and length of laterals), c) comparison of various locally produced synthetic envelope materials, and evaluation of their effectiveness and costs, and d) evaluation of the effect of using plastic collectors on implementation quality, hydraulic performance, cost and economy and maintenance requirements. This project is a joint activity of the Drainage Research Institute (DRI), MPWWR and the Directorate General for International Cooperation, Ministry of Foreign affairs, Government of the Netherlands.

The results of this research on subsurface drainage will be applied to the areas to be provided with subsurface drainage facilities in future and also areas to receive improved facilities.

Reuse Monitoring Programme;

The objectives of this programme are to provide the Ministry of Public Works and Water Resources with data concerning the quantity and quality of the generated drainage water in the Nile Delta and to provide the Reuse of Drainage Water Project with reliable data for

calibration. This project is being implemented by the Ministry of Public Works and Water Resources with financial assistance from the Netherlands Government.

In the vicinity of the Study Area, seven sites of the reuse of drainage water projects are in progress.

Omoum Drain Project;

Egyptian Government made a plan to expand irrigation area as a government policy, in order to meet rapid population growth in the country, by means of reuse of drainage water of the Omoum main drain.

The objectives of Omoum Drain Project is to collect the drainage water from the three catchments of Omoum main drain, Abu Hommos, Shereshera and Truga in a channel, which flows opposite to the direction of the Omoum main drain by the provision of regulator in drain and three pump stations. This collection of water will then be mixed with the fresh water of Nubariya canal at km 46.0. The quantity of drainage water to be used in the project is about one billion cubic meter per year, and has an average salinity of 2,090 ppm according to the obtained data in 1994. The expected salinity of water after mixing will be in the margin of 630 ppm.

Balaqtar Irrigation Project;

The project is located in the Mahmoudia irrigation area of 11,500 feddan (4,830 ha), and aims to demonstrate the modernized irrigation systems including the of on-farm level (Meska), to increase irrigation efficiency in the canal systems and to conduct well-water management at field level. Major project components are; a) provision of head regulator in the Mahmoudia irrigation area and improvement of 16.8 km of the Balaqtar canal, b) provision of pipeline systems branching off from the Balaqtar canal, c) improvement of drainage conditions, d) improvement of on-farm facilities at Meska level, and e) establishment of farmers' groups in each irrigation system. The Project was implemented by the Irrigation Department, MPWWR over a period of five years, from 1988 to 1992 with the assistance of the World Bank.

Mahmoudia Irrigation Improvement Project;

The objectives of the projects are; a) increase of agricultural production by improving the irrigation facilities, b) improve farmers'

income and involve them in the management as well as operation and maintenance of tertiary canals, c) improve communication with farming community, policymakers and technical staff of the Government, and d) improve institutional planning and implementation capacity of Ministry of Public Works and Water Resources in the irrigation subsector. The project will be implemented between 1995 and 2002, with assistance from the World Bank.

West Nubariya Agricultural Intensification Project;

The Food and Agricultural Organization (FAO) and World Bank programmed to undertake a project to intensify agricultural production in the West Nubariya Region through a six year project intending to a) rehabilitate on-farm irrigation infrastructure, b) remodel the open drainage network and installation of subsurface tile drains in some areas, c) strengthen the adaptive research and agricultural extension services, d) develop farming cooperatives, e) develop agricultural credit institutions, f) provide funds for incremental inputs and long-term investments in agricultural machinery, livestock, fruit tree, etc., and g) establish a project management unit.

The detailed descriptions of these related projects and studies are given in Annex K.

CHAPTER IV. DEVELOPMENT POTENTIAL AND ITS RESTRICTIVE FACTORS

CHAPTER IV. DEVELOPMENT POTENTIAL AND ITS RESTRICTIVE FACTORS

4. 1 Land and Water Resources

4. 1. 1 Land Resources

1) Farmland Improvement with Subsurface Tile Drains

About 50 percent of the Study Area is of deeply deposited fertile alluvial soils which are suitable for growing various crops. Most of the area has already been covered by the subsurface tile drain project, and it was reported that the farmers have benefit fed to ascertain extent. It is envisaged that further benefits may be obtained through drainage improvement in this drainage project.

2) Farmland Improvement for Cultivable Waste Land

As explained in the paragraph of "3.5 Soils and Land-Use", Chapter III, land classes from first to fourth cover only 62 percent of the related Districts in the Study Area and the remaining area are classified into fifth (cultivable waste land) and sixth class land (non-agricultural land). This land can be converted to a suitable cultivable land. This land is mostly found in the Districts of Abu El Matameer, Delengat and Hosh Esa. In these Districts, the rate of cultivation is very low due to the high content of salty substances in the soils (electric conductivity is more than 16 mS/cm) and the high groundwater table. A comparison revealed that the situation has not changed adequately during the last 30 years.

In the downstream area, especially in Hares and Truga Areas, where the land is of fifth class, there has not yet been subsurface tile drain improvement. In both of the areas, land is utilized less efficiently and the yield is considerably low although there is a development potential to cultivate the land. Not only improvement of Omoum drainage system but also a comprehensive farmland improvement is required to convert the uncultivated or less utilized land to productive land.

4.1.2 Water Resources

1) Effective Use of Limited Water Resources

From a water balance study it was learnt that two main canals that serve as the water sources for the Study Area have insufficient water to serve their overall command areas. According to the information, Western Desert Reclamation Plan is on going, which is located on the left side of Nubariya canal. The present possible source of water for this area would be the Nubariya canal or groundwater. But extraction of groundwater could be costly and scope for increasing the share of Nubariya canal from Behera Raya is also very thin. Therefore, only way left is to divert the water in Omoum main drain that flows into the Mediterranean Sea, about 2,440 MCM per year. But before making any reuse of drainage water, proper attention should be given on its water quality.

2) Adequate Distribution of Water

At present irrigation is performed on a rotation basis, that is, in the Mahmoudia area five-days-on and five-days-off, and in Nubariya area five-days-on and ten-days-off rotation is practiced. But the rotation is not strictly followed. If a rotational system is strictly practiced, it will help increase irrigation efficiency reducing the drainage discharge and bring positive results in the overall water management system.

3) Water Level Management of Mariut Lake and Omoum Main Drain

The existence of Mariut Lake in the area is an important feature not only from the environmental viewpoint but also for the water resources. The deterioration of the water quality has made it necessary to cut the embankment of Omoum main drain and Nubariya canal, in order to feed it with fresh water. Due to these cuts up to 10 km of Omoum main drain and 12 km of the Nubariya canal have become part of this Lake, and have caused the water level of Omoum main drain to be higher than its design water level of (-) 3.25 m.MSL. This increased water level is causing adversely in the upstream drainage systems, especially tile drainage.

4) Water Quality Conservation of Sewage Water

Among the present inflow sources to the Mariut Lake, discharges from Qalla pump station (which includes ETP water) and WTP (378 MCM annually) are primarily treated sewage water with huge amount of suspended particles. Deposition of these particles at the bottom of the Lake is one of the main cause not only for an un-healthy environment for fish culture in the Lake but also for loosing Lake's reserving capacity.

4.2 Irrigation and Drainage Aspects

4.2.1 Irrigation

1) Strengthening of Water Management in the Canal Systems

Main, secondary and tertiary irrigation canals in the Study Area are operated and maintained by the related Irrigation Directorate. In the course of these canal systems, it is considered that remarkable amounts of water are wasted and flow into the drains due to inadequate operation of gate structures and poor water management. These facts lead to an increase in electricity charges due to increased use of drainage pumps to drain the excess water.

2) Reduction of Water Losses at On-Farm Level

On the other hand, irrigation at the on-farm level is undertaken by farmers using small pumps on Saqia. Usually, water is lifted from the tertiary canals and delivered to the field ditches (Marwa). Marwa is a small earth ditch with a width of about 50 cm and a depth of 20 cm. Conveyance losses at on-farm level seem to be high, so that necessary countermeasures to reduce these losses should be undertaken, by applying suitable irrigation methods.

3) Establishment of Water Users' Association

At present there is no water users' association and the farmers do not pay any charge for water. Therefore, the farmers are taking irrigation water much more than they actually need. In order to utilize water resources

precisely and effectively, the establishment of water users' association and training for water management for the farmers will be essential in the area.

4. 2. 2 Drainage

1) Setting of Adequate Water Level in Open Drain

According to requests from fisheries and navigation sectors, water level of the Mariut Lake and the Omoum main drain are maintained relatively high, about (-) 2.70 m.MSL below mean sea level, which is 0.5 m higher than the designed water level of (-) 3.25 m.MSL. Consequently internal water level in each drainage block is also high compared with the designed one, in accordance with raised delivery side water level in the Omoum main drain. This situation will have a negative effects to subsurface drainage.

2) Adequate Provision of Subsurface Tile Drains

About 44 percent of the Study Area has already been furnished with subsurface tile drains, and these areas generally have a good drainage conditions with well-functioning tile drains. But according to the survey results, some areas have not reached the expected target, so that it is considered that there are technical problems during the course of execution or maintenance of the tile drains, although technical research involving spacing and depth of tile drain and suitable envelope materials, etc. has been undertaken in Hares Pilot Area by DRI.

3) Improvement of On-Farm Drainage Systems

Generally speaking, no severe crop damage resulting from poor drainage during summer season has occurred in the cultivated land. But during the winter season, November to February, daily rainfall of 20 to 30 mm occurs since the on-farm drain is generally abolished in the areas after implementation of subsurface tile drain, the on-farm drainage is not sufficient, and some winter upland crops sustain partial damage from inundation.

4. 3 Agricultural Aspects

1) Intensification and Diversification of Crop Production

Behera Governorate which covers most of the Study Area is a vegetable and fruit production area. It is considered that the climate is suitable for growing these crops and this area is adjacent to the market in the nations' second largest city, Alexandria. However, some farmers enjoy considerably high and stable production with various diversified crops in limited areas in the upstream drainage blocks, which benefit from subsurface tile drain project. Contrarily, it can be observed that the land is inadequately utilized to a considerable extent in the downstream area, especially in Hares and Truga areas, where considerable fallow and cultivable waste land exist.

2) Increase in Crop Yield

The crop yield in the Study Area are lower than the level of the whole country as well as the Behera Governorate. It seems that the low crop yield is basically related to farmland conditions, which may include high soil salt content, high groundwater table, flooding, shortage of irrigation water, and some coarse and less fertile soils, and so on. These problems could be solved through integrated farmland improvement including improvement of the drainage system. The irrigation improvement up to on-farm level for more timely and efficient water intake, together with the subsurface drainage project will be needed in the Study Area. Then, the advisory activities regarding on-farm irrigation and drainage to the beneficial farmers should play an important role for the substantial improvement of farmland at on-farm level.

3) Strengthening of Agricultural Supporting Services

Very limited agricultural supporting services are provided to farmers concerning to the farmers' participation in drainage improvement at on-farm level as well as operation and maintenance of the drainage facilities, because EPADP has just establish Drainage Advisory Units which are responsible to organize Drainage User' Associations with necessary advisory services. Also, there are limited agricultural supporting services for improvement of marketing of vegetables and fruits for domestic and foreign markets at

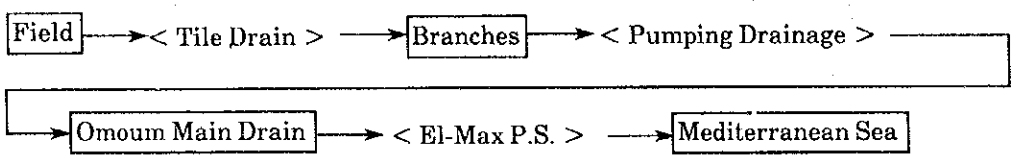
agricultural cooperative level. Among various agricultural supporting service, the above two items of services should be strengthen with high priorities.

4. 4 Drainage Facilities

4. 4. 1 Drains and Related Structures

1) Improvement of Omoum Main Drain and Branches

Drainage system of the Omoum area may be outlined as follows;



From the above diagram, the importance of Omoum main drain and branches for smooth flow to the pumping station may be well understood. According to the information, Omoum main drain and its branches were constructed in the early 1960 and periodical maintenance works such as removal of sediment, cleaning of aquatic plants, etc. have been taking place.

The present hydraulic cross-sections of these drains have been transformed from original sections. Damaged side slopes and sedimentation on the drain bed could be mentioned as the reasons. In the case of Omoum main drain, particularly, between Dishudi and Truga pumping stations, the water level almost reaches the crest of the drain's embankment. In the future, when the drainage discharge increases along with subsurface tile drain improvement as well as the change of run-off due to regional development, these timeworn drainage facilities will have great difficulty coping with the increased discharge. Therefore, improvement of these drains is a prerequisite not only for optimum operation of the pumps but also for smooth drainage flows from the fields.

The original maximum capacity of Omoum main drain is 102 cu.m/sec (unit drainage discharge is 22 cu.m/feddan/day for a catchment area of 400,000 feddan). In the future, a larger capacity is essential. But the present situation,

houses and power poles on the both banks of this drain makes it difficult to enlarge the hydraulic cross section. Moreover, in the case of reconstruction of embankments, especially in the Mariut Lake section, if provisions for resupplying the Lake are not considered, a recurrence of acts such as cutting of the embankments by the fishermen may be unavoidable.

2) Improvement of Nubariya Siphon

Nubariya Siphon plays an important role in terms of the social and economical aspects, facilitating safe navigation in Nubariya canal and also allowing upstream discharge to flow through it while separating Omoum main drain from Mariut Lake. Therefore, restoration of its drainage capacity and proper maintenance are obvious prerequisites.

3) Improvement of Bridge Immediately Upstream from El-Max Pumping Station

The hydraulic section of this point is narrow compared with other sections. Moreover, accumulation of extensive aquatic plants at the bend, just upstream of this bridge is providing expensive to clean up. Therefore, amelioration of hydraulic cross-section at bridge-point and measures in the upstream for restricting aquatic plants are necessary.

As the railway bridge, the oil, water, gas pipelines and electricity supply are running together, any construction work at this point may affect railway traffic and flows in the pipelines. This problem may be overcome by securing an appropriate cross-section when the plan for a new railway-bridge is implemented.

4) Discharge-Channel at Downstream from the El-Max Pumping Station

This discharge-channel is the only channel for the discharge from El-Max pumping station to the Mediterranean sea. The operation of the El-Max pumping station is directly influenced by the capacity of this drain. At present, many houses are built on both banks which has limited any expansion of its width. In some places, water level has almost reached the houses. Therefore, it is feared that serious damage to inhabitants may occur due to the increased drainage volume from the development of this area or due to heavy rainfall.

For this reason and also in order to operate the El-Max pumping station to its full capacity, it is essential to improve this discharge-channel.

Due to the reasons mentioned above, it is be very difficult for any horizontal expansion of this discharge-channel to be undertaken, in order for the required cross-section to carry 150.0 cu.m/s of proposed discharge. But, according to EPADP, a concrete plan to move the inhabitants from the bank to a safer place is already underway. Therefore, widening of this discharge-channel would be possible.

4. 4. 2 Drainage Pump Facilities

The purpose of drainage pumps is to drain the excess water into the outside of the beneficial area as early as possible without any damages by inundation. The existing drainage pumps fulfill their duties through 24 hours, replacing the necessary equipment parts and carrying out the routine maintenance works. However, following restrictions and constraints on the improvement of drainage pump facilities are identified:

1) Shortage of the Drainage Capacities

In case the existing drainage pumps will keep their design capacities and it will be no increase of the drainage discharge in future, any expansion of the existing pumping stations will not be required except that of the Hares pumping station.

It is expected that there is a increase of drainage discharge in the Hares, Dishudi and Truga areas with increase of drainage duty and also the improvement plan on inundation conditions due to rainfall. Moreover, it is observed the decrease of pump capacities in the El-Max and Hares pumping stations due to the overaged facilities. Accordingly, the increase in pumping capacity for the said pumping stations will be required in the near future.

2) Unbalance of Drainage Capacities between El-Max Pumping Station and Others

The replacement of pump facilities in the Qalla, Abis, Dishudi, Truga, Abu Hommos pumping stations have been carried out in the past five years and also some of pumps have been increased in their capacities. Accordingly, the drainage capacities of the El-Max pumping station are smaller than the total pump capacity of other pumping stations as shown below:

Pump Station	Total Design Discharge	Design Discharge
El-Max	150 cu.m/s	125 cu.m/s
Others	200 cu.m/s	153 cu.m/s

Note: Total design discharge = Design discharge includes one stand-by unit.

Only nine units of pumps out of ten units (full operation) was operated at the average maximum discharge of 115 cu.m/s in the El-Max pumping station during the flood in December, 1991. During the flood, Mariut Lake reduced the peak discharge, playing a role of a regulating pond. The flow of Omoum main drain was also decreased by side slope erosion and weeds.

In case Mariut Lake and the Omoum main drain will be separated and the improvement of drains will be carried out in the Study Area in future, it is expected the present pump capacities will be insufficient to meet its requirements in the El-Max pumping station.

3) Increase of Pump Capacities due to Reduction of Pump Operation Hours

The present pumps are operated through 24 hours. In case the pump operation hours will be reduced from the viewpoint of operation and maintenance (e.g. 20 hours), the pump capacities shall be increased. However, the present practices, 24 hour operations including one stand-by unit, shall be actually adopted by the reason that there are no enough flood storage basins in the Study Area in order to ease the peak discharge.

4) Overage Pump Facilities

It have been passed 31 years and 26 years in the El-Max and Hares pumping stations respectively since their operation were started. The impeller,

bearings, sleeves, etc. have almost reached to their lifetime. The overall improvement shall be more inevitable than the partial one considering the decrease of pump capacities and the increase of operation and maintenance costs due to the overage pump facilities, although the repairs and replacement have been partially carried out from time to time.

5) Higher Suction and Delivery Water Level

The platforms at inlet canal and outlet basins are under the submerged conditions in some pumping stations. It have been caused by the present high regulating water level at Mariut Lake and the reduction of flow area of the Omoum main drain due to weeds, trashes, and it makes the operation and maintenance works of stop-logs, trashracks, flap valves, etc. difficult and cause the corrosion of the said equipments.

Therefore, the suction and delivery water level shall be maintained at more lower level as the original design. Moreover, the water level of Mariut Lake is 50 cm higher than the suction water level in the El-Max pumping station due to the lack of proper maintenance in the Omoum main drain. It causes the increase of power tariff in the El-Max pumping station.

6) Others

- Operation Method

  The main pumps, overhead cranes, hoist cranes, trashracks, etc. are manually operated, although their operations are not efficiently.

- Abis Pumping Station

  No pump house are provided in the Abis pumping station. The pump house shall be provided in order to protect the equipments from direct sunshine and open air from the viewpoints of its safe operation and proper maintenance. The siphon type delivery pipes are provided instead of the flap valves. The problems arise on the increase of total head and power tariff due to the breakdown of siphon breaker.

- Qalla Pumping Station

  Drains of black colored water containing sludges makes the life time of pumps shorten. The overflow on the top of outlet basin's wall will be

also expected to be taken places by high delivery water level caused by the sedimentation of such sludges, in case the proper maintenance works are not carried out.

- Supply of Spare Parts

  It is very difficult to purchase timely the spare parts because main equipments shall be imported from the foreign countries in each pumping station.

4. 5 Environmental Aspects

Farmland environmental improvement plan in Omoum area should be formulated take into account not only the drain system restrictive factors, but also the effects to the Mariut Lake. From the environment aspects, the basic concept of improvement plan for the Study Area could be described as follows;

- All of the problems concerning environments should be solved by means of polluter (Causer) pay principle, that is, sewage from Alexandria city, industrial effluence from the factories, agricultural chemicals, domestic and livestock sewage, etc.
- It should be recognized that Omoum main drain is main water source for the Mariut Lake and also the sole outlet or drain of the Lake. Omoum drain supplies the best water among the water sources to the lake in terms of contents such as DO, BOD, COD and Total Nitrogen.
- Improvement plan of Omoum drainage systems and operation of the El-Max pump station should be executed according to the Mariut Lake utilization program.

From the view point of water quality conservation of Mariut Lake, it is both necessary and important to formulate a utilization plan for the Lake, which has so many purposes and functions (fisheries, navigation, preservation water body for birds and small animals, disaster prevention, landscape and on environmental purification facility).

CHAPTER V. FORMULATION OF BASIC DEVELOPMENT PLAN

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5. 1 Basic Concept for Development Plan

5. 1. 1 Objectives of the Development Plan

The Third Five-Year Plan (1992/93 - 1996/97) states the ten most important pivots, around which the Government of Egypt puts the highest priority for "modernizing and maximizing productivity in the various productive and service aspects of the economy and increasing the rate of local savings".

In order to achieve the above most important objectives, the Third Five-Year Plan also states that the agricultural sector should do its activity base on the following policies;

- Modernization of the agricultural sector,
- Realizing the maximum possible self-sufficiency from the essential crops,
- Increasing the agricultural output having competitive advantage regarding exports, and
- Increasing the efficiency of utilizing agricultural resources.

5. 1. 2 Development Strategies and Targets

Farmland environmental improvement, especially emphasizing drainage improvement in the Study Area is a major objective of the Feasibility Study, and this will be achieved by developing the following project components;

i) Drainage Improvement

Adequate drainage water level of Mariut Lake, Omoum main drain and each branch drain should be achieved through drainage simulation for various alternative plans, and drainage facilities consisting of Omoum main drain, pumping facilities, branch drains

and subsurface drains should be improved or constructed in order to to improve farm drainage conditions.

ii) Water Source Development and Improvement of Irrigation Water Management

Water source development through reuse of drainage water in the Study Area should be planned considering the scarce water resources in newly developed areas. And, an adequate water distribution plan should be formulated so as to achieve effective water utilization at the field level.

iii) Agricultural Development Plan

In order to achieve more productive farming, the land-use plans, cropping pattern, farm management, agricultural supporting services, farmer's organization, etc. should be formulated for the Area.

iv) Rural Environmental Improvement and Mariut Lake Environmental Plans

Rural infrastructure such as village roads and village water supply, should be adequately provided, and water quality of the Mariut Lake should be controlled with a suitable water level and water supply to the Lake and adequate countermeasures by law regulation should be recommended to retain the Lake's water level under natural environment.

5. 2 Sectional Development Plan

5. 2. 1 Land and Water Resources Development Plans

1) Land Resources Development Plan

Especially for soils with very high rates of salinity, particular attention has to restore the soils to productive cultivated land in addition to lowering the groundwater table. The downstream areas, especially Hares and Truga drainage areas require this kind of attention. According to information provided by the Abis Control Office of the Authority for Project and Development, Department of Cooperative and Development, MALRF, most of the Hares drainage area is facing the same situation as that of the Abis, which was developed from the lake deposited land. It is hard work to make the Abis

land productive, and in order to stabilize farm management the following development procedures are needed

- Identification of soil management problems through detailed soil survey and propagation of a soil amendment / management plan,
- Implementation of drainage improvement works,
- Implementation of leaching the saline substances with land improvement such as leveling, deep plowing, and application of gypsum,
- Providing comprehensive agricultural supporting services for stabilization of farm management

The Abis Control Office says that the most important point in the development of the area is application of a proper method for soil amendment including the leaching of salts together with deep plowing. In this regard, the establishment of an organization to develop the areas of high soil salinity in the downstream area, will be proposed to implement the soil management project through the establishment of a related organization as a short and medium-term project.

Through implementation of the proposed project, subsurface drainage in the remaining areas will be carried out together with soil improvement and agricultural development in the Study Area The cultivable waste land will thus become available as productive cultivable land. Therefore, the percentage of actually cultivated land will reach 200 percent in the Study Area. The implementation of this project will also promote the diversification of crops facilitating vegetables and fruit growing in the newly expanded areas.

2) Water Resource Development Plan

Water resources in Egypt are solely dependent on the share of Nile water that passes through Aswan High Dam. Therefore, the prospect of water resource development has to rely on the reuse of drained water. In the Study Area, there are seven drainage water reuse projects. Apart from two, all are in operation. The biggest one is the Omoum Drain Project.

The purpose of the Omoum Drain Project is to reuse the drainage water that comes from upstream of the Omoum main drain covering Abu

Hommos, Shereshera and Truga areas. The aim of this project is to collect water from a catchment area of about 120 thousand hectares (285 thousand feddan) at the 24km point of the Omoum main drain and divert it into the Shereshera drain. Three pumping stations will be used in order to feed this water to Nubariya canal at a point 46km from the beginning. The total length of this reverse/feeding drain is 45 km.

The maximum proposed quantity of water flow would be 48.2 cu.m/sec (4.12 MCM/day), in other words 1,000 MCM per year. Considering the water quality, the mixing of drain and canal water is planned. The ratio would be 1:3.5, which will reduce the salinity from 2,200 ppm to 700 ppm. This reused water will be mainly supplied to irrigate the West Nubariya New Reclamation Area of 210 thousand hectares (500 thousand feddan). This project was supposed to have been completed in 1991. The construction work has been delayed due to unavoidable reasons and 1994 has been targeted as new completion year. As of March,1995 construction of one pumping station has been completed and two others are a waiting completion(refer to Table D-1-13 and D-1-14, Annex D).

After the completion of another reused project i.e. Zohol EL-Omara pumping station, the amount of reused water will be 1,650 MCM per year and the reuse ratio will be 73 percent (1,650MCM / 2,259 MCM, discharge of seven drainage pumps in 1993). The above figure indicates that the amount of reused water in the Study Area has limitations.

5. 2. 2 Irrigation and Drainage Plans

1) Irrigation

In the Study Area, the only source of drainage water is from excess irrigation water. The amount of drainage water indicates that there is a need for control of over-intake and unattended night-time irrigation. The components of the irrigation development plan should include counter-measures for over-intake.

2) Drainage

Proposed Unit Drainage Discharge

From the collected information/data, it was discovered that the unit drainage discharge in the Study Area is different according to different levels. The EPADP's standards are as follows;

Lateral drain of the tile drain	1.5mm/day
Collector drain of the tile drain	4.0mm/day
Open drain in drainage block	29 to 50 cu.m/fed/day
Drainage pumping station	26 to 62 cu.m/fed/day

On the other hand, the actual discharge from a drainage block ranges from 12 to 56 cu.m/fed/day. These variations are assumed to be due to different land-uses, soils and geographical conditions and the years planned. But calculation basis of these figures is not clear.

In the case of any regional drainage planning, the unit drainage discharge should be calculated on the uniform drainage criteria considering the changes in land-use and expansion of well-drained paddy fields. It is assumed that in the Study Area, tile drain implementation will be continued and paddy cultivation will expand. Therefore, increased drainage discharge is expected.

Unit drainage discharge in each drainage block is decided through the comparison between the normal discharge depending on irrigation water supply, which will be occurred during the summer season and flood discharge caused by rainfall during the winter season. In the analysis of flood discharge, 10-years probable rainfall is applied as a designed rainfall. Through the studies, it was revealed that unit drainage discharge depending on flood discharge was bigger than the normal discharge, so that flood discharge is decided to be the designed unit drainage discharge.

Pumping Station, Main and Lateral Drains

Designed drainage discharges for pumping stations and drains were estimated based on the unit drainage discharge mentioned in the above and drainage areas. And it was revealed that the pump capacity of Hares, Dishudi

and Truga should be increased because of shortages of pump capacity against the present pump capacities, as shown below.

The designed discharge of the Omoum main drain could be estimated with an accumulation of each block discharge. In this case, according to the rainfall characteristic such as rainfall locality in the vicinity of the Study Area, some area-reduction rate should be taken into account in the case of large areas in extent.

The designed discharge of El-Max pumping station can be estimated with summing the discharges of the Omoum main drain and a discharge from the direct/indirect catchment area of the Mariut Lake.

Through the studies mentioned in the above, the Omoum main drain and El-Max pump should be improved to meet the designed discharge of 150.0 cu.m/sec, which is equivalent to 20 percent increase compared with present capacity of them (see Table D-2-9 and D-2-10, Annex D).

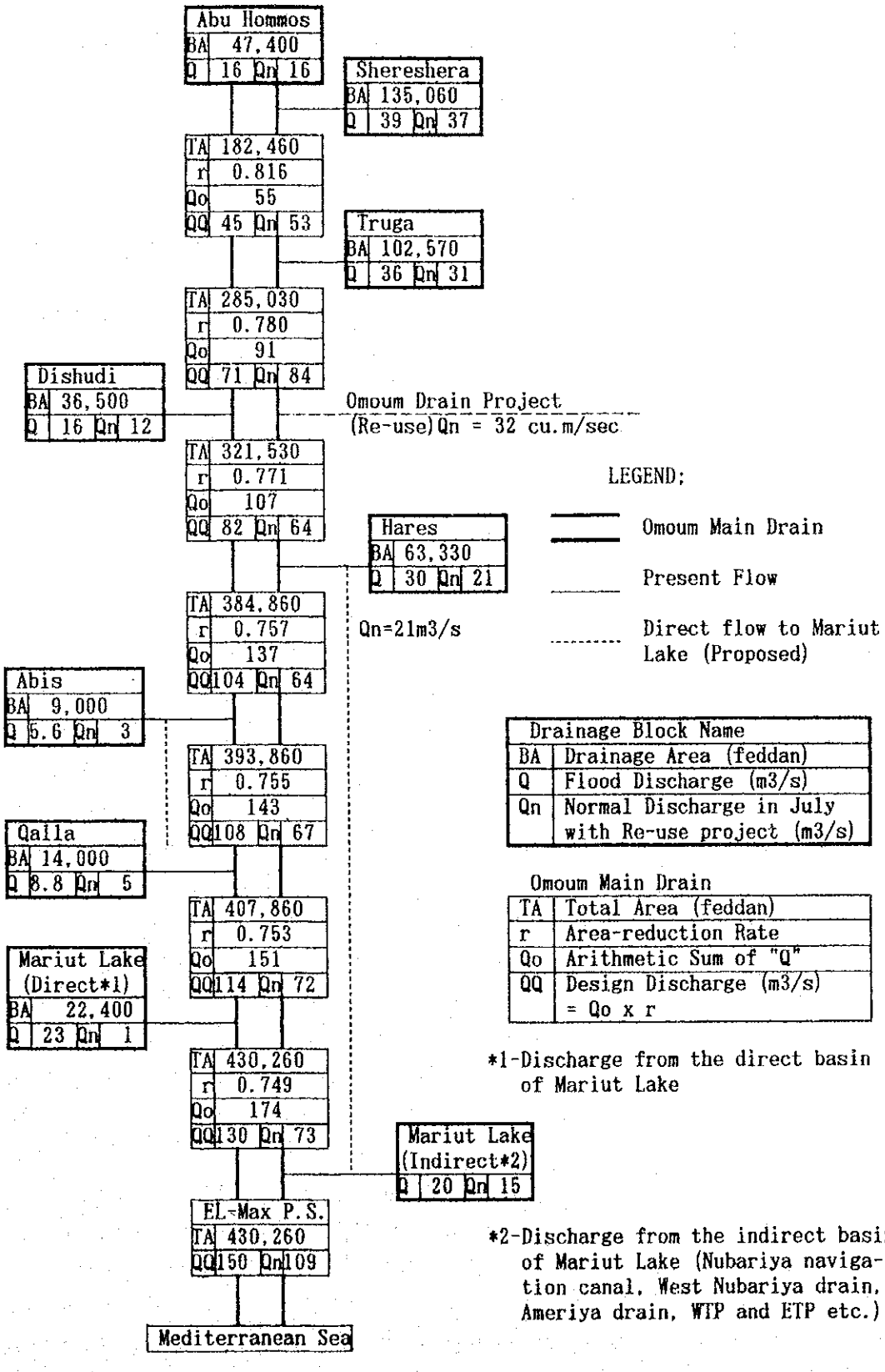
Figure 5-1 shows the proposed diagram of drainage systems.

Designed Drainage Discharges

(unit: cu.m/sec)

Drainage Block	Normal Discharge	Flood Discharge	Designed Discharge	Present Capacity	Increased Capacity
Qalla	5.0	88.8	8.8	10.0	-
Abis	3.0	5.6	5.6	5.4	-
Hares	21.0	30.0	30.0	24.0	6.0
Dishudi	12.0	16.0	16.0	12.0	4.0
Truga	31.0	36.0	36.0	32.0	4.0
Shereshera	37.0	39.0	39.0	40.0	-
Abu Hommos	16.0	16.9	16.0	25.0	-
El-Max Pump	125.0	150.0	150.0	125.0	25.0

FIGURE 5-1 PROPOSED DRAINAGE DIAGRAM OF STUDY AREA



Tile Drain

Depending on the crops, EPADP has a standard rate of groundwater discharge for lowland areas with salinity problems. In the areas located lower than three meters below mean sea level, a drainage discharge rate of 1.5 mm/day is considered acceptable for implementing subsurface tile drain facilities in the area.

The present mean spacing of the lateral drains is 67 m. The soil characteristic in the Study Area is sandy silt/loam with a hydraulic conductivity of 1×10^{-3} to 1×10^{-4} cm/sec. Considering the soil conditions and the rainfall effects during the winter season, the above mentioned lateral drain spacing is considered rather large. The lateral spacing should be denser, i,e, at a 30m in space.

5. 2. 3 Agricultural Development Plan

1) Agricultural Development Plan

At present, there are various problems on-farm drainage management even if subsurface tile drain is functional. For example, it is difficult to control groundwater level for upland crops, where paddy are planted in the same block. To solve this problem, linkage between crop rotation and water management at on-farm level is necessary. In this connection, advisory services regarding farm-level operation and maintenance of drainage through the establishment of farmers' organization are needed. Recently, EPADP's West Delta Directorate has formed an organization for drainage advisory services. Strengthening the organization and training programs for officials through necessary equipment provision and coordination between EPADP and MALRF is required in order to improve operation and maintenance of drainage facilities.

Another important component of agricultural development projects is the provision of adequate supporting services. In order to attain the target within the scheduled time, the introduction and development of appropriate production technology will become necessary. Strengthening plan for agricultural extension services has to be formulated in the short-term

development plan, in order to enable the farmers to cope with the new situation.

2) Crop Production Plan

Though full utilization of cultivable land with project, the cropping intensity will be raised to 200 % in the following proposed cropping pattern (refer to Table F-1-32, Annex F). Also crop diversification with expanding the area for vegetable crops by 50 percent of the existing area is incorporated in the pattern. The yield increase of crops through farm land improvement under the project is estimated as follows, applying the yield increase rates in "8.5.2 Prevention of Flood Damage and Target Yield",

Increase of Crop Yield with Project

Crop	Without Project (ton/ha)	With Project (ton/ha)	Rate of Increase (%)
Winter			
Wheat	5.00	5.76	15
Beans	2.02	2.36	20
Berseem, Long Season	59.52	71.42	20
Berseem, Short Season	26.19	31.42	20
Vegetables	19.05	23.81	25
Summer			
Cotton (Seed cotton)	7.63	3.28	25
Maize	5.09	5.86	15
Rice	6.19	6.50	5
Vegetables	28.57	35.71	25
Orchard (Orange)	14.76	16.23	10

For the area where the subsurface drainage has been facilitated, the increase rate of crop yield with project is estimated at 50 percent of the above figures, taking into consideration the possible reduction in lowering subsurface water table with project.

Based on the above said target yield with project, the crop production with project is estimated at about 4,770 thousand ton with 590,570 feddan (248,040 ha) of the annual total cropping area as follows. The production will be increased by 43 percent of total production without project with 17 percent of increased annual cropping area.

Crop Production with Project

Crop	Cropping Intensity	Area	Unit Yield	Production
	(%)	(ha)	(ton/ha)	('000 ton)
Cultivation Area = 132,630 ha	100			
Winter Crop				
Wheat	28	37,140	5.76	208
Beans	5	6,630	2.36	15
Berseem, Long Season	15	19,900	71.42	1,369
Berseem, Short Season	25	33,160	31.42	1,004
Vegetables	14	18,570	23.81	423
Sub-total	87	115,400		3,019
Summer crop				
Cotton	22	29,180	3.28	92
Maize	28	37,150	5.86	212
Rice	19	25,200	6.50	163
Vegetables	18	23,870	35.71	815
Sub-total	87	115,400		1,282
Orchard (Orange)	13	17,840	16.23	274
Total	187	248,640		4,575

Note: The land use amounts 200 % although the total cropping intensity is indicated at 187 % due to the some area coverage of orchard. The total cultivation area includes 8,510 ha of culturable waste. Details of crop production are given in Table F-1-32, Annex F.

Source: MALRF

5. 3 Area-Wide Drainage Improvement Plan

5. 3 .1 Alternative Plans for Drainage Systems

The simulation of a drainage water balance taking into account of Omoum main drain, Mariut Lake, and Nubariya navigation canal will be essential in formulating the most suitable/optimum drainage systems for the downstream reaches of the Omoum area. In this alternative study, due attention should be paid to the following matters, that is, the water level of Mariut Lake should be kept as low as possible from the agriculture drainage side, while on the other hand that of the water level for fisheries activities, lake environment, industrial water sources, navigation, and natural scenery should be kept as high as possible. These demands from various fields are requested strongly to the EPADP.

In considering the above situation in the area, optimum drainage systems related to Omoum main drain, Mariut Lake, Nubariya navigation canal were studied, on the basis of the alternative systems mentioned below;

1) Pre-Conditions for Delineating Alternative Plans

The following pre-conditions are assessed for delineating alternative plans;

Inflow to Mariut Lake

- Drainage discharges from seven drainage blocks into Omoum main drain.
- Inflow from Nubariya canal
- Inflow of Alexandria waste water (WTP and ETP)
- Run-off generated by rainfall
- Inflow from West Nubariya drain

Outflow

- Discharge from the El-Max pumping station
- Evaporation loss from Mariut Lake
- Reused water from Omoum main drain

Water Level

- Present suction water level at the El-Max pumping station : (-) 2.70 m.MSL to (-) 2.80 m.MSL
- Proposed max. water level of Mariut Lake : (-) 2.40 m.MSL
- Designed normal water level in Omoum main drain (Suction water level of the El-Max pumping station) : (-) 3.25 m.MSL

2) Alternative Plans

Regarding alternative plans, the following four cases were finally delineated through the field survey and discussion with related Egyptian Governmental agencies concerned.

Case - 1 : Present Condition(Mariut Lake, Omoum main drain and Nubariya navigation canal will be unified. ---W/O Separation)

Case - 2 : Improvement Plan(same as Case - 1)

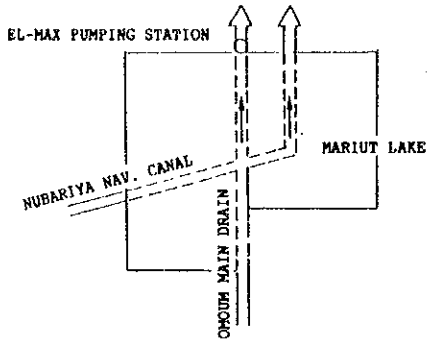
Case - 3 : Improvement Plan(Omoum main drain will be separated from Mariut Lake.--- W/ Separation)

Case - 4 : Improvement Plan(Mariut Lake, Omoum main drain and Nubariya navigation canal will be separated completely. --- W/ Separation)

The subsequent figures and items give the major features and merit/demerit of each alternative plan. Figure 5 - 2 to Figure 5 - 5 indicate the layout of the plans.

Case - 1 : Present Condition (see Figure 5 - 2)

Drainage system : Omoum main drain, Mariut Lake and Nubariya navigation canal will be unified.



Drainage Facilities :

- El-Max pumping station

Maintained Water Level :

- El-Max pumping station : (-) 2.70 m.MSL
- Hares pumping station : (-) 2.38 m.MSL

Merit :

- Favorable for fish culture, navigation, and water quality of Mariut Lake with relatively high water level
- Effective regulation of flood discharge by Mariut Lake

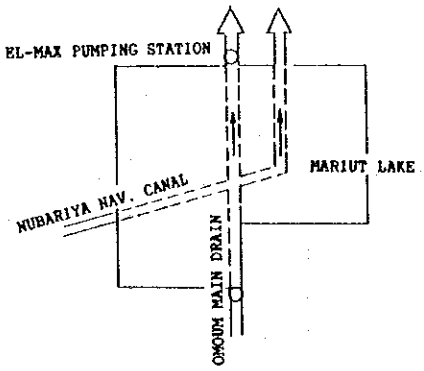
Demerit :

- Unfavorable for farm drainage due to high water level of Omoum main drain
- Necessity of embankment of Omoum main drain due to high water level
- Improvement of pumping facilities due to high delivery water level in Omoum main drain

Case - 2 : Proposed Plan (see Figure 5 - 3)

Drainage system : Omoum main drain, Mariut Lake and Nubariya navigation canal will be unified.

New pumping station will be provided upstream of Mariut Lake to lower the water level of Omoum main drain at (-) 3.25m.MSL



Drainage Facilities :

- El-Max pumping station
- New Omoum pumping station
- Embankment of Omoum Main drain

Maintained Water Level :

- El-Max pumping station : (-) 2.40 m.MSL
- Omoum New pumping station : (-) 3.25 m.MSL

Merit :

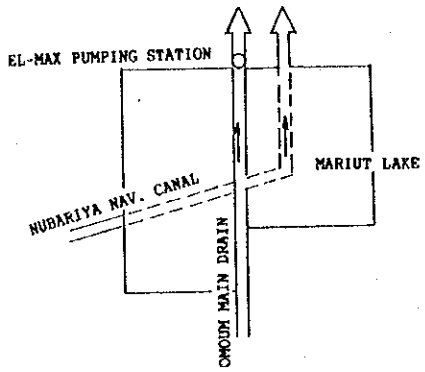
- Favorable for agriculture with low water level in Omoum main drain
- Favorable for fish culture, navigation, and water quality of Mariut Lake with relatively high water level
- Effective regulation of flood discharge by Mariut Lake

Demerit :

- Additional pumping station with the same capacity as El-Max pumping station will be needed.

Case - 3 : Improvement Plan (see Figure 5 - 4)

Drainage system : Omoum main drain will be separated from Mariut Lake, and Nubariya navigation canal will be connected with Mariut Lake as it is.



Drainage Facilities :

- El-Max pumping station
- Embankment of Omoum main drain
- Improvement of Nubariya siphon

Maintained Water Level :

- El-Max pumping station : (-) 3.25 m.MSL
- Mariut Lake : (-) 2.40 m.MSL

Merit :

- Favorable for farm drainage with low water level, and also fish culture, purification of lake water quality, and navigation with relatively high water level in Mariut Lake.

Demerit :

- Diversion facilities to maintain suitable water quality in Mariut Lake will be needed at Hares and Abis pumping stations, due to separation of Mariut Lake from Omoum main drain.
- Improvement of Nubariya Siphon crossing Nubariya navigation canal
- Gate structures to enable boats to pass between Omoum main drain and Mariut Lake will be needed.

Case - 4 : Improvement Plan (see Figure 5 - 5)

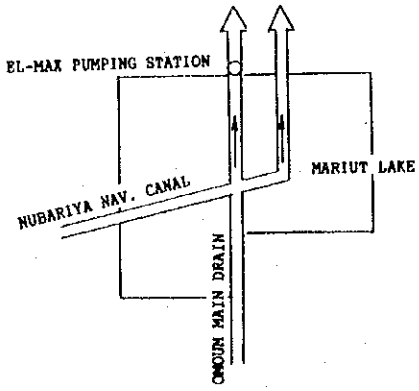
Drainage system : Omoum main drain and Nubariya navigation canal will be completely separated from Mariut Lake.

Drainage Facilities :

- El-Max pumping station
- Embankment of Omoum main drain
- Improvement of Nubariya siphon
- Embankment of Nubariya canal

Maintained Water level :

- El-Max Pumping station : (-) 3.25 m.MSL
- Mariut Lake : (-) 2.40 m.MSL



- Nubariya navigation canal
  : (-) 2.50 m.MSL

Merit :

- Same as Case - 3 Plan

Demerit :

- Basically same as Case - 3 plan, but Mariut Lake will be completely separated from Omoum main drain and Nubariya navigation canal, necessitating close attention to water quality conservation in Mariut Lake.

5. 3. 2 Hydraulic Analysis of Alternative Plans

In order to analyze the hydraulic phenomenon for each alternative plan mentioned above, focusing in particular on the water surface profile of the Omoum main drain from the beginning of the Omoum main drain to the Abu Hommos pumping station, (most upstream from Omoum main drain), hydraulic analyses were performed by applying the non-uniform flow method.

The following table indicates the main conditions related by the hydraulic analysis.

Main Conditions

Alternative Plan	Starting Point	Max. Designed Discharge (cu.m/sec)	Starting Water Level (m.MSL)	Drain Section
Case-1	Hares P.S.	82.0	(-) 2.38	Present section
Case-2	Hares P.S.	82.0	(-) 3.25	Present section
Case-3	El-Max P.S.	150.0	(-) 3.25	Improved section (El-Max to Hares)
Case-4	El-Max P.S.	150.0	(-) 3.25	Improved section (El-Max to Hares)

FIGURE 5-2 ALTERNATIVE DRAINAGE SYSTEMS (CASE-1)

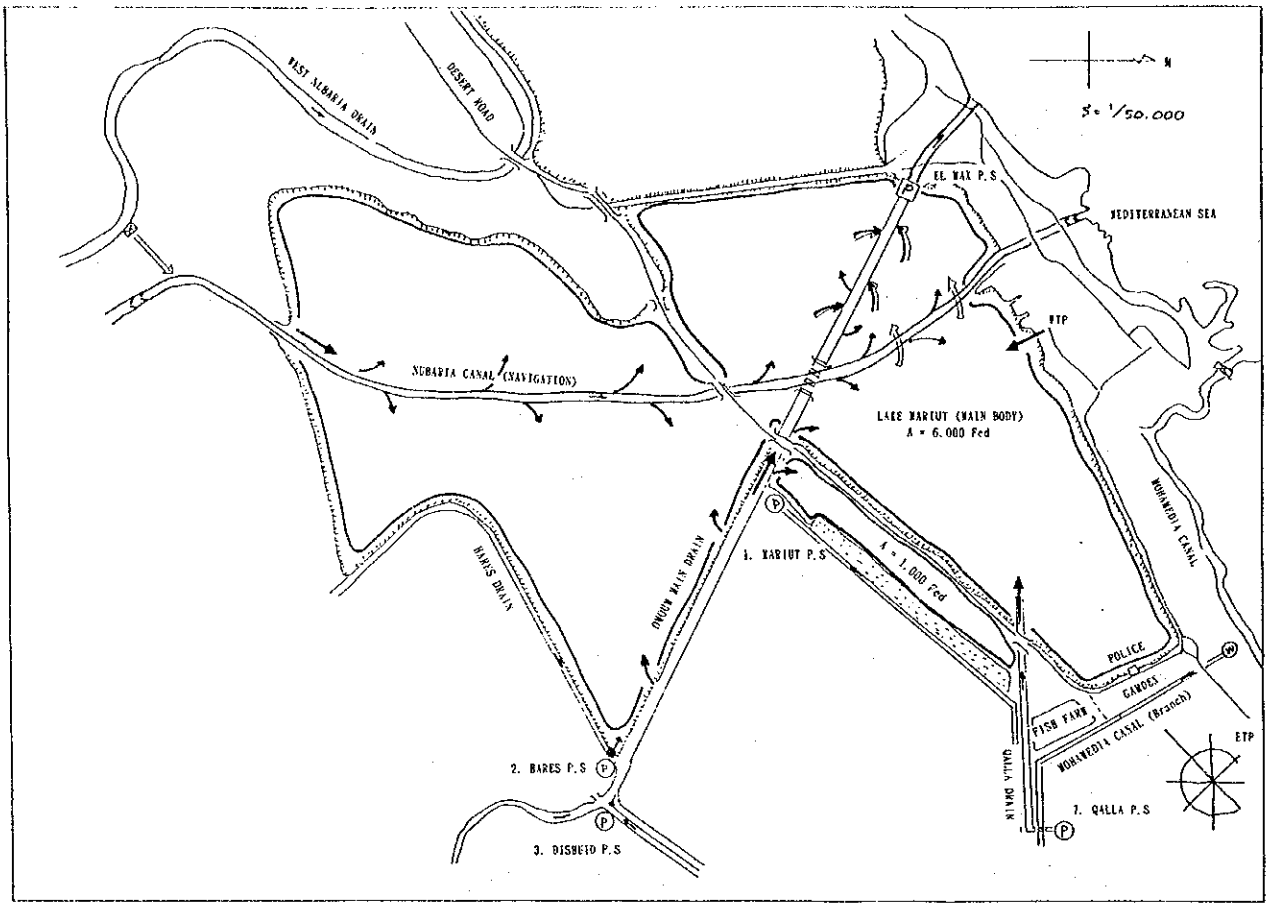


FIGURE 5-3 ALTERNATIVE DRAINAGE SYSTEMS (CASE-2)

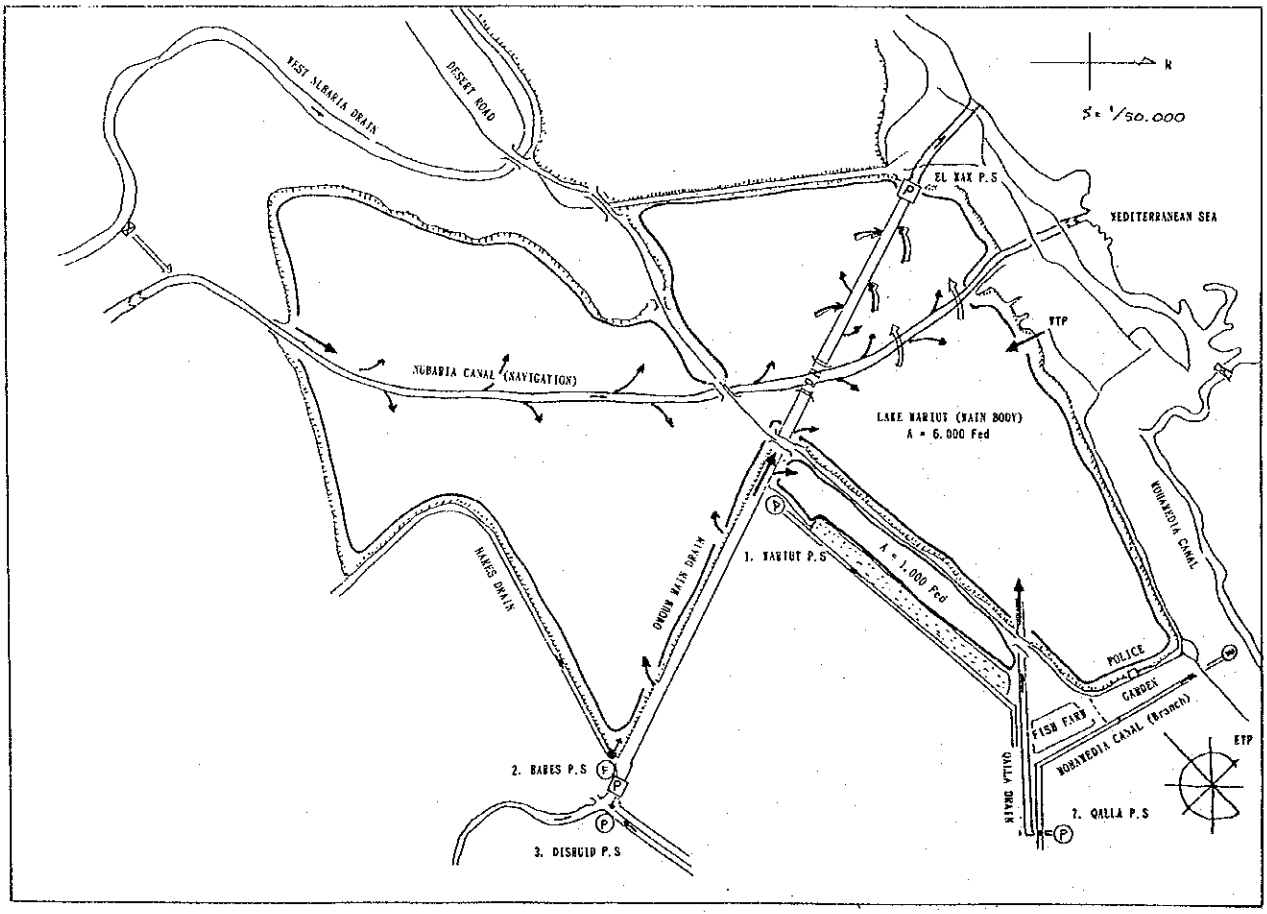


FIGURE 5 - 4 ALTERNATIVE DRAINAGE SYSTEMS (CASE-3)

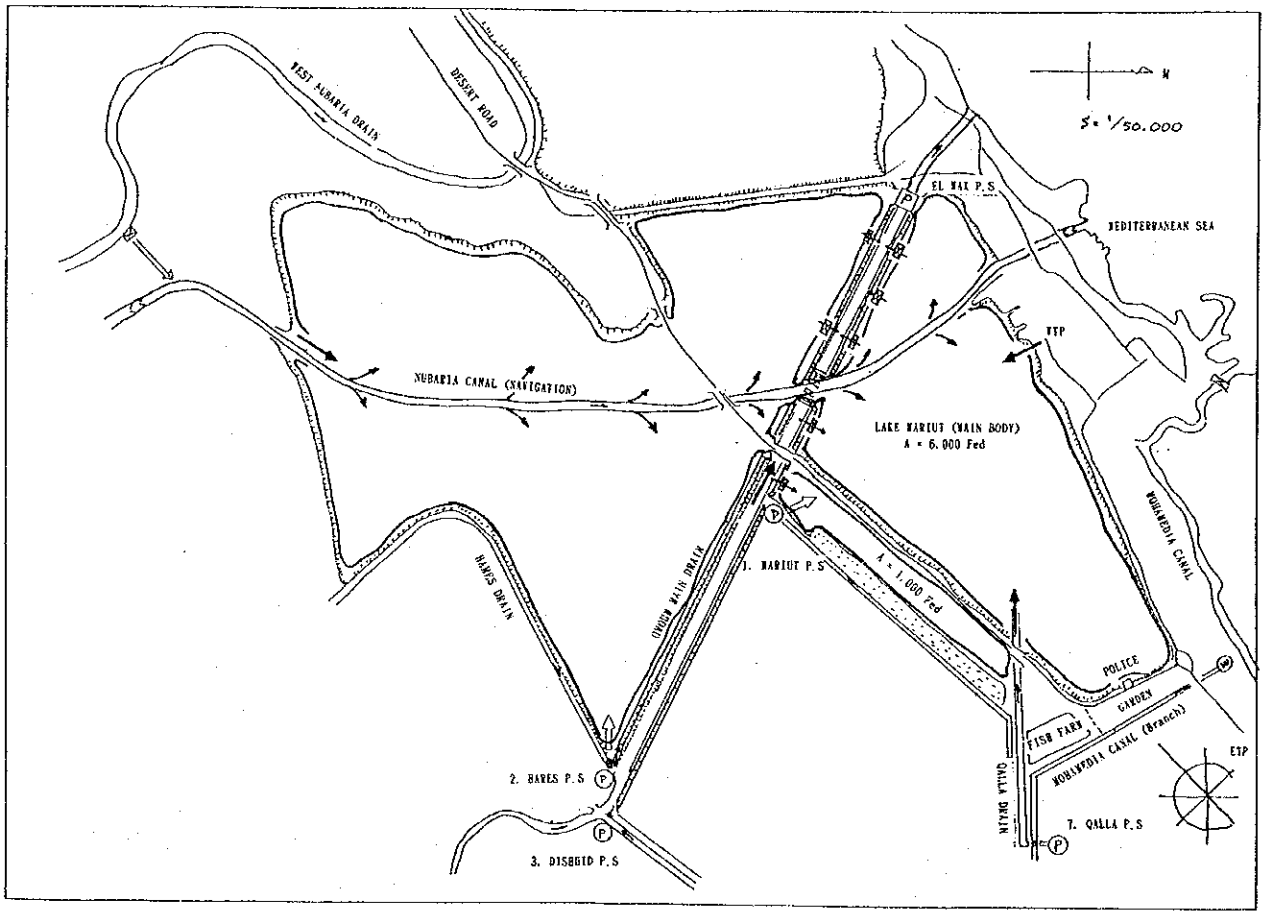
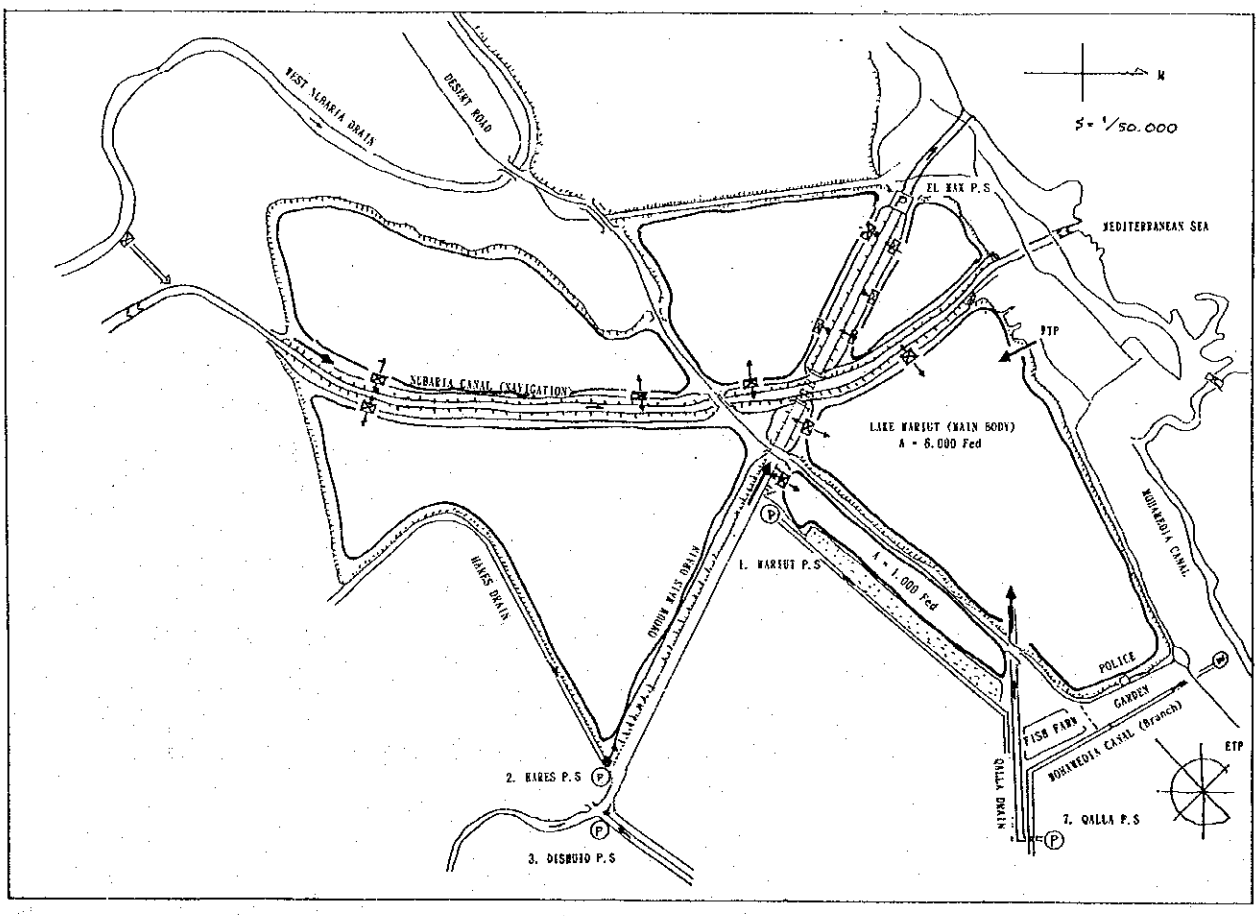


FIGURE 5 - 5 ALTERNATIVE DRAINAGE SYSTEMS (CASE-4)



The following table presents the summary of the analysis.

Results of Hydraulic Analysis

Pumping Station	Designed Water Level of Omoum Main Drain	Analyzed Water Level			
		Case-1	Case-2	Case-3	Case-4
	(m.MSL)	(m.MSL)	(m.MSL)	(m.MSL)	(m.MSL)
El-Max	(-) 3.25	(-) 2.75	(-) 2.40	(-) 3.25	(-) 3.25
Abis	(-) 2.70	(-) 2.40	(-) 2.75	(-) 3.02	(-) 3.02
Hares	(-) 2.80	(-) 2.38	(-) 3.25	(-) 2.93	(-) 2.93
Dishudi	(-) 2.63	(-) 2.35	(-) 3.16	(-) 2.92	(-) 2.92
Truga	(-) 2.00	(-) 1.74	(-) 2.05	(-) 2.00	(-) 2.00
Shereshera	(-) 1.60	(-) 1.42	(-) 1.63	(-) 1.59	(-) 1.59
Abu Hommos	(-) 0.80	(-) 1.13	(-) 1.24	(-) 1.28	(-) 1.28

In the Case-1 Plan, analyzed water level of Omoum main drain is higher than the design water level except for the water level at Abu Hommos pumping station, so that this plan deems to be inadequate in the project. On the other hand, Case-2 and Case-3 Plans satisfy the water level mentioned above, but economical comparison involving project costs should be undertaken. The result of Case-4 Plan is same as that of Case-3 Plan.

Figure 5-6 indicates the hydraulic analysis of Omoum main drain in case of Case-3 Plan, and the results of other cases are shown in Annex E.

5.3.3 Selection of Optimum Drainage Systems

The most optimum drainage system for the downstream reaches of the Omoum area was selected out of the three alternative improvement plans, from technical, economical, operation and maintenance, and Mariut Lake environmental viewpoints. Table 5-1 shows the comparison of these alternative plans, on the basis of above factors.

Through comprehensive studies on the alternative plans mentioned above, Case-3 Plan, in which Omoum main drain will be separated from Mariut Lake, was selected as the best drainage systems for the area.

Major project dimensions of the Case-3 Plan are summarized as follows;

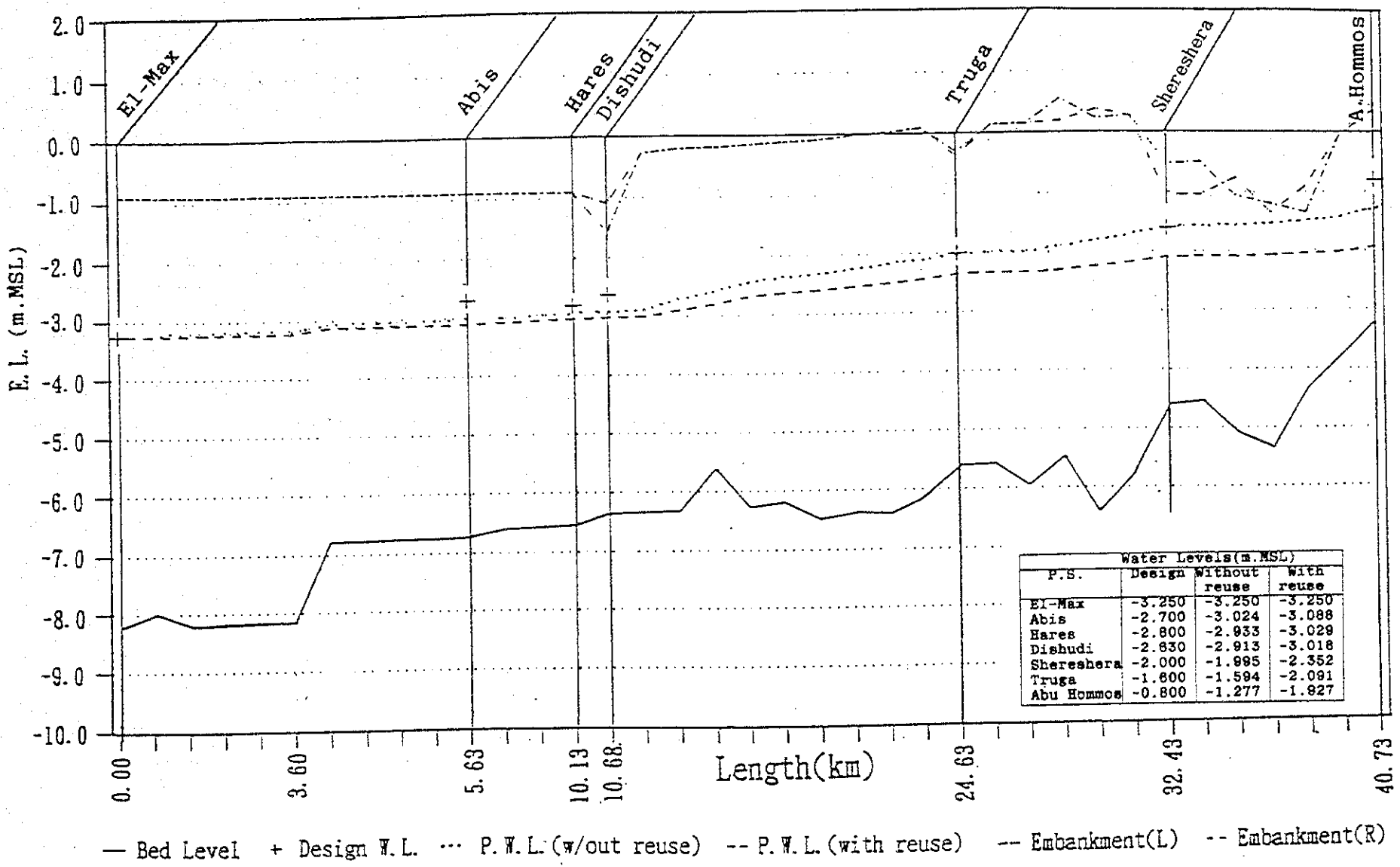


FIGURE 5-6 RESULTS OF HYDRAULIC ANALYSIS OF OMOUM MAIN DRAIN (CASE-3)

Table 5 - 1 Comparison of Alternative Drainage System Study

Item	Case - 2 Plan	Case - 3 Plan	Case - 4 Plan
1) Improvement/Construction of Drainage Facilities	- Construction of El-Max pumping station (new) - Construction of new Omoum pumping station - Improvement of Hares pumping station - Improvement of Dishudi and Truga pumping stations - Improvement of main drains and branches in each block, L=701 km - Provision of tile drain, A=74,600 ha	- Construction of El-Max pumping station (new) - Improvement of Abis pumping station - Improvement of Hares pumping station - Improvement of Dishudi and Truga pumping stations - Improvement of Omoum main drain, L=10 km (including separation dike of Omoum main drain) - Improvement of main drains and branches in each block, L=701km - Provision of tile drain, A=74,600 ha	- Construction of El-Max pumping station (new) - Improvement of Abis pumping station - Improvement of Hares pumping station - Improvement of Dishudi and Truga Pumping stations - Improvement of Omoum main drain, L=10 km (including separation dike of Omoum main drain) - Improvement of main and branches in each block, L=701 km - Improvement of Nubariya navigation canal with embankment, L=12 km
2) Project Cost	1,052.8 million LE (108)*1	971.4 million LE (100)	1,028.9 million LE (106)
3) Operation and Maintenance	Since new Omoum pumping station with almost same capacity to existing El-Max pumping station should be constructed upstream from Mariut Lake, operation and maintenance costs will be high, and operation of pumps will be complicated.	Operation of the El-Max pumping is same as the existing one, so that no operational problems will occur.	Same as the Case-3 Plan
4) Environment of Mariut Lake	Mariut Lake acts as a big storage reservoir with relatively high water level of (-)2.40 m.MSL, and this condition leads to favorable situations for fisheries activities in Mariut Lake and also water quality conservation of the Lake.	Mariut Lake is separated from Omoum main drain, which is a main water source to purify the Mariut Lake water. Therefore, water quality management of the Lake is needed not only by releasing drainage discharges through diversion facilities provided at Hares and Abis pumping stations, but also by supplying Nubariya navigation canal water, in order to achieve Lake water conservation.	Mariut Lake is completely separated by Omoum main drain and Nubariya navigation canal, which are main water sources to purify the Mariut Lake water. Therefore, intensive water quality management of the Lake is needed by releasing drainage discharges through diversion facilities provided at Hares and Abis pumping stations, in order to achieve Lake water conservation.

Note; *1 : Figures in parenthesis show the index of construction costs in cases that construction cost of Case-3 Plan are assumed to be 100.
Details of project costs are referred to Table E-1-1 to Table E-1-3, Annex E.

Planning Dimensions

- El-Max pumping station
  - Proposed drainage area : 180,710 ha (430,260 feddan)
  - Proposed drainage discharge : 150.0 cu. m/sec
- Omoum main drain
  - Proposed drainage discharge : 150.0 - 16.0 cu. m/sec
- Proposed maintaining water level
  - Omoum main drain : (-) 3.25 m.MSL (at El-Max pumping station)
  - Mariut Lake : (-) 2.40 m.MSL

Improvement/Construction of Drainage Facilities

- Construction of new El-Max pumping station (new) : 87.5 cu.m/sec (7 units)
- Improvement of Abis pumping station : Provision of diversion facilities
- Improvement of Hares pumping station : 30.0 cu. m/sec (5 units)
- Increase of Dishudi and Truga pump stations : 4.0 cu. m/sec
- Improvement of Omoum main drain : L = 10 km (including separation dike of Omoum main drain (10 km) and Nubariya siphon)
- Improvement of discharge-channel : 1.0 km
- Improvement of main drains and branches in each block : Length = 701 km
- Provision of tile drain : Area = 177,620 feddan (74,600 ha)

5. 3. 4 Drainage Facility Plan

All facilities described below were planned according to Case-3 of the Alternative Plan, mentioned previously.

1) Drains and Related Facilities

a) Necessity for Improvement

Cross-Sectional Improvement as a Result of Increased Discharge

The cross-sections of the present Omoum main drain is designed for a designed discharge of 102 cu.m/sec. As time has passed, erosion, sedimentation and vegetation growth have decreased the capacity of the drain. The delivery water levels of all the upstream pumping stations were decided on the basis of water surface profile of Omoum main drain when discharge is 102 cu.m/sec. It is obvious that the present cross section is not capable of carrying the designed discharge with the same water surface profile.

Moreover, the newly proposed maximum drainage discharge is set at 150 cu.m/sec, which is 48 cu.m/sec more than the previous designed discharge. Therefore, enlargement of Omoum main drain cross-sections is essential to facilitate safety drainage.

Necessity of Related Drainage Facility Improvement

There are two related facilities in the Omoum main drain, namely, Nubariya siphon and Discharge-channel, downstream from El-Max pumping station. Nubariya siphon plays an important role in making a safe passage way for navigation in the Nubariya canal, while allowing drainage discharge to flow downstream from Omoum main drain. The discharge-channel is very important, because all discharge through the El-Max pumping station passes this channel into the Mediterranean sea.

For increased drainage discharge, both the facilities must have sufficient capacity. Therefore, partial improvement of the siphon and larger cross-section for the Discharge-channel are proposed. Details will be discussed in the following paragraphs.

Construction of New Facilities for Mariut Lake

In Case-3 of the Alternative Plan, it is proposed that Omoum main drain will be separated. In this case, Mariut Lake will not be able to be supplied through the cuts in the embankment. Therefore, in order to retain some provisions for supplying Mariut Lake, a few gates in Omoum main drain are proposed.

b) Hydraulic Design Criteria

- Cross-section type : Trapezoidal
- Side slope : 3 : 2 and 2 : 1
- Range of velocity : 0.7~0.3 m/sec
- Roughness coefficient : 0.025
- Free board : $Fb = 0.07 \times d + hv + (0.05 \sim 0.15)$

where, Fb = free board (m)
d = flow depth (m)
hv = velocity head (m)
However, at least 0.3 m will be maintained.

c) Basic Design Principles

(1) Omoum Main Drain (part within Mariut Lake)

- Should satisfy the hydraulic conditions and suitable for existing situations
- Maximum discharge would be 150 cu.m/sec. According to the proposed plan discharge from Hares and Abis pump station, (respectively 30 cu.m/sec and 4 cu.m/sec will be diverted directly to the Mariut Lake.
- Suction water level of the El-Max pumping station would be (-)3.25 m.MSL
- Water surface profile must not topple the delivery water levels of upstream pumps
- Considering the settlers on the embankments, enlargement of the cross-section will be limited to the deepening of drain bed.

(2) Gates in the Embankments

- The gates with attached weirs in the embankments should control not only the normal flow but also serve as the safe passage during any emergency period
- Size, numbers and operation procedure of these facilities will be decided on the basis of the results of Water Balance Simulation

(3) Nubariya Siphon

- Considering the good condition of the Siphon itself, improvement of only damaged manholes and replacement of screen bars and stop-log gates will be proposed
- Construction of facilities to control sedimentation in the Siphon

(4) Discharge-channel from El-Max Pump Station

- Enlargement of the cross-section is necessary to cope with the new increased discharge. A plan to move the settlers from the banks is already underway
- No improvement work will be planned for the sections intersected oil pipe lines
- To determine the size of the cross-section hydraulic analysis and local condition will be the basis. The hydraulic analysis should be performed taking normal flow as 110cu.m/sec and maximum flood flow as 150cu.m/s into consideration

d) Summary of the Facility Planning

- The dimensions of the proposed facilities are presented below. Detail is presented in Chapter XIII.

(1) Omoum Main Drain(part within Mariut Lake)

- Design discharge : Maximum 150 cu.m/sec
- Total length : 10 km (from El-Max P.S. to Hares P.S.)
- Drain type : Unlined trapezoidal
- Bed width : 53 - 55 m

- Longitudinal slope : 2cm/km(1/50,000)
- Embankment width : 10 m

(2) Gates and Weirs

Seven sets of gates including weirs attached to both sides are proposed. The dimensions are as follows.

Gate

- Gate type : Roller gate
- Dimensions : B=3mXH=2mX2
- Design W.L. of Omoum main drain : (-)3.25m.MSL
- Design W.L. of Mariut Lake : (-)2.40m.MSL
- Elevation : (-)3.60m.MSL

Weir

- Width : 10mX2(both sides)
- Height of the sill : (-)2.50m.MSL

Bridge

- Structure : Concrete pile
- Total length : 35m
- Width : 4.5m

(3) Nubariya Siphon

Settling Facility

- Size : B=70m, H=5.1m, L=65m
- Other structures : Riprap, Revetments etc.

Maintenance Facilities

- Stop-log gate : Timber made, manually operated crane
- Dimensions : (3.2mX0.5mX11plates/gate)X8
- Manhole : W=1.2m, B=1.2m, H=3.85mX16
- Screen bar : 3.2mX3.2mX8

(4) Discharge-channel and Resettlement Program

Discharge-way

- Design discharge : 150 - 110cu.m/sec
- Total length : 600m
- Type : Trapezoidal
- Bed width : 20m
- Longitudinal slope : Same as existing

Resettlement Program

- Number of house-holds to be moved : 135 house-holds

2) Drainage Pumping Facilities

a) Summary of Improvement Plan

Improvement Plan of Pumps

Pumping Station	Methods of Improvement	Design Pump Capacities	Justification
El-Max (1)	Overall improvement for seven units.	87.5 cu.m/sec	· Shortage of design discharge (25.0 cu.m/sec) · Overage · Deterioration of pumping rate
Hares	Overall improvement for five units.	30.0 cu.m/sec	· Shortage of design discharge (6.0 cu.m/sec) · Overage · Deterioration of pumping rate
Dishudi	Expansion for one unit.	4.0 cu.m/sec	· Shortage of design discharge
Truga	Expansion for one unit.	4.0 cu.m/sec	· Shortage of design discharge

b) Design Dimension

(1) Design Discharge

The existing and proposed design discharge in each pumping station are as follows:

Design Discharge of Pumps

Pumping Station	Design Discharge		Deficit
	Existing	Proposed	
	(cu.m/sec)	(cu.m/sec)	(cu.m/sec)
El-Max (1)/(2)	125.0	150.0 (87.5/62.5)	25.0
Qalla (1)/(2)	10.0	8.8	-
Abis	5.4	5.6	0.2
Hares	24.0	30.0	6.0
Dishudi	12.0	16.0	4.0
Truga	32.0	36.0	4.0
Shereshera	40.0	39.0	-
Abu Hommos	25.0	16.0	-

Note: 1. Deterioration of pumping rate are excluded in the existing design discharge.

Referring to the above table, the existing pumps in the El-Max, Hares, Dishudi and Truga pumping stations do not satisfy with the proposed design discharge at the rate of 25.0, 6.0, 4.0 and 4.0 cu.m/sec, respectively. Therefore. The above mentioned unbalance rate shall be added to the existing pump capacities.

(2) Design Water Level

Design suction and delivery water levels for the both existing and proposed pumps in each pumping station are as follows:

Existing and Proposed Water Level

Pumping Station	Design Suction Water Level (MSL)			Design Delivery Water Level (MSL)		
	Existing	Proposed	Deficit	Existing	Proposed	Surplus
	(m)	(m)	(m)	(m)	(m)	(m)
El-Max (1)/(2)	(-) 3.25	(-) 3.25	-	0.75	0.75	-
Qalla (1)/(2)	(-) 6.50	(-) 6.55	0.05	(-) 2.50	(-) 2.40	0.10
Abis	(-) 7.80	(-) 6.55	-	(-) 2.70	(-) 2.30	0.40
Hares	(-) 6.00	(-) 5.75	-	(-) 2.80	(-) 2.30	0.50
Dishudi	(-) 5.75	(-) 5.75	-	(-) 2.63	(-) 2.91	-
Truga	(-) 4.90	(-) 4.75	-	(-) 2.00	(-) 2.00	-
Shereshera	(-) 4.25	(-) 4.25	-	(-) 1.60	(-) 1.59	-
Abu Hommos	(-) 2.62	(-) 2.65	0.03	(-) 0.80	(-) 1.28	-

Referring to the above table, the proposed design suction water levels in the Qalla and Abu Hommos pumps are a little lower than those of the

existing, while the proposed design delivery water level in the Qalla, Abis and Hares pumps are higher than those of the existing.

The proposed design delivery water level in the Abis and Hares pumps are 40 cm and 50 cm higher than these of the existing in order to drain the water into Mariut Lake.

(3) Head Between Suction Water Level and Delivery Water Level (Actual Head of Pumps)

Existing and Proposed Actual Head

Pumping Station	Actual Head		Deficit
	Existing	Proposed	
	(m)	(m)	(m)
El-Max (1)/(2)	4.00	4.00	-
Qalla (1)/(2)	4.00	4.15	0.15
Abis	5.10	4.25	-
Hares	3.20	3.45	0.25
Dishudi	3.12	2.84	-
Truga	2.90	2.75	-
Shereshera	2.65	2.66	-
Abu Hommos	1.82	1.37	-

The proposed actual heads of the Qalla and Hares pumps are 15 cm and 25 cm higher than these of the existing due to the rise of water level in Mariut Lake by the application of the separation plan of the Omoum main drain from Mariut Lake. The increase of the proposed actual head in the Qalla pumps is rather small amount, 4 percent, so that it can be considered the existing pumps can be accommodated to such changes. Then, all the existing pumps in each pumping station can cope with the proposed water level conditions except those in the Hares pumping station.

c) Needs of Improvement Works

The overall improvement works in the El Max (1) and Hares pumping stations are required by the following reasons:

Overage Facility and Decreased Pump Capacity

The El-Max (1) and Hares pumping stations have served for 31 and 26 years respectively. It is said the lifetime, 25 years generally, of pump facilities

have been already consumed in both stations. Some units in the El-Max and Hares pumping stations have run up to about 207,000 hours and 116,000 hours respectively. It is also observed that the pump capacity has been decreased at about 80 to 85 percent of the original. At the same time, the repairs and the replacements of equipments have been required very often and they have caused the increase of O/M costs.

Large scaled repairs are also required for some portions of the inlet canal, pump house and outlet basin due to the deterioration and cracks of concrete and the exposure of reinforcing bar caused from the poor workmanship. Although it is said that the lifetime of civil and architectural structures mentioned above is 50 years, it seems that it is rather difficult to maintain the exiting structures in good conditions for another 20 to 30 years.

From the above, the countermeasures for the improvement of the El-Max (1) and Hares pumping stations shall be taken without any delay.

Age of Pump Facilities and Operation Hours

Pumping Station	Age of Facilities	Average Total Operation Hours
	(year)	(hr/unit)
El-Max (1)	30.8	179,000
El-Max (2)	11.3	43,200
Qalla (1)	15.4	36,300
Qalla (2)	5.4	15,600
Abis	4.0	15,300
Hares	26.4	98,300
Dishudi	5.0	18,400
Truga	4.8	17,300
Shereshera	16.8	51,800
Abu Hommos	4.0	6,000

Shortage of Pump Capacity

From the previous paragraph (1) and (3), 2), 5.3.3, the existing pumps in the El-Max, Hares, Dishudi and Truga pumping stations have shortage in pump capacity and those in the Hares pumping station have also shortage in actual head. Based upon the age of facilities, overall improvement of the existing both pump facilities and civil/architectural structures are required in

the El-Max and Hares pumping stations, while the expansion of an additional pump station are required in the Dishudi and Truga pumping stations.

Importance of Pump Facilities

The Study Area is fully dependent on 24 hour pump drainage due to topographic conditions which the gravitational drainage system can not be employed. The malfunction of pumps will cause the damages not only to farmland but also to public utilities such as private houses, roads and production facilities.

Especially, the El-Max pumping station which locates in Alexandria city, the second largest city in Egypt, is only the outlet of excess water to the Mediterranean Sea. The El-Max pumping station has been firstly established in 1882 and has a great responsibility on the ease of damages by the inundation for the farmland of about 430 thousand feddan (180 thousand hectares) in the Study Area and also the perimeters of Mariut Lake.

From the above, the improvement works of El-Max pumping station are required as early as possible, because any shutdown of pump operation shall not be allowed even in a second.

Purification of Mariut Lake

The Omoum main drain also plays an important role as a water resources for the inland fisheries and the water purification in Mariut Lake. However, based upon the proposed plan, the Omoum main drain will be separated from Mariut Lake and its water level will be lower than that in the Lake. Therefore, the Omoum main drain can not supply her water to the Lake by gravity. The partial water supply are carried out to the Lake through the Abis and Hares pumping stations at present, however, EPADP plans the total amount of water from the said pumping stations will be diverted into Mariut Lake in future.

d) Method of Improvement Works

(1) El-Max Pumping Station

The El-Max pumping station consists of two pump stations, (1) and (2). The (1) is to be improved with an increased total capacity of 87.5 cu.m/sec (150.0 - 62.5 = 87.5 cu.m/sec).

There are two alternative plans for the improvement, one is replacement of only mechanical and electrical facilities utilizing the existing stations, and another is replacement of all facilities. Although the former is economical way when the initial cost is considered, the latter is recommended taking into consideration the space required for new facilities and the overage of existing structures.

The total number of pumps are adopted to be seven units including one stand-by unit with the same pump diameter, which is the same numbers as the existing, from the viewpoint of operation/maintenance. The design discharge per unit is 14.6 cu.m/sec. It can be considered that one stand-by unit will not be qnantitatively required considering (two) pumping stations. However, one stand-by unit is provided considering 24 hour operation are required throughout a year and a rather longer period will be required for the procurement of the equipment parts because of its importation. The inclined shaft axial flow pump, the same type as the existing one, are selected considering the familiarization of the equipments with its operation and maintenance.

(2) Hares Pumping Station

The full replacement of this pumping station are planned by the same reasons mentioned in the El-Max (1) pumping station. The total number of pumps are adopted to be five units including one stand-by unit and the inclined shaft axial flow pump is selected. The design discharge per unit is 7.5 cu.m/sec. The basic idea on the selection of number of pumps and pump type are same as the reasons mentioned in the El-Max (1) pumping station.

Number of Pumps, Pump Diameter and Discharge Per Unit

No. of pumps	El-Max (1) Pumping Station		Hares (1) Pumping Station	
	Discharge per Unit	Pump Diameter	Discharge per Unit	Pump Diameter
	(cu.m/sec)	(mm)	(cu.m/sec)	(mm)
4	-	-	10.00	ø2,000
5	21.88	ø2,800	7.50	ø1,650
6	17.50	ø2,500	6.00	ø1,500
7	14.58	ø2,300	-	-
8	12.50	ø2,300	-	-

(3) Dishudi Pump Station

The mechanical and electrical facilities of this pumping station has been replaced in 1989. Considering the proposed additional discharge and total head, one additional vertical shaft axial flow pump with a capacity of 4.0 cu.m/sec is provided.

(4) Truga Pumping Station

One additional vertical shaft axial flow pump with a capacity of 4.0 cu.m/sec is provided in the same manner with the Dishudi pumping station.

(5) Others

The upgrading of operation system with mechanization and electrification are employed as much as possible for more reliable operation and maintenance, considering 24 hour continuous operation are required.

5. 4 Phased Development Plan for Drainage Improvement

In the planning for project implementation of the Farmland Environmental Improvement Project in Omoum Area, the following three phases of development and their target time, totaling 15 years are planned considering project characteristics such as drainage improvement.

- First Phase : Short-term Development (1996-2000)
- Second Phase : Middle-term development (2001-2005)

- Third Phase : Long-term Development (2006-2010)

For project implementation during the short-term period, the most urgent projects will be categorized as the First Phase, while those projects to be implemented during middle and long-term periods will be in the Second and Third Phases, respectively. The projects in each phased stage are itemized as follows;

Short-Term Development (1996-2000);

- Provision of open and tile drains, mainly in the lower reaches of the basin,
- Construction of optimum drainage systems in Mariut Lake area, from the viewpoint of agriculture, fishery, environment and, navigation,
- Improvement/replacement of over-aged pumping facilities and structures at the El-Max and Hares pump stations
- Improvement of Omoum main drain (cross section, O & M roads)
- Partial utilization of Omoum main drain's water as reused water resources,
- Establishment/strengthening of farmers' organization and water and drainage users' associations for well water management
- Water quality monitoring and regulation by law for water purification and pollution sources, in order to conserve water quality of Mariut Lake

Middle-Term Development (2001-2006);

- Implementation of land consolidation and provision of an irrigation canal lining by concrete or other suitable materials
- Strengthening of irrigation water management
- Implementation of optimum utilization of Omoum main drain's water as a reused water resources.

Long-Term development (2006-2010);

- Implementation of intensive irrigated agriculture facilitated by land consolidation and land leveling

- Introduction of remote control and regulation systems for pump facilities and Mariut Lake, in order to monitor drainage water and water quality

5. 5 Selection of Priority Development Area

5. 5. 1 Criteria for Selecting Priority Development Area

The priority area to be developed (Project Area), which corresponds to the objective area for the Feasibility Study, was selected in the Study Area of 180,710 ha (430,260 feddan). The priority area will coincide with one drainage block from the viewpoint of topography and existing drainage systems.

Criteria for selecting the priority development area are itemized as shown below;

- Consistency in Government Policy

  On-going and/or proposed Government improvement plans already authorized will be given high priority in the Master Plan.

- Satisfaction of Local People's Demand

  Local people's demands and the urgency for drainage improvement should be satisfied as far as possible.

- Farmers' Income Increase and Employment Opportunity Generating Effects

  In order to alleviate the local income disparity and socio-economic conditions, the plan which will raise the income level and increase employment opportunities for local people will be given high priority.

- Investment Scale

  Considerable project benefits will be expected in accordance with the scale of the project such as the size of the drainage area. And also, taking into consideration the scale of investments and benefits, plans with high project economy will be given top priority.

5. 5. 2 Selection of Priority Development Area

By applying the above-mentioned criteria, comprehensive evaluations for priority development area was made from technical, economical and social viewpoints in the Master Plan Study, in order to select priority area. The study results are shown in Table 5-2. In this study, local people's demands were obtained through verbal information from the local people themselves in the course of Phase-I field work. Regarding project economy, economic internal rate of return (EIRR) was preliminarily analyzed as an economic index of the project.

- Project Benefits

  Project benefits to be gained from the project implementation were estimated based on the drainage improvement including the installation of subsurface tile drains. Project benefits were estimated by utilizing project benefit data in the priority development area and project mentioned in chapter XII and XIII. Details are given in Table E-1-4, Annex E.

- Project Costs

  Projected costs for the selected Alternative Plan of Case-3 were preliminarily estimated for each drainage block (see Table E-1-5, Annex E). Project costs were also referred to the estimated project costs mentioned in Chapter XII and XIII. Major improvement and construction facilities are Omoum main drain, gates, pump stations, main and secondary drains, and tile drains.

- Project Evaluation

  Project evaluation was made applying economic internal rate of return (EIRR) on the basis of the following conditions;

  · Analysis period : 30 years
  · Development period : 4 years
  · Benefits and costs : Economic

Evaluation results are summarized in Table 5-2 (details are shown in Table E-1-6, Annex E), and the followings are found out;

- From the viewpoint of drainage improvement, each block requires some form of improvement for some reasons. However, improvement

of pump facilities and provision of subsurface tile drains in the Hares Area and improvement of the El-Max pumping facilities have been given top priority in the drainage improvement program under the MPWWR, as in Project Planning Report, Drainage Project 5.

- The most sever flood damage, which has been caused by 1991 December flood is observed in Hares Area with flooded area of 19,050 feddan (about 8,000 ha), followed by Truga area with 18,100 feddan (about 7,600 ha) of flooded area.

- Taking into consideration the scale of the project and the large areas to be benefited, together with the local people's enthusiasms for drainage improvement in the Hares, Dishudi, and Truga Areas, a considerable impact on the rural economy is anticipated in the form of employment opportunities and resulting economic benefits.

- In particular, the Hares Area is facing a difficult situations in terms of of its rural living environment, because of not only low agricultural production due to poor soil conditions and no provision of subsurface tile drain, but also a lack of social infrastructure. Therefore, necessary countermeasures to alleviate rural income disparity should be taken as early as possible in this area. Furthermore, pumping facilities in the Hares Area are very old and have deteriorated since installation in 1968.

- The economic internal rates of return (EIRR) in the Hares Areas are evaluated to be 17 percent, which seems to be economically viable from the viewpoint of project economy.

Through the overall study mentioned in the above, priority development area within the Study Area has been selected at the Hares Area, and a Feasibility Study was made for this area during the Phase-II field works.

5.6 Selection of Priority Development Project

As mentioned in the previous paragraph, it is generally considered that the poor drainage in the fields are caused by insufficient drainage capacity and maintenance works of the drainage facilities such as drainage pumps, main drains and subsurface tile drains. However, principal reasons causing such poor drainage conditions in the Study Area are deteriorated and insufficient

capacity of main drainage facilities such as El-Max pumping station, Omoum main drain and discharge-channel.

Consequently, in order to improve the drainage situation in the Study Area, improvement of above mentioned main drainage facilities is essential, together with the improvement of prevailing irrigation and drainage water managements. Under these circumstances, the improvement of El-Max pumping station, Omoum main drain and discharge-channel are selected as a Priority Development Project to be urgently improved in the Area, based on the following reasons;

- It is assumed that the separation of Omoum main drain from the Mariut Lake is necessary from the viewpoint of suitable water level in the drain that will ensure a smooth passage for drainage water from the area, conservation of water quality and better fishery activities in the Mariut Lake.

- In fact, the El-Max pumping station is the only facilities that deals with such a huge amounts of water coming from the Study Area by pumping out to the Mediterranean Sea. Out of two pumping stations, No.1 and No.2, No.1 pumping station was installed 31 years ago, i.e in 1963, and it was reported that maintenance costs have become a burden for the related Department. From the view stated above and for the following vital roles, the importance of improving of No.1 pumping station will be realized.

  - The importance may be realized from the necessity of 24 hours operations for drainage water to Mediterranean Sea. In winter, especially, from November to February, drainage of runoff generated in the Study Area is solely depends on this pumping station. In case of floods, to protect public facilities such as railway, roads, water supply lines, gas lines etc., safe and effective operation of drainage capacity will be essential.

  - Another important function which is draining of water stored in the Mariut Lake is also performed by this pumping station which helps to keep the water quality reasonable.

Table 5 - 2 Evaluation for Selecting Priority Development Area

Items	Qalla Area	Abis Area	Hares Area	Dishudi Area	Truga Area	Shereshera Area	Abu Hommos Area	Study Area (El-Max Area)
1) Drainage Area (ha)	5,880	3,780	26,600	15,330	43,080	56,720	19,910	180,710
2) Population Density (pers./sq.km)		1,638	509	1,887	707	788	1,491	909
3) Cultivation Area Ratio (%)	68.8	90.4	87.2	86.4	87.9	87.3	95.1	88.0
4) Pump Capacity								
Total Capacity (cu.m/sec)	10.0	5.4	30.0	16.0	36.0	40.0	25.0	150.0
Unit Capacity (mm/hr)	0.61	0.51	0.40	0.38	0.30	0.25	0.45	0.29
5) Consistency of Government Policy*								
- Improvement of Pump	◇	○	◎	◇	◇	◇	◇	◎
- Required Tile Drain Area (ha)	5,000	3,210	24,440	13,030	26,050	0	0	69,730
- Flood Damage Area by December 1991 Flood	630	1,050	7,980	2,100	7,560	970	-	20,290
- Water Quality (EC: Aug. 1994) (mS/cm)	2.85	8.75	12.71	7.00	5.09	3.05	2.07	9.49 Mariut Lake
6) Satisfaction of Local People Demand	○	○	◎	◎	◎	○	○	○
7) Income Increase (Potential Net Benefit) (million LE)	11.60	7.48	66.69	29.71	74.23	87.64	39.31	316.66
8) Investment Cost and EIRR								
- Project Cost (million LE)	8.47	5.50	64.39	21.61	53.96	63.56	28.56	246.05
- EIRR (%)	12.2	12.3	17.0	11.4	11.3	14.1	18.9	14.1

Note ; The drainage area of Study Area includes Mariut Lake area of 9,410 ha
* : Project Planning Report, Drainage Project 5.
◎ : high priority
○ : normal priority
◇ : low priority

Project costs include the priority development project costs.

CHAPTER VI. ENVIRONMENTAL IMPACT STUDY

CHAPTER VI. ENVIRONMENTAL IMPACT STUDY

6. 1 Features of the Study

1) Name of Study

Farmland Environmental Improvement Project in the Omoum Area

2) Purpose of the Study

Purpose of the Study is to improve and rehabilitate the Omoum main drain systems and to intensify the subsurface drainage systems.

3) Location of the Study Area

The Study Area is located in the Behera and Alexandria Governorates in the Western Nile Delta. The Area has an arid climate, and fertile agricultural land with irrigation systems fed by Nile water sources.

4) Type of Study

The Study is to improve the Omoum drainage systems, which has a drainage area of 430,260 feddan (180,710 ha). Social features around the Study Area are summarized as follows (excluding Qalla Area);

- Number of villages : 81 village
- Number of houses and families : 222,000 houses
- Population : 1,175,000 person
- Population Density (A = 1,259.0 km^2) : 932 person/sq.km

5) Drainage Improvement Works

- Improvement of drainage pump station

  - El-Max pumping station (replacement): Q = 14.6cu.m/sec × 7units
  - Hares pumping station (replacement) : Q = 7.5cu.m/sec × 5units
  - Dishudi pumping station (Increase in pump capacity) : Q = 4.0cu.m/sec × 1set
  - Truga pumping station (Increase in pump capacity) : Q = 4.0cu.m/sec × 1set

- Improvement of Omoum main drainage system : Length = 10.6 km
- Improvement of Omoum drain dike in the Mariut Lake : Length = 10.0 km
- Improvement of branch drains : Length = 701 km
- Improvement of subsurface drainage systems : Area = 177,690 feddan (74,630 ha)

6) Operation of Drainage Systems

Omoum main drain and El-Max, Hares, and Dishudi pumping stations, play an important role in the Study Area, and Operation of these main facilities will be continued in future, that is, seven drainage pumping stations in the Area will operate to maintain and to control the water level of drains, which collect the discharge from farmland. The El-Max pumping station will drain the excessive water to The Mediterranean sea, and will maintain the Lake water level appropriately.

- Proposed operating water level for Omoum main drain : (-)3.25m.MSL
- Proposed Mariut Lake water level : (-)2.40m.MSL

6.2 Present Conditions In the Study Area

Location;

The Study Area which has a drainage area of 1,807 sq.km is located in the West Nile Delta.

Land-Use;

Item	Area	
	sq.km	(%)
Farmland	1,326	73
Lake	72	4
Drain and Road	336	19
Residential Area	73	4
Total	1,807	100

Natural Conditions;

- Geographical Features

  - The Study Area is situated in the alluvial flat plains, and it's altitude is 5 to (-)3.5 m below mean sea level. About forty percent of the Area is situated below sea level which was reclaimed from marshy land about one hundred years ago, and the present Lake area is only four percent of Omoum plain.

  - Permeable silty clay and loamy sand soil are distributed throughout the Area.

  - Expansive farmland is reclaimed from the desert which is located in the west side of the Study Area. Large amounts of water needed for this area will affect the Omoum Area in future.

- Atmosphere (Alexandria)

  The Study Area belongs to the arid or semiarid zone, and meteorological data are as follows;

  - Mean temperature : 20.4 °C
  - Monthly average maximum temperature : 30.5 °C
  - Annual average humidity : 68 %
  - Annual rainfall : 197 mm (Alexandria)
    107 mm (Damanhur)
  - Wind : North or north west winds prevail throughout the year, windspeed is 4 km/hr.

- Water

  - Surface water

    Annual rainfall in the Study Area ranges from 100 mm to 200 mm and is concentrated in winter, therefore, drainage discharge of drains is caused mainly by intake water for irrigation.

  - Groundwater

    Groundwater level is affected by drainage pump suction level due to the fact that the Study Area is situated in very flat low-lying

land. It can be said that the sources of groundwater are mainly used for irrigation from Mahmoudia and Nubariya canals, and partially intruded sea water.

- Flood

It is recorded that the lower Omoum area was flooded in December 1991 and damaged by flooded water. The water level of Mariut Lake be increased by more than (-) 1.86 m MSL.

Existing Biological Conditions

- Flora

- Cultivated crops such as paddy, corn and orchard are grown on most of the land except the marshy area reserved for Mariut Lake.
- Reeds (boos in arabic), cattail (bordy) and water hyacinth (ward Al Nile) are grown around the Lake gregariously.

- Fauna

- Wild ducks and small birds such as swallow and sparrow are observed by the Lake. Brackish water fish such as Tilapias, Mullet, Catfish and Carp live in the Lake and in the Omoum main drain, shrimp and shellfish are seldom caught in these areas due to the polluted water.

Social Conditions

- Land-Use

Ninety percent of the Study Area is used for farming and land for irrigation and drainage canals, and the remaining ten percent is residential land, Lake or marshy land.

- Man made Facilities and Activities

- Transportation net works for motor traffic, train and ships exist in the Study Area, i.e., Nubariya navigation canal beginning at

Mariut Lake supplys the domestic and irrigation water to the Study Area, so this canal has a close relationship with the project.

- Omoum main drain and Mariut Lake are the places of livelihood for fisherman and the local people. The maintenance of Lake water is a important matter for them, and the fishcatch supplies their essential protein.

- Mariut Lake is receiving the preliminary treated waste water from Alexandria city, and functions as a biological treatment pond with natural vegetation, and also

- Mariut Lake is located near to Alexandria, and it's water space and aquatic plants constitute natural scenery and a rich space for the citizens.

- Fishing, which is undertaken in Mariut Lake also constitutes a valuable recreation space for the citizens of Alexandria.

6.3 Environmental Impact Study

6.3.1 Environmental Impact

According to the results of the evaluation undertaken in an Initial Environmental Examination (IEE), the environmental impact due to take place resulting from the project are as follows;

- Impact on the fisheries
- Impact on the surface water flow
- Impact on the groundwater flow
- Impact on navigation
- Affect on the Lake water both in quality and in quantity
- Affect on eutrophication of the Lake
- Impact on the inhabitants

6. 3. 2 Forecast and Evaluation of Impact

1) Impact on Fisheries

The principal features of fisheries related to the Mariut Lake and Omoum main drain are as follows;

- Number of fishermen : 5,500
- Mean annual fish production : 3,448 tons (1985~1993 average)
- Selling price : 5 to 7 LE./kg
- Fish species : tilapia, carp, eel, catfish etc

The separation dike of Omoum main drain in the Lake will have the following impact on fisheries.

- Freshwater from the Omoum main drain and Nubariya canal cannot easily flow into the Lake without the gate facility, since more than 10 years ago, fisherman cut the dike at many places (about 30 places) to introduce the water from Omoum main drain,
- Obstacles to inland navigation will occur, and the countermeasures or mitigation plans to be considered are as follows;
- Omoum drain dike in the Mariut Lake should be retained as it is,
- Intake and navigation facilities should be provided to introduce freshwater from Omoum main drain and to enable the fishermens' boats to pass through.

2) Impact on Surface Water

The water flow in the Omoum main drain is controlled by operation of drainage pumps which are located along the drain. The impact on water flow to the Mariut Lake can be characterized as twofold. One assumes that discharge from Omoum main drain will increase after the project, while inflow of Mariut Lake will decrease due to reuse of water at Truga pump site, based on the reuse plan, that is, about 40 cu.m/sec of drain water after mixing, will be used for the new reclaimed area. As a countermeasure, the capacity of the El-Max pumping station will be increased as part of the project. Concerning the latter, the agency or the project office of the reuse drainage water project should

implement the countermeasure for changing the inflow. But, it is considered that the effects of reduction in discharge are not serious apart from water salinization (see Table J-2-5, Annex J.).

3) Impact on Groundwater

The level of groundwater in the Study Area's farmland is maintained at about (-) 1.2 m below the ground surface with tile drain and drainage pumps. Therefore, it is considered that negative impacts will not take place.

4) Impact on Navigation

The separation of the Lake by the Omoum drainage dike will obstruct navigation in the Lake. The improvement and rehabilitation plan for Omoum main drain should be formulated taking into account inland and lake navigation as well as fishing activities. The Nubariya navigation canal should be, needless to say, left as it is.

5) Affect on Lake Water

The Lahe's water sources

The present Mariut Lake is divided into four parts by a desert road and the Omoum main drain. North parts of the Lake, named "Main Body" (M1), plays multipurpose role in social activities and the environment of Alexandria city. The main inlets are;

- Omoum main drain
- Nubariya navigation canal
- Qalla drain
- West Treatment Plant (WTP)

These water sources affect the main body of the lake both in quality and quantity. The east side of the Lake along the desert road receives the water from Omoum main drain and the Abis drainage pump directly, and the west side (M3) and south side of Lake receive water from the Omoum main drain and Nubariya navigation canal.

Quantity of Water in Mariut Lake

The water surface area and storage of Mariut Lake are described below;

Storage of Mariut Lake

Location	Area	Water Surface Area	Depth	Storage	Daily Inflow
	(feddan)	(feddan)	(m)	(MCM)	(MCM)
North Lake (M_1)	5,200	4,000	1.0	16.8	
East Lake	1,000	700	1.0	3.0	8.4
West Lake (M_3)	3,800	3,800	1.0	15.9	
South Lake (M_2)	6,000	4,500	1.0	18.9	
Total	16,000	13,000		54.6	8.4
	(6,720 ha)	(5,460 ha)			

Daily Mariut Lake Inflow

(Units: 1,000 cu.m)

Inlet	Aug.'94	Sep.'94	Average	1994 Average
Omoum	6,264	7,518	6,891 (82%)	4,849 (71.6)
Nubariya	400	400	400 (5%)	625 (9.2)
Qalla	948	959	954 (11%)	1,000 (14.8)
W.T.P.	175	175	175 (2%)	197 (2.9)
Other.	-	-	-	101 (1.5)
Total	7,787	9,052	8,420 (100%)	6,772 (100.0)

Note: Details are given in Figure J-1-24, 25 and Table J-2-7, Annex J .

Water Quality of Inflow (Aug. 1994)

Location	EC	DO	BOD	COD	T - N	T-P	Coliform
	(μs/cm)	(mg/ℓ)	(mg/ℓ)	(mg/ℓ)	(mg/ℓ)	(mg/ℓ)	(10^3 MPN/100cm^3)
Mariut Lake (M1)	3,700	1.0	21.3	38.5	40.0	0.88	24,000
Mariut Lake (M2)	6,300	6.4	19.8	35.5	50.0	0.96	24,000
Mariut Lake (M3)	13,300	6.7	7.8	14.0	2.5	0.13	1
Omoum main Drain	6,210	7.7	2.4	14.5	0.96	0.11	7.5
Nubariya Canal	6,300	6.6	13.8	26.2	-	-	24
Qalla Drain	2,420	0.9	56.0	346.3	-	-	24,000
W.T.P. Outlet	-	3.4	144.5	369.2	-	-	-
Nubariya Irrigation Canal	300	8.5	9.3	17.4	0.01	0.05	2.3

Note: Details are given in Annex J.

Namely, the inflow of Mariut Lake is eight to nine million m^3 per day on average and almost, the same amount of Lake water is discharged into the Mediterranean sea through the El-Max pump every day. The distribution share of inflows into each part is not clear, but only the main body gets water from Qalla drain and WTP which includes waste water from Alexandria city.

Water Quality of the Lake and Drain

According to water quality analysis during phase-I fieldwork, water quality at the inlet of drain and Mariut Lake is evaluated as follows;

EC Value : The salinity in Electrical Conductivity for Qalla drain and the main body of Lake are comparatively low ranging from 2.4 to 3.7 mS/cm. Omoum main drain, Nubariya canal and south side of the Lake have the same value of EC, about 6.3 mS/cm. Electrical conductivity of closed western Lake is very high (11.0~13.0 mS/cm). EC value in winter season is higher than that of summer, and the concentration rate of salinity in the Abis, Dishudi, Hares and Truga pumping stations is about 1.7 times as compared with summer E.C value. The main reasons for high contents are assumed that the water supply to the area through Behery Rayah and Nasery Rayah decreases. The changes in salinity of water and intake water from Behery Rayah canal are shown in Annex J, Table J-2-1 and Figure J-1-21.

DO : Main body (M1), Qalla drain and WTP outlet's water are affected by oxygen starvation. This problem is concentrated on the north east side of the Lake due to the discharge of waste water from Alexandria city. DO of other drains range from 6.4 to 7.7 mg/l, which is evaluated as being the normal condition of water.

COD, BOD : Both COD and BOD values at Qalla drain and WTP are very high, ranging from 56 to 369 mg/l, and the south side of the Lake which is affected by these drains has relatively high values in BOD and COD. Omoum main drain has lowest values in BOD and COD, 2.4 and 14.5 mg/l respectively. The water quality complies with Egyptian standards.

T-N, T-P : Eastern (M1) and Southern (M2) parts of the Lake are polluted by sewage from Alexandria city and have a very high value in

Total Nitrogen (T-N), reaching 40 to 50 mg/l. These Lakes can be called over-eutrophic Lakes. Omoum main drain has normal conditions concerning nutrients which are less than 1.0 mg/l in T-N.

Coliform : As with nutrient, the MPN of Coliform in the M1 and M2 parts of the Lake range above one million and comes out top in the sampling sites. Omoum main drain and western Lake are clear of coliform, and the MPN is 1,000 to 7,500. Omoum main drain water complies with standards set by National Law 48 of 1982, for the coliform bacteria (less than $<5{,}000$ MPN/100 cm^3).

Variation of Water Quality

Variation of water quality in Omoum main drain from upstream to downstream can be characterized as follows; (see Figure J-1-5 to Figure J-1-18, Annex J.)

- EC values in the upstream, middle and downstream sections are 2~3 mS/cm, 3~4 mS/cm and 5~6 mS/cm respectively, while the salinity of drains gradually increases from upstream to downstream.
- TSS (Total Suspended Solids) and Coliform also have a tendency to increase with contents and numbers from the upstream to downstream sections.
- There is no variation of DO, BOD, COD and pH, contrary to EC and TSS values. It is observed that contents change from high to low by dilution or biological purification through water flows downstream.
- pH of all sampling sites apart from Nubariya canal range from 7.5 to 8.0 as neutral. But Nubariya canal water is slightly alkaline; While pH values range from 8.6 to 9.1.

Namely, the water quality of the Omoum main drain at the outlet into the Lake is comparatively clean, as is Nubariya irrigation canal apart from EC values. Therefore, no negative impact from Omoum main drain water affects Mariut Lake, and, water from the Omoum main drain should be supplied to the Lake. From the environmental aspect, countermeasures to be executed can be summarized as follows;

- Existing water flows in the estuary of the Omoum, (the water supply function of the Omoum main drain) should be maintained, so, construction of a water supply facility to the Lake and it's operation are essential.
- Regarding the restoration plan for Mariut Lake, it is expected that the countermeasures mentioned in the "Environmental Action Plan of Egypt" and "Recommendations" of the workshop on Mariut Lake in 1994 (see Annex J-1-B and C) should be implemented immediately.
- The long-term Improvement and preservation plan of Mariut Lake should be planned and executed on the basis of the polluter pays principle (PPP). For this purpose, Law No.48, 1982 and Law No.4, 1994 will play an important role in environmental preservation. Moreover, an Environmental Action Plan is recommended to modify the Law No.48 standard, Namely. It is better to add the description of water standards for fisheries, irrigation and recreation and also it is expected to execute area-wide total pollutant load control in the River and Lakes.

6) Impact on Eutrophication

Based on the results of water analysis and the indices of eutrophication in Japan (see Annex Table J-1-8, 9), the inescapable conclusion was that all the waters surrounding Mariut Lake are eutrophicated. Apart from the western Lake (M3), other parts of the Lake became over eutrophied due to sewage from Alexandria city. Also Ameriya city sewage affects the southern part of the Lake (M2) through Nubariya canal. Contrary to these water sources, the Omoum main drain supplies clean water to eutrophic Lakes. So, the improvement project of Omoum main drain will have a positive affect on the Lake water.

7) Impact on the Inhabitants

The Omoum drainage systems, including the El max pump, control the waters of a large area of farmland and the Lake water situated near to Alexandria city. Therefore, it is expected that the improvement of Omoum main drain system will be beneficial for inhabitants and contribute to expanded economic activities and enhanced landscape. During the planning of Omoum drainage dike project in the Mariut Lake system, the following attention should be paid to prevent negative impacts on fisheries and on water quality.

- A sufficient length of unseparated dike should be retained, that is, Alternative plan with existing Nubariya navigation canal takes high priority.
- Gate facilities for intake water and to enable fishermens' boats to pass through should be provided.

6.4 Environmental Conservation Plan

6.4.1 Environmental Conservation Policy

The separation embankment proposed in the Project is expected to give some adverse effects to the local fisheries, navigation and the Mariut Lake water quality. In this connection, there will be effective countermeasures to be required so as to avoid or minimize such adverse effects. The proposed facilities shall be constructed to keep the following environment level and Mariut Lake water quality as the targets.

- The local fisheries and navigation should be maintained at the level as of 1982 when the old separation embankment would not be partially destructed.
- The Project works should not degrade the Mariut Lake water quality any further. In other words, it should be considered important to keep existing mechanism of introducing and discharging a plenty of water illegally for upgrading of the Lake water.
- The heavily polluted Mariut Lake water, however, could not be cleaned by the aforesaid mechanism only, but cleaning improvement plan (Regional Master Plan) proposed separately by the workshop is expected to be effective. In view of the water quality, the Lake water quality should be almost equal to that of the water introduced of the Omoum Area, and restriction of application of agri-chemicals and kitchen waste water treatment shall be appropriately carried out for adequate pollution sources control in the Study Area.

6.4.2 Mitigation Plan

The necessary countermeasures for the local environment conservation shall be provided on the pollutants' cost basis, and the proposed

plan should be prepared as follows in considering that adverse effects of discharges to the Mariut Lake should be avoided or minimized through realization of the drainage improvement works.

1) Physical plan

- The plan to minimize the length of the separation embankment shall be) primarily prepared (Adoption of the Alternative Plan of Case-3 for Drainage Plan).
- The plan should include those facilities to allow fishing boats to navigate and water to flow and discharge flow into the Lake. (Construction of five gates, approx. discharges of 40 cu.m/sec)
- The facilities shall be produced so that drainage water can be introduced from the Omoum Area directly to the Mariut Lake. (Hares pumping station of 30cu.m/sec, Avis pumping station of 5.4 cu.m/sec).
- Improvement work shall be implemented in paying careful attention to avoiding polluted water.

2) Mariut Lake Water Control

a) Fluctuation of Lake Water Level

The discharge records for past 30 years reveal the characteristic features of the Lake water fluctuation as follows (see Figure 6-1);

- The monthly average water level observed from 1966 to 1980 was found below (-)3.00 m.MSL on an average water level of the Lake. The Lake water level has fluctuated by about 80.0 cm between (-) 2.50 and (-) 3.30 m.MSL.
- The recorded fluctuation for the latest five years have shown that the maintenance water level has dropped by about 40 cm since the summer in 1992, or the maintenance water was kept at (-)2.40 m.MSL in the former two years for 1990-91, while at (-)2.80 m.MSL in the latter three years for 1992-93 and -94.
- The high water levels in the Lake appeared in the months in summer up to 1989, but in the recent five years, has appeared concentratively in the winter months from November to February. The major reasons of such concentration of the months with Lake water level increase are considered to be concentrated drainage

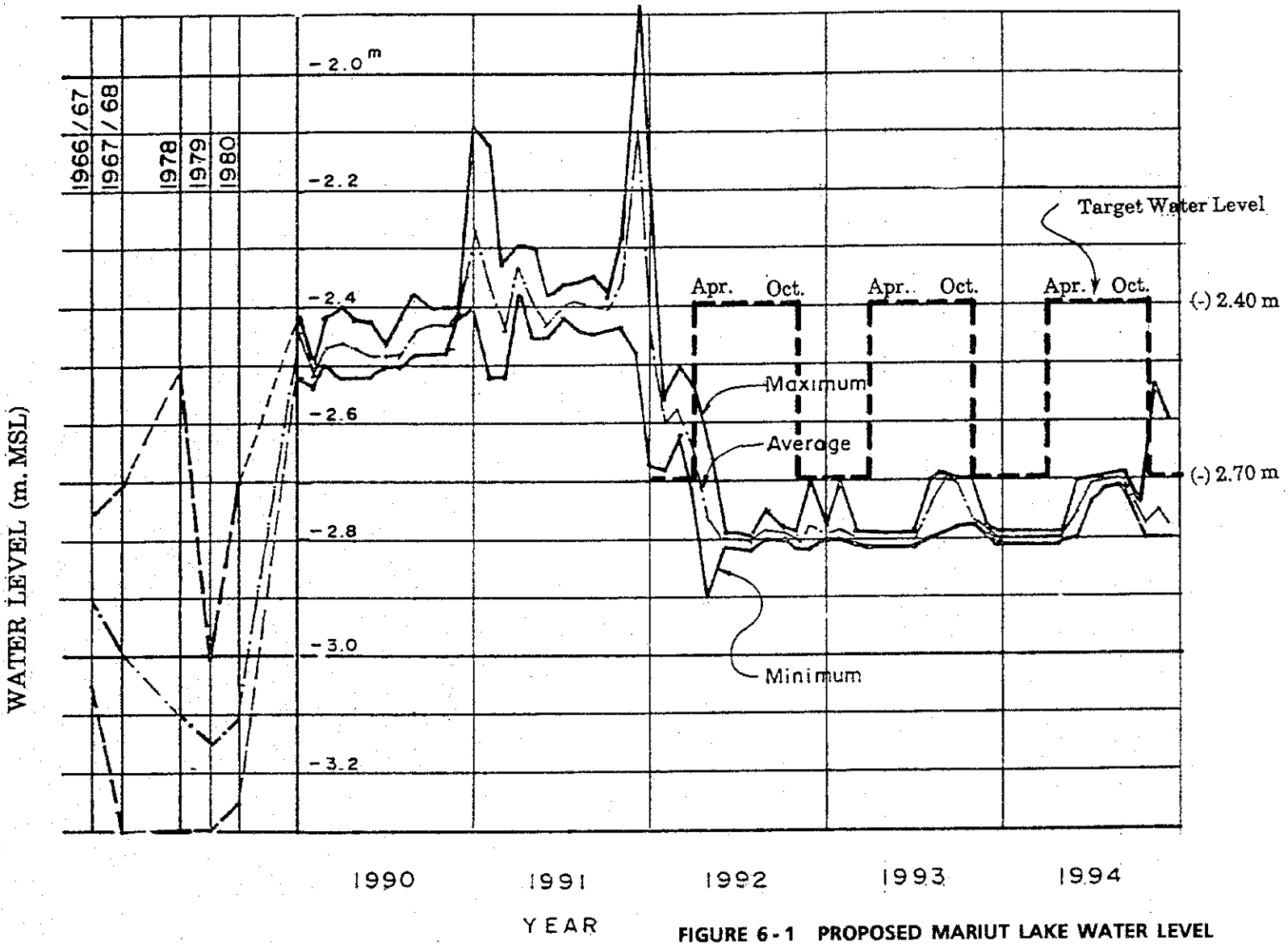


FIGURE 6-1 PROPOSED MARIUT LAKE WATER LEVEL

water out of the farmland and rainfall. Recently, however, it seems to mainly come from rainfall.

b) Mariut Lake Water Management

There have been the following two problems reported as rapid degradation of the Mariut Lake water quality with abrupt development made around the Lake and flood damages given to the Lake surrounding areas in the winter in 1991 and 1994.

A planned Lake water control in quality and maintenance of water level are vitally important matters in taking into consideration the Lake fisheries, flood control function and increasing drainage from the newly developed areas.

From the viewpoint of the recorded water level fluctuation, Lake water management and existing fisheries, the plan for effective Lake water management can be proposed as follows;

- Introduction of drainage discharge of Omoum main drain into the Lake.
- Establishment of target Mariut Lake water level

Introduction of Drainage Discharge of Omoum Main Drain

The drainage water introduction into the Mariut Lake shall be made according to the existing habitual rule and the request by EPADP as following plan;

- Drainage discharges by both the Abis and Hares pumping stations shall be directly introduced into the Mariut Lake.

Pumping Station	1994 Average	Designed Discharge (Max)
	(cu.m/sec)	(cu.m/sec)
Abis P.S	1.4	5.4
Hares P.S	15.8	30.0
Total	17.2	35.4

- Water in the Omoum main drain will be introduced into the Lake from time to time.

Discharge from the Mariut Lake to the Omoum main drain will be conducted by the following facilities, but the water to the Lake will be through the following gates.

- Lake water control gates : 5 sites
- Discharge volume : 28 cu.m/sec (2.8 cu.m/secx5 sitesx2 gates)
- Water level control gate : 2 sites

The inflow into the Mariut Lake is arranged as follows, according to the observation records in 1994 and the proposed water intake plan.

Inflow into the Mariut Lake

(unit: cu.m/sec)

Items	Present *2 (1994 Ave.)	Plan *2 (1994 Ave.)	Plan (Average Year. July)	Plan (Flood) *3
Omoum Main Drain	20.0 *1	(35.4)	(35.4)	(35.4)
Nubaria Navigation Canal	7.2	7.2	7.2 *2	14.1
Hares P.S	5.5	15.8	20.8 *3	22.0
Abis P.S	0.0	1.4	3.0 *2	4.0
Qalla Drain	9.2	9.2	9.2 *3	9.9
WTP	2.3	2.3	2.3 *3	2.0
Run-off Discharge	1.2	1.2	1.1 *3	16.0
Sub-Total	45.4	37.1	43.6	68.0
Direct Discharge of Omoum Drain *5	25.5	39.9	95.2	82.0 (50.4)*4
Total	70.9	77.0	138.8	150.0 (118.4)

Notes: Sources
*1. Table of Reuse
*2. Table of results of drainage in 1994.
*3. Designed drainage (monthly average, Max.)
*4. Reuse is conserved, (82.0 cu.m/sec - 996 MCM/year = 50.4 cu.m/sec)
*5. A Part of Omoum Drain water is discharged directly to Mediterranean Sea though El Max P.S

Proposed Mariut Lake Water Level

It is recommended that the Mariut Lake water level control should be practiced with maintenance water level prepared by seasons in consideration of

water level fluctuation and flood control for the last five years together with fishing practices, etc. And the proposed water levels can be shown as follows;

Proposed Mariut Lake Water Level

Season	Maintained W.L (Average)	Lower Limit	Upper Limit
Winter (Nov.~Mar.)	(-) 2.70 m	(-) 2.80 m	(-) 2.60 m
Summer (Apr.~Oct.)	(-) 2.40	(-) 2.50	(-) 2.30
Maximum Water Level	(-) 2.30	-	-

Mariut Lake Water Level and Drain Operation

Since the Project will separate the Omoum main drain water from the Mariut lake water, the water level control must be carried out according to a plan. The seasonal fluctuation of the Mariut Lake and the Omoum main drain can be given as follows respectively.

Water Level and Flow of Mariut Lake

Season	Omoum Main Drain	Mariut Lake	Water Flow
· Normal Time			
Winter	(-) 3.25 m	(-) 2.70 m (ave.)	Lake→Omoum Drain
Summer	(-) 3.25 m	(-) 2.40 m (ave.)	Lake→Omoum Drain
· Flood Time			
Winter	(-) 3.25 m	(-) 2.80 m ~ (-) 2.30 m	Lake→Omoum Drain
· Environmental Operation Time			
Year-Round	(-) 3.25 m ~ (-) 2.30 m	(-) 2.40 m ~ (-) 2.70 m	Omoum Drain→Lake

The water pumped out from both the Abis and Hares pumping stations shall be always poured into the Mariut Lake.

The following rules and procedures are proposed to secure successful operation of the gates for the Mariut Lake water control.

- In principle, discharge of the Lake water to the Omoum main drain shall be made in steady by seasons. In details, the operation shall be made so as to keep the rule that the discharge amount of water is always equal to inflow amount into the Lake.
- The water level shall always be maintained by gate operation. A water pullet system shall be provided with overflow type spillways

and gates in combination so as to avoid miss operation during rainfall or night time.

- Ordinarily, the gate opening degree shall be obtained from the mean inflow (the results in 1994 : 40 cu.m/sec), while for extraordinary inflow fluctuation, gate operation shall respond based on the given fluctuating water level and overflow weir (100 m long, (-)2.50 m.MSL in sill elevation of (-)2.50 m.MSL, overflow volume of 20.0 cu.m/sec).
- An organization shall be established for ensuring the successful maintenance of the Mariut Lake water level.

3) Compensation for Improvement of Discharge-Channel

The discharge-channel shall be improved with capacity of the proposed El-Max pumping station. There are some inhabitants found along the channel widening zones, who have not been officially allowed yet to live in, and it is quite essential to have their good understanding on the works and to give some compensation for promoting the Project successfully. The objective inhabitants are as follow;

- Objective residents

  Right bank : 61 households
  Left bank : 74
  Total : 135

- Scale of their houses

	Right Bank	Left Bank	Total
One-storied House	47	66	113
Two-storied House	14	8	22
Total	61	74	135

- The structure of the building is with concrete and lime block walls, and thatched with wooden materials.
- Compensation for their moving

  EPADP has already started environment assessment for the area since January, 1994, and the necessary countermeasures for the movement have been determined as follows.

Housing lots for movement	:	the site at the side of the El-Max pumping station office building (obtained already as official land lot)
Compensation for movement	:	LE 270,000(135 households x LE 2,000 /household)

4) Water Quality Control System

MPWWR has been carrying on water quality control covering water level and discharges in the Nile Delta as a part of the routine works of the study on MSM (Main System Management) and DRI (Drainage and Research Institute). Monitoring in the Omoum main drain basins covers the whole major points of the irrigation canals and drains as shown in Figure 6-2.

The MSM monitoring has been carried out on the following points.

- Most effective control of irrigation water sources
- Quick delivery of correct data and information to the relevant personnel to control the water resources
- Utilization as the most effective measures of the irrigation water use system, and
- And DRI has been studying irrigation water quality control, particularly on the following materials considered adversely working through water sampling.

  · Water contents on Solvable salt
  · Natrium, Calcium, Magnesium etc.
  · Poisonous contents such as Boron etc.
  · COD, BOD, Coliform, etc in sewers from time to time.

The Project, as mentioned already, will not give any adverse effects to the Mariut Lake in view of both quality and quantity. It is, however, proposed to provide remote monitoring systems at major points for monitoring progressive Lake water pollution as well as quality of reuse water. On top of the above, thoroughly effective operation of the systems is desired for successful environmental control of the Lake water.

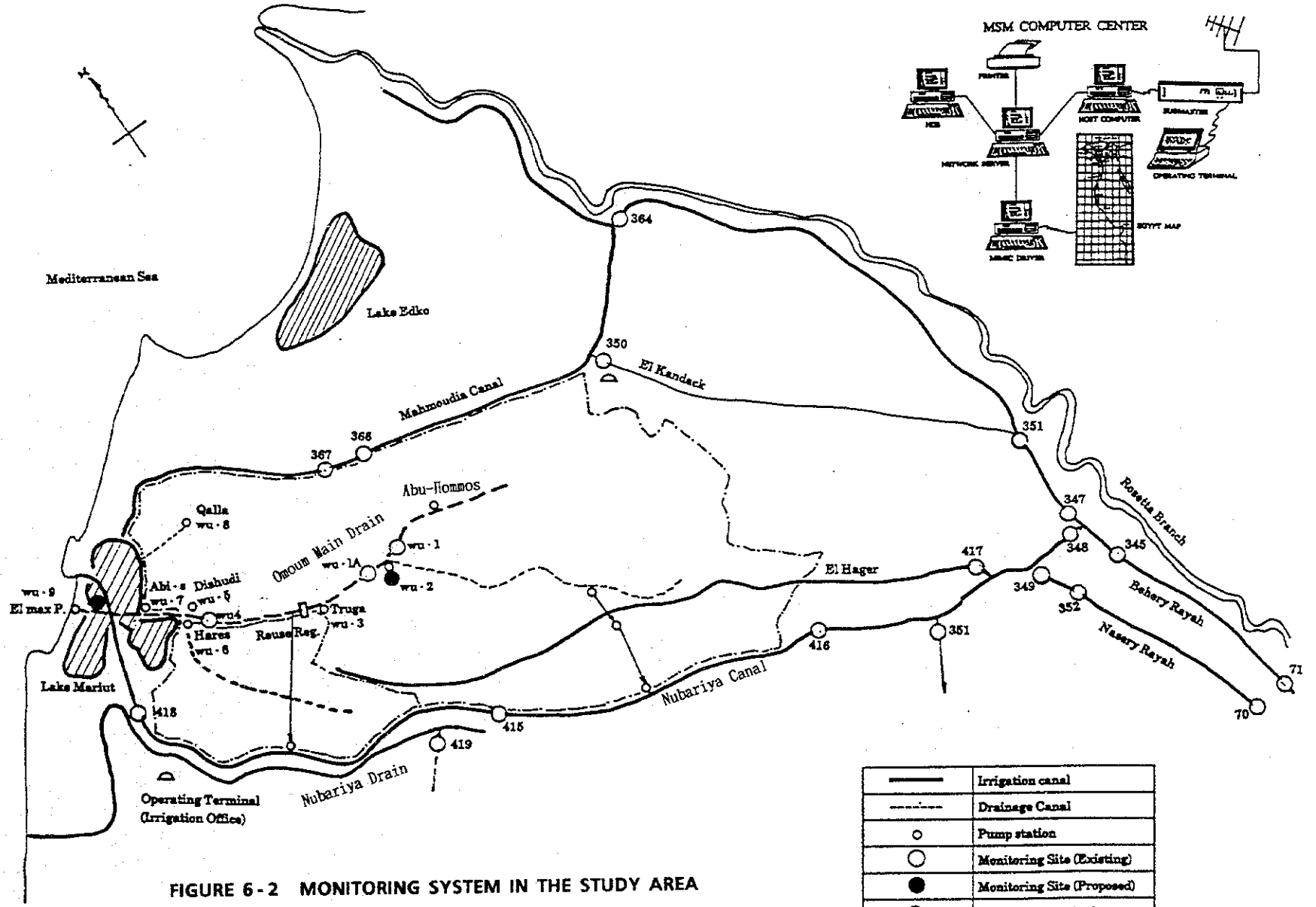


FIGURE 6 - 2 MONITORING SYSTEM IN THE STUDY AREA

- Remote monitoring systems : 2 sites
  - Water quality in the suction side of the El-Max pumping station
  - Water quality at the point of the water reuse in the Omoum drain
- Water quality monitoring items
  - Water temperature
  - Electric conductivity (EC)
  - Dissolved oxygen (DO)
  - Chemical oxygen demand (COD)
- Remote monitoring systems for water quality : 2 sets

6. 4. 3 Environment Conservation of the Mariut Lake

Water pollution of the Mariut Lake has been proceeding heavily, and the Egyptian Environmental Affair Agency (EEAA) has considered the situation critical to make its best effort for taking countermeasures against the heavy pollution through making regional master plan for the Mariut Lake together with environmental action plans, recommendations and other papers based on the Mariut Lake workshop.

The necessary countermeasures to be taken possibly early are i) to extinct the pollutant supply sources, ii) to eliminate pollutants accumulated in the Lake bed, and iii) to carry out the biological water treatment. And it is strongly recommended to take powerful countermeasures as above including the legal restriction of drainage water.

Furthermore, as for existence of heavy metals such as mercury or other poisonous materials as described in the Environmental Action Plan, the following recommendations are made on the treatment so as to avoid discharging into the Mediterranean Sea, dispersion through biological cycle as fishes, and giving adverse effects to the human beings.

- The heavily polluted east Lake shall be separated from the main Lake by means that would be possibly available.
- The fishes caught in the east Lake shall be prohibited to serve as edible purpose.

- The water quality monitoring shall be made for the Lakes at the possibly early stage and practiced regularly from now on. And, it is deemed vitally important that environmental control by administration is strengthened in carrying out the water quality monitoring on the inflow to the Mariut Lake through the Omoum main drain, etc. Together with restriction drainage, and also human resources are developed in the area of the environmental control administration.

6. 4. 4 Preparation of Environmental Impact Assessment

As the results of preliminary study on the Initial Environmental Examination (IEE) made by JICA Preliminary Survey Team and Phase-I field works, it was revealed that environmental impact by the Project should be evaluated objectively and rightfully, and its study report on the Environmental Impact Assessment (EIA) should be presented, prior to the project implementation.

Egyptian Public Authority for Drainage Projects (EPADP) and Mechanical and Electrical Department (MED), Ministry of Public Works and Water Resources, which will be main implementation organizations of the Project, should prepare the EIA report in cooperation with Environmental Research Institute (ERI), and submit it to Egyptian Environmental Affairs Agency (EEAA) and its related committee to get approval on it.

There will be no existence of significant environmental impact to the water quality and quantity of the Omoum main drain systems to be induced by the project implementation. However, it is considered as a current fact that Omoum main drain has supplied water to Mariut Lake to purify the water quality of the Lake. From the environmental point of view, such functions should be maintained even after the project implementation.

Under the circumstances, proper intake and drainage facilities in connection with Mariut Lake and their operation methods as an environmental mitigation plan were requested to maintain an adequate seasonal water level of the Lake. The project plan, in which direct release of drainage discharges from Hares and Abis pumping stations to the Lake was proposed in addition to the

present inlet to the Lake, will significantly contribute to the purification of the Lake's water as better as present systems.

The main sources to contaminate water quality of Mariut Lake are mainly effluent of waste water from Alexandria city. Eradication of polluted water source and elimination of accumulated sludge in the Lake are sole countermeasures for restoration of the Lake. Therefore, it will be expected that the restoration program recommended by the workshop on organizing committee for Mariut Lake held on April 1994 should be realized as early as possible.

The EIA report should be carefully prepared by the implementation agencies of the Project as mentioned in the above, in accordance with the direction described in this Feasibility Report, and the followings should be mentioned in the report; i) restoration measures of Mariut Lake to be executed, ii) compensation plan and its progress to resettle the related houses living on both banks of the proposed discharge-channel, iii) mitigation measures for water contamination to be caused by the Project during the construction period of drains and pumping station, and iv) monitoring of water quality and quantity of Mariut Lake after operation of Omoum Drain Project.

PART II FEASIBILITY STUDY

CHAPTER VII. PRESENT SITUATION OF THE PROJECT AREA

CHAPTER VII. PRESENT SITUATION IN THE PROJECT AREA

7.1 Location of Project Area

1) Priority Development Area

Hares Area (hereinafter referred to as Project Area), which has been selected as a priority development area in the Master Plan Study, is located on the downstream reaches of cultivated land in the Study Area and is situated in the left side of Omoum main drain, extending about 27 km in a northwest to southeast direction, and about 20 km in a northeast to southwest direction, respectively. The Area has a total drainage area of 63,330 feddan (26,600 ha) and lies between Nubariya irrigation canal to the south and Omoum main drain to the east, and faces Mariut Lake to the north.

2) Priority Development Project

As identified in the Master Plan Study, the Priority Development Project is located in the most downstream part of the Study Area, adjacent to the Priority Development Area in the south. The Priority Development Project mainly consists of improvement works of Omoum main drain for a length of 10 km within Mariut Lake and related facilities, the El-Max pumping station and discharge-channel downstream from the El-Max pumping station.

7.2 Physical Conditions

7.2.1 Topography and Geography

1) Priority Development Area

Elevation of the Area ranges from (-)2.5 m to 6.0 m.MSL, and about 67 percent of the Area is lying below mean sea level, which is mostly located on the eastern part of the Area, while the western part has relatively high elevation within the range of five to six meters above mean sea level. Therefore, topography is gradually sloping from west to east direction.

Hares main drain, which is a major drain with a drainage area of 63,330 feddan (26,600 ha) runs gently through the middle of the Area in a southeast to northwest direction, and joins with the Hares pumping station at the end.

2) Priority Development Project

Mariut Lake, in former times, was separated into four or five parts by the Omoum main drain and Nubariya navigation canal. However, due to the short-age of water in the Lake and also the deterioration of the lake water quality, embankments of the Omoum main drain and Nubariya navigation canal have been cut in many places, not only in order to maintain a reasonable water depth for fish culture, but also to minimize the water pollution that is taking place as a result of the pouring of primarily treated water from Alexandria city into the Lake. The water depth of the Lake currently ranges from 1.0 m to 2.5 m on an average.

Owing to these conditions in the vicinity of Mariut Lake, poor farmland drainage has caused one of the severe social problems in the Study Area.

7.2.2 Administration and Area

1) Administrative Division and Socio-Economic Conditions

a) Administrative Division

About 64 percent of the Project Area belongs to two Districts of Abu El Matameer and Kafr El Dawar in the Behera Governorate and the remaining 36 percent to Ameriya Square of Alexandria City in Alexandria Governorate. The areas in Kafr El Dawar District and Ameriya Square were developed at last under the two national land reclamation projects, namely the El Hager and Nahda Land Reclamation Projects in the late 1960's (refer to Table F-2-1, Annex F).

Local Unit administrative division has not yet been established in the national land reclamation areas. However, two control offices of the El Hager

and Abis, the Authority for Project and Development, MALRF render various agricultural supporting services to the farmers through ten agricultural cooperatives. In the area of Abu El Matameer District, five Sheyakhas under Koum El Farag Local Unit are established. A Sheyakha has a population of between 10,000 to 20,000 and comprises several Ezbas (small villages) with populations of about 250.

b) Socio-Economic Conditions

No other industries apart from agriculture exist except for small-scale commercial activities dealing with agricultural inputs and daily commodities. The Project Area is adjacent to the market in the country's second largest city, Alexandria, having a large development potential in developing vegetable produion. However, vegetable cultivation is limited to the areas which have no drainage problems.

2) Project Area

The Project Area is located in the extreme downstream on the left of the Omoum main drain; its area is 63,330 feddan (26,600 ha). The cultivable area amounts to 53,930 feddan (22,650 ha), equivalent to 85 percent of the Area. The actual cultivated area under irrigation is 47,190 feddan (19,820 ha).

There are two drains in the central part of the Project Area. One is the Hares drain that runs from southeast to northwest and the other is the Tameer EL-Sahery drain that flows from east to west. The Project Area is divided into three parts by these drains. Based on the area of cultivable land, the irrigable area in each part is shown below;

Command Area in Hares

Area	Drainage Area	Cultivable Area	Rate
	(ha)	(ha)	(%)
El-Hager Extension	7,280	6,230	86
Nahda	10,940	9,300	85
El-Moshtarak	8,380	7,120	85
Total	26,600	22,650	85