SUMMARY

II. Feasibility Study

7. Present Situation of the Project Area

7.1 Location and Topography

Priority Development Area

Hares Priority Development Area (hereinafter referred to as Project Area) is located on the left side of the downstream reaches of Omoum main drain covering an area of 63,330 feddan (26,600 ha). The elevation of the Area ranges from (-) 2.5 to (-) 6.0 m.MSL and about 67 percent of the Area lies below mean sea level. The Hares main drain run through the middle of the Area in a southeast to northwest direction.

Priority Development Project

The Priority Development Project mainly consists of improvement of Omoum main drain for a length of 10 km within Mariut Lake, the El-Max pumping station and discharge-channel downstream from the El-Max pumping station. All these elements of the Project are located in the most downstream of the Study Area, in other words north side of the Priority Development Area.

7.2 Administration and Area

About 64 percent of the Project Area belongs to the 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. Development activities in these areas were started through the implementation of National Land Reclamation Projects in the late 1960's but Local Unit of administration has not yet established.

Total gross area of the Project is 63,330 feddan (26,600 ha) and cultivable area amounts to 53,930 feddan (22,650 ha), equivalent to 85 percent of the total area. And, present cultivation area is 47,190 feddan (19,820 ha).

7.3 Hydrology

Priority Development Area

A review of rainfall data for 20 years (1973-94) reveals that the amounts of maximum annual, monthly and daily rainfall are 405 mm (1991), 167 mm (Dec. 1991) and 54.3 mm (Dec. 4, 1974) respectively. The average annual rainfall is 200 mm.

The main hydrological features surrounding Project Area are the Nubariya canal along the northwestern side, Omoum main drain along the northeast and the Mariut Lake in the north. The excess water from the field is collected by a drainage network and carried to the Hares main drain. Finally through the Hares pumping station water is pumped into the Omoum main drain. An annual average discharge of the Hares pumping station is 600 MCM.

Due to the shortage of irrigation, water of Omoum main drain is being used in the Area. The estimated daily average amount is 0.26 MCM.

Priority Development Project

The main hydrological elements related to the Priority Development Project are Omoum main drain, Nubariya canal and the Mariut Lake with a total water surface area of 13,000 feddan (5,460 ha). Originally, Omoum main drain used to carry drainage discharge from seven upstream blocks to the El-Max pumping station. The average annual discharge from the El-Max pumping station to Mediterranean Sea is 2,440 MCM.

Recently, to conserve the deteriorating water quality and to maintain a reasonable water level in the Lake, local fishermen have cut the embankments of Omoum main drain and Nubariya navigation canal. Due to these cuts, Mariut Lake is playing a role as a big reservoir. On the other hand, these activities have increased the water level of Omoum main drain, adversely affecting the upstream drainage. The design suction water level at the El-Max pumping station was (-)3.25 m.MSL, but at present it is maintained between (-) 2.70 and (-) 2.80 m.MSL. The data reveal that in December 1991 water level increased to a level of (-) 1.86 m.MSL.

There is a plan for using Omoum main drain water through the implementation of Omoum Drain Project. According to the plan 996 MCM of Omoum drain-water will be reused annually in the development of West Nubariya desert area and this water will come from the three upstream blocks, namely, Abu Hommos, Shereshera and Truga. In implementing this reuse plan it is very important to consider the amount of actually available water, not only the quality.

7.4 Soils and Land-Use

About 67 percent of the Project Area lies below the mean sea level and the land comprises of lacustrine and pliocene marine deposits with a texture of sandy clayey to clayey soil varying point to point. The groundwater table is high, only 50 to 80 cm below the ground surface. The land has a low lying flat topography with an elevation of (-) 2.50 m.MSL and water logging is very common. About 80 percent of the soils in the Project Area have a very high salt content and are classified as "saline and alkaline soils". The value of salt content is more than 4 mS/cm with a Sodium Absorption Ratio (SAR) more than 15. This values become higher, about 30 cmS/cm, especially in the areas with the lowest elevation.

According to the soil survey carried out in the Study Area, presence of fourth and third class land in the Project Area is 11 and 31 percent respectively. The major limiting factors in the land classification are high groundwater table, high soil salt content and high content of exchangeable natrium and magnesium. The soil survey also revealed that about 73 percent land of the Project Area suffers from high groundwater table and high salt contents.

The high content of exchangeable natrium and magnesium causes severe problems in soil permeability, makes the soil toxic and degrades the soil structures. In order to cope with the situation, application of gypsum at a rate of 2 to 13 ton/ha, subsoiling and improvement of drainage have been included in the Project.

The present land-use pattern of the Project Area could be outlined as follows; In the total area of 63,330 feddan (26,600 ha), cultivated area shares 47,190 feddan (19,820 ha) i.e. 75 percent, cultivable waste shares 6,740 feddan (2,830 ha) i.e. 11 percent and the rest 9,400 feddan (3,950 ha) i.e. 15 percent is covered by non-farmland. Land under cultivable waste category may be improved to cultivable land providing efficient drainage and soil improvement measures.

7.5 Present Irrigation and Drainage Conditions

Irrigation Water Supply

Irrigation water for the Project Area is supplied from the Nubariya canal mainly by seven canals and also by a few direct intake canals. The present irrigated area is 47,190 feddan (19,820 ha).

The amounts of water supply from the Nubariya canal were 408 MCM in 1993, while an annual required irrigation water demand was 586 MCM, which means about 30 percent of water shortage. Under the situation, irrigation is performed on a 5-days on and 10-days pause rotation basis, of which water management for this Area is controlled by the Nubariya Irrigation Directorate. The facts that systematic water management can not be expected due to scattered main project facilities, and also water distribution plan does not coincide with cropping schedule introduced in the Area, are the major reason of water shortage mentioned in the above.

Present Drainage Conditions

The Project Area is divided into 13 drainage areas. The excess water from the field is collected by a drainage network and ultimately carried to the Hares pumping station, from where water is pumped into the Omoum main drain or Mariut Lake. In December 1991, 30 percent of the Area was inundated and suffered from serious damages due to a flood caused by heavy rainfall in the Area. The average inundation depth was 50 cm on the fields for a period of 11 days. The reasons for this damages may be mentioned as inefficient drainage system and shortage of Hares pump capacity.

Implementation of subsurface tile drains has not yet taken place in this Area, although it is very necessary to install subsurface tile drains for controlling groundwater and thus salinity. At present Drainage Research Institute (DRI) is conducting researches for selecting design criteria on a plot called Hares Pilot Area.

7.6 Present Agriculture

The total number of farm households is estimated as 11,100, having an average farm size of 4.2 feddan (1.8 ha). The number of owner farm households is 9,590 (86%) and the same for tenant farm household is 1,510 (14%). The crop intensities for winter and summer crops are 97 and 98 percent respectively, making an annual crop intensity of 195 percent (considering total area as 100 %). In the Area main winter crops are berseem (38 %), wheat (36 %), vegetables (12 %) and beans (11 %), and main summer crops are vegetables (37 %), maize (36 %), cotton (17 %) and sunflower (8 %), respectively.

The yields of the major crops in the Project Area are lower than the level of Egypt, Behera and Alexandria Governorates as well as the Study Area. Three major factors such as high groundwater table, high soil salt content, and high content of exchangeable natrium and magnesium may be mentioned for this low crop yield. Especially in the El-Hager Extension area the features of standing crops are very bad and this is due to poor drainage conditions in the area.

The Area suffers from floods quiet often especially in the winter season. One of the recent floods in 1991, damaged crops of 9,550 feddan (4,010 ha) and estimated production loss was 61,500 tons. There are more farm households growing vegetables in the areas where there is no drainage problem in comparison to the other areas. On the other hand, the number of farm households raising cattle are limited. However, about 62 percent of total households in the Project Area raise cattle and water buffaloes.

7.7 Farmers' Economic Conditions

The average annual income of a farmer's family in poor area is LE 3,192 and same in the good areas is LE 3,351, which is less than that of Study Area (LE 3,500). According to the farm economic survey, the most serious problems hindering the development of the Area are shortage of irrigation water, inadequate drainage and insufficient communication/transportation measures.

7.8 Agricultural Supporting Services and Farmers' Organization

Agricultural extension services are rendered to the farmers by MALRF in the areas of national reclamation projects, and at village level it is done by Agricultural Cooperative Societies. The effective services are hampering due to the lack of technology in the fields of improved drainage system, dealing with high alkaline and saline soils etc. Moreover, bad communication/transportation system is also a neck for improved services.

There are no Water Users' and Drainage Users' Associations organized in the Area. The farmers are not involved in water management or O&M activities even in the on-farm level.

7.9 Drainage Facilities

Omoum Main Drain

The Omoum main drain under the subjects of Priority Development Project is 10 km from El-Max pumping station to Hares pumping station within Mariut Lake. The both embankments of this length have been cut by local fishermen, and water level of both Mariut Lake and Omoum main drain become same with water level ranging from (-) 2.70 to (-) 2.80 m.MSL, and no presences of drain function are observed at present. These situation cause high water level of Omoum main drain at whole length, resulting in one of the reason of poor drainage in each drainage block due to raised delivery water level at each pumping station.

Nubariya siphon is constructed at the crossing point of Omoum main drain and Nubariya navigation canal. However in accordance with the separation of Omoum drain from Mariut Lake in the Project, some improvement works of this siphon will be required.

Drains and Roads

Hares main drain flows through the middle of the Project Area from northeast to northwest and ends at Hares pumping station. This is an unlined drain. The bed width varies from 2 to 18 m with a side slope of 3 : 2. The longitudinal slope ranges from 1/10,000 to 1/40,000. The existing conditions of Hares main drain can be outlined as follows;

- Deposition of sand at the drain bed due to damaged side slopes is affecting the flow capacity.
- The design capacity of Hares main drain is designed based on unit drainage discharge of 33 cu.m/feddan/day. Improvement has become necessary for coping with the increased drainage discharge that has been proposed for this Project with unit drainage discharge of 41 cu.m/feddan/day.
- With a few exceptions, maintenance roads do exist in the Area, but the condition especially in winter season turns very bad due to lack of maintenance. From the viewpoints of their importance not only as maintenance roads but also as village communication roads, improvement/replacement is very essential.

Subsurface Tile Drains

Subsurface tile drains are not in use in this Area, except in a Pilot project covering an area of 500 feddan (210 ha). Therefore, groundwater table is relatively high and causing salinity problems in the Area. In order to increase the agricultural production, implementation of subsurface tile drains in the cultivable area of 53,907 feddan (22,650 ha) is necessary.

Pumps

Hares pumping station in the Priority Development Area and El-Max pumping station (No.1) of the Priority Development Project are respectively 27 and 32 years old, and both of these stations are suffering from timeworn. Due to their old-age, capacity has decreased and O&M costs have become higher. It is said that present low capacities are unable to cope with the flood runoff in the winter season and responsible for the flood damages in the Area.

The present conditions of Hares and El-Max pumping stations will be briefed as follows;

- Pump Type and Capacity

Pump Station	Total Discharge	Pump Type and Capacity
Hares	24.0 cu.m/sec	Axial flow pump, 8.0 cu.m/sec × 4units (includes one stand-by unit)
El-Max(No.1)	62.5 cu.m/sec	Axial flow pump,12.5 cu.m/sec × 6units (includes one stand-by unit)

- During the flood in November 1994, discharges of El-Max and Hares pumping stations were 120.8 cu.m/sec and 32.0 cu.m/sec respectively, and recorded as the highest but the suction water levels were lower than that of the 1991 flood.

- The results of the discharge measurement show that the both stations have lost 15 - 20 percent of their design capacity.

- The El-Max pumping house (No.1) has become very old and no measures have been taken. Measures should be taken to improve its conditions.

- The water level of Omoum main drain between El-Max and Hares pumping station has increased from its design level. This increased water level is causing the problems for management of water level and the increase in running costs of the El-Max pumping station.

Discharge-Channel immediately Downstream of El-Max Pumping Station

The discharge-channel with a length of one kilometer releases the drainage water from the El-Max pumping station to Mediterranean Sea. The cross section of this discharge-channel is not sufficient to drain the required capacity, and this fact causes one of the reason for no full operation of the El-Max pumping station. Therefore, some parts of the channel should be improved in the Project.

8. Development Plan

8.1 Objectives of the Project

The restrictive factors for the development in the Priority Development Area as well as its vicinity may be pointed out as follows;

- Deterioration and changes in land and water resources,
- Deterioration of rural living environment,
- Low agricultural productivity, and
- Inadequate function of agricultural and rural infrastructures.

Accordingly, the objectives of the farmland environmental improvement project in Omoum Area emphasizing on drainage improvement are to formulate development plan mentioned below, in order to eliminate the above-stated factors impeding development and to improve the existing conditions.

- Drainage improvement plan should be established aiming at alleviation of flood damage for agricultural crops and increase in agricultural production by means of improvement of drainage facilities of El-Max and Hares pumping stations, Omoum main drain, branch drains, subsurface tile drain facilities, and roads.

- Living standard of local people and living environment in the rural area should be raised and improved through increased agricultural production mentioned in the above.

- Water management techniques for both irrigation and drainage up to the on-farm level should be improved, in order to execute smooth and effective works for land-use, crop husbandry, water distribution and pump operation ,and so on.

- Scarce water resources inclusive of reuse of drainage water should be utilized effectively, which will be achieved through improvement of water management mentioned in the above.

- Water quality conservation of the Omoum main drain and Mariut Lake should be undertaken through adequate water management and monitoring on water quality and quantity.

8. 2 Components of the Project

The Project components will be made with the following development concepts to achieve the above mentioned development objectives.

- Improvement of Major Drainage Facilities

  In order to improve the drainage conditions in the lower reaches of Omoum Area including Project Area, El-Max pumping station, Nubariya siphon and Omoum main drain, including facilities in Mariut Lake should be replaced or upgrade. Also an appropriate water management plan emphasizing on water levels of Omoum main drain and Mariut Lake should be established.

- Improvement of Agricultural and Rural Infrastructure

  Comparatively the Project Area is behind from the viewpoint of socio-economic development due to newly reclaimed land with a low elevation and insufficiency of agricultural and rural infrastructure such as drains, subsurface tile drains, on-farm facilities, rural roads, etc. Especially, the deterioration of Hares pumping station is causing severe drainage problems not only for agriculture, but also the rural life in the Area. Therefore, these agricultural and rural infrastructure should be installed and/or improved at an early date.

- Water Source Development and Improvement of Water Management

  Water source development by means of reuse of drainage water should be promoted considering shortage of water resources in the vicinity of the West Delta Region and newly developed desert area. And an adequate distribution plan in terms of quality and quantity management should be formulated to achieve an effective utilization of water resources.

- Agricultural Development Plan

  In order to achieve more productive farming, improvement of drainage facilities along with the measures for improving alkali soils, adequate land-use plan, cropping pattern, farm management, animal husbandry, agricultural supporting services and farmers' organization should be formulated.

- Mariut Lake Environmental Conservation Plan

  From the viewpoint of conservation of water quality of Mariut Lake, suitable water level of the Lake and amount of water supplied to the Lake should be strictly maintained and monitored. Laws and regulations may also be enacted in order to preserve the Lake's natural environment.

8.3 Formulation of Optimum Project Planning

According to the proposed plan, Omoum main drain will be separated from Mariut Lake. Owing to this development plan, and to know the optimum size and operation methods of the El-Max pumping station, Omoum main drain and gates and weirs in separation dikes, water balance studies with the following preconditions were performed.

- Drainage area covered by the El-Max pumping station : 430,260 feddan (180,710 ha)

- Design discharge for Omoum main drain (after reuse)
  - El-Max P.S. to Nubariya siphon : Q=150.0 cu.m/sec
  - Nubariya siphon to Abis P.S. : Q= 86.0 cu.m/sec
  - Abis P.S. to Hares P.S. : Q= 82.0 cu.m/sec

- Related water level and discharge
  - Design water level of Mariut Lake : (-)2.40 m.MSL
  - Design water level of Omoum main drain (suction water level of El-Max P.S.) : (-)3.25 m.MSL
  - Drainage discharge from Hares P.S to the Mariut Lake : Qmax=30.0 cu.m/sec
  - Drainage discharge from Abis P.S to the Mariut Lake : Qmax = 5.6 cu.m/sec

- Model used in the analysis : Continuous reservoir model

Case studies show that seven sets of gates and wiers are necessary in the separation dike to allow necessary amount of flow from Mariut Lake to Omoum main drain. It seems that construction sites of gates and weirs will not be close to the EL-Max pumping station. Owing to this fact and from viewpoint of future operation, a simple seasonal/monthly operation procedure is recommended. For normal years, from December to February ten gates, March to June six gates, July to August eight gates, September to October four gates and for November six gates.

In fact, in some months weekly or fortnightly operations may be needed when Lake water level decreases/increases beyond the desired level.

From the results of the water balance study, for an efficient, safe and environmentally friendly drainage system for Omoum main drain and Mariut Lake and its vicinity, the following dimensions for the drainage facilities are proposed.

- El-Max pumping station
  - Design discharge : Q = 150.0 cu.m/sec
  - New pump capacity(No.1) : Q = 87.6 cu.m/sec (14.6 cu.m/s × 6 units)

- Omoum main drain (the part within Lake)
  - Improvement method : Separation from Mariut Lake
  - Design discharge : Q = 150.0 - 82.0 cu.m/sec

- Number and size of gates and weirs(set)
  - Number : 7 places
  - Gate size : width = 3.0 m, height = 2.0 m
  - Gate opening : H = 0.30 m
  - Weir elevation : (-)2.50 m.MSL
  - Weir length (total) : L = 140 m

8.4 Land-Use Plan

With drainage and soil improvement under the project implementation, 6,740 feddan (2,830 ha) of the fourth class land will be converted to the cultivated area. The second and third class lands will be utilized as the first class land with broader crop selection bringing total cultivated land 53,930 feddan (22,650 ha), an increase of 14 percent making 85 percent of the total area.

It is planed to apply 2.4 to 4.8 tons of gypsum per hectares for three to five years, depending upon the type of soils as well as to employ subsoiling for the whole cultivable land of 53,930 feddan (22,650 ha).

8. 5 Irrigation and Drainage Plan

Irrigation Water

Irrigation water requirements of the Project Area (63,330 feddan with a cropping intensity 200 %) were calculated using the water requirements of each crop in Delta area which have been regionally decided by the Department of Irrigation (DOI), MPWWR. Applying the data of field measurement in the adjacent areas, irrigation efficiency is raised to 0.50 from its present value of 0.35. The annual gross water requirement is calculated at 480 MCM. This amount seems to be close to the annual intake discharges for Hares Area i.e. 497 MCM. But the actual intake of 1993 (408 MCM) was still 15 percent less than this new requirement.

In the Nubariya irrigation area the West Nubariya Agricultural Intensification Project that composes with canal linings and improvement of lateral canals is presently on-going. Early implementation of this project along with this subject Project is desired for an increased irrigation efficiency.

Reuse Plan of Drainage Water

The major reuse plan of drainage water in the Study Area is Omoum Drain Project. This Project has a plan to reuse 996 MCM of Omoum main drain water annually, and seems that water shortage in the Area will be solved to some extent. According to the plan the water of Omoum main drain will be mixed with the fresh-water from Nubariya canal to bring its salinity down to 700 ppm (1.1 mS/cm). Although there is no restriction to use this water, salinity monitoring of water quality is very essential.

8.6 Drainage Plan

Design Drainage Discharge

Considering the project economy and the present field drainage conditions, the drainage plan has been done to bring down the inundation period half of the present period applying a rainfall of probability 1/10-year. The drainage discharge of the Project Area is mainly originated from excess irrigation water and from the rainfall runoff in winter season. In deciding the design drainage discharge, out of these two sources the bigger value is considered. Accordingly the design drainage discharge of the Hares pumping station is determined at 30 cu.m/sec, equivalent to a unit discharge of 41 cu.m/feddan/day.

Subsurface Tile Drain

In deciding the design drainage discharge for laterals and collectors, EPADP standard is used, which is 1.5mm/day and 4.0mm/day respectively. For a good control of the groundwater, the spacing of lateral drains is recommended as 30 m with a hydraulic conductivity k = 0.086 m/day. This density is double of the present one.

Inundation Analysis

Inundation analyses in the Project Area were studied for two cases using consecutive three-days rainfall with the probability of 1/10-year and the actual rainfall occurred during the flood of the December 1991 (consecutive six days rainfall=73.5 mm). According to the results of the analysis inundation period will be reduced to 1/3 to 1/2 from its present period with the proposed drainage facilities.

8.7 Agricultural Development Plan

Crop Selection and Proposed Cropping Pattern

The cropping area of vegetables for both winter and summer seasons is increased by 50 percent of the present cropping intensity, taking account the promising domestic and foreign market in Alexandria city and European countries. To avoid the crop damage caused by intensive cropping of vegetables and also in order to maintain the soil fertility with animal husbandry, present main crops aside from vegetables are proposed in the cropping pattern. The annual cropping intensity is increased to 200 percent considering winter and summer cropping area as 100 percent.

The irrigation water source for the Project Area is mainly the reuse water mixed with Nubariya canal water, where the salt content will be controlled to keep the EC below 1 mS/cm (700 ppm). Therefore, this water would not cause any crop damage, because the salt content as well as the sodium absorption ratio (SAR) are below the permissible level.

Reduction of Flood Damage and Yield Increase

According to the drainage plan, crop damage will be reduced to one third of the level of December 1991. And accordingly, the annual average flood reduction is estimated at about 4,100 ton based on the record on the crop flood damage in December 1991.

The increase of average yield with Project is estimated at five to 25 percent, based on the data of FAO/UN/WB on average yield increase in Nile Delta attributable to subsurface drainage alone.

Crop Production

According to the proposed cropping pattern and the targeted yield increase, it is estimated that about 960,000 tons of crop production which is an increase of 50 percent will be attained from 107,860 feddan (45,300 ha) of total cropping area, 17 percent increase in terms of area.

Agricultural Supporting Services

To develop proper on-farm drainage facilities as well as their functional operation and maintenance, it is indispensable for the farmers to be involved in Project from the planning stage. It is planned that the activities of Drainage Advisory Unit of EPADP will be strengthened to provide Drainage

Users' Associations necessary guidance on proper management of drainage facilities, keeping and renewing of operation and maintenance data.

The MALRF agricultural extension staff will also be trained on farming technology regarding drainage and soil improvement in the proposed operation and maintenance strengthening program.

It is highly recommended to organize specialized cooperatives in handling vegetable sales and export under the guidance of MALRF, so that farmers are able to get adequate share from the profit.

9. Project Engineering

9.1 Drains and Roads in the Area

The following works are proposed for the Project Area.

- Improvement of Hares main drain (L=24 km, including El-Hager siphon)
- Improvement of branch drains (24 branches, L=113 km)
- Improvement of O&M roads and bridges (L=125 km, 22 places)

The improvement works of drains will be on the basis of a unit design discharge of 41 cu.m/feddan/day. Enlargement for cross-sections will be limited only to deepening the drain bed, if unavoidable, expansion within the presently available land will take place.

9.2 Hares Pumping Station

The pumps and pump house of the Hares pumping station are very old. The loss of efficiency of the pumps has become a problem. Due to the development activities in the Area drainage discharge has increased and in the winter season damages from inundation have become very common. Therefore, new pumps with increased capacity and new pump house were proposed for the Hares pumping station. After a comparative study, the particulars of the proposed plan are decided and they are as follows. Total discharge would be 30.0 cu.m/sec (existing is 24.0 cu.m/sec), and after a comparative study the type and number of the pumps are selected as five units (including one stand-by unit) of axial flow pumps with a power output of 430 KW.

10. Project Implementation and Operation and Maintenance

10. 1 Executing Agencies of the Project

There will be two executing agencies of the Project. For drains EPADP will be responsible and the pumps will be taken by MED. The foreign currency portion of the project costs will be financed by an international financing agency and local currency portion by the Egyptian Government.

Development of agricultural supporting services for the farmers in the Area should be done maintaining close cooperation with the Ministry of agriculture, Land Reform and Fishery (MALRF).

10. 2 Land Acquisition and Compensation

The construction of drains, pumping house and related facilities will be carried out on contract basis. Regarding land acquisition, construction of the Hares pumping station will require one hectares of land and for drains, roads etc. 30 ha of land will be required. Since the site for new Hares pumping station is located between Hares main drain and Mariut Lake, therefore, no acquisition will be needed. Regarding roads and drains, improvement works will be done by placing excavated materials temporarily on the adjacent fields, so that compensation can be kept minimum.

10. 3 Implementation Schedule

The Project will be implemented over seven years period from 1996 to 2002. The contents include the evaluation of the Project by the Egyptian Government including environmental aspects, economic viability, loan procedure, detailed design and construction of civil works. The construction of the Hares pumping station, drains, subsurface tile drains and on-farm facilities is scheduled to start from the 2000 year and should take three years to complete.

10. 4 Operation and Maintenance Plan

Operation and maintenance (O&M) of the Project will be responsibility of two agencies of EPADP and MED. In particular, actual O&M of drains, roads and subsurface tile drains will be taken care by the Nubariya Drainage Directorate under the General Directorate for West Delta Drainage Region. On the other hand, actual O&M of Hares pumping station will be under the responsibility of El-Max Directorate within the General Directorate for North West Delta.

O&M of subsurface tile drains will be put on the farmers groups to be established covering an area of 30 to 40 ha on average.

The annual O&M costs are estimated at about 1.87 million LE, equivalent to 29.5 LE/feddan (70.2 LE/ha). The O & M costs and construction costs for on-farm facilities will be paid by farmers.

11. Project Costs for Priority Development Area

The project cost for the Priority Development Area is estimated at about 271.1 million LE. And project costs without price escalation is 202.0 million LE, which is equivalent to 7,600 LE/feddan or 2,250 US$/ha. The preconditions for cost estimation were set as follows;

- The unit price of civil works will be same as the prevailing prices used by EPADP in other projects.
- The construction machineries and equipment will be provided by the contractors and only depreciation costs is included in the construction costs.
- The exchange rate of Egyptian Pound(LE) and U.S. Dollar is fixed as follows;

  US$ = 3.374 Egyptian Pound(LE)

- The physical contingency related to the construction and associated costs is set at 10 percent of the direct costs. The price escalation for foreign currency is predicted according to World Bank index and local currency by index fixed by the Egyptian Central Agency for Public Mobilization and Statistics.

12. Project Evaluation for Priority Development Area

The economic evaluation of the Project was carried out on the basis of the followings;

- Economic benefits and costs of the Project are expressed in monetary terms.
- The project benefits were estimated in terms of crop production increase benefits and flood damage reduction benefits.
- The Standard Conversion Factor (SCF) applicable to the foreign portion of the project components is used at 0.87 to convert economic costs.
- Financial and economic internal rate of return (FIRR and EIRR) were analyzed as the main indicator of financial and economic evaluation.
- The farm budget analysis for typical farm households was performed with project condition.
- Implementation of the Project will also improve the overall socioeconomic condition of the society. Therefore, some intangible benefits of the Project would be expected.

12. 1 Project Benefits

The incremental project benefits to be created from the 4th-year after implementation of the Project are as follows;

- Benefits from crops production increase	:	62.7 million LE/year
- Benefits from flood damage reduction	:	1.7
Total	:	64.4

12.2 Economic Project Costs

Economic Project Costs

Since the project costs are based on financial basis, they have to be converted into economic costs. After conversion the economic costs of the Project is become as 199.6 million LE. However, this cost includes the allocated costs of Priority Development Project based on the sharing of drainage area by Project Area and discharge of agricultural sectors among various sectors.

O & M Costs and Equipment Replacement Costs

These costs also include the costs allocated from the cost of Priority Development Project. The estimated economic O&M costs and equipment replacement costs are 1.9 and 30.0 millions LE, respectively.

12.3 Economic Internal Rate of Return (EIRR)

From the above mentioned economic benefits and costs, the economic internal rate of return (EIRR) is calculated at 19 percent (financial internal rate of return (FIRR) is 17 percent).

12.4 Sensitivity Analysis

The result of sensitivity analysis for three cases such as decrease in project benefits, delay in implementation and increase in project costs are as follows;

		FIRR (%)	EIRR (%)
- In case of 20 % decrease in project benefits	:	13.8	15.7
- In case of two years delay of implementation	:	13.5	15.0
- In case of 20 % increase in project costs	:	14.1	16.0

12. 5 Financial Analysis of Typical Farmers

The result of the farm budget analysis showed that the implementation of the Project will enhance the annual income of a family with an average farm size of 4.2 feddan to LE 5,734 from present income of LE 2,412 per year. This increment of income will help the farmers in the Area in a great deal who have a little cash income.

12. 6 Justification of the Project

The economic internal rate of return (EIRR) of the Project is 19 percent, which is a bigger than 12 percent of Egyptian opportunity cost of capital. Therefore, not only from economic viewpoint, but also technical viewpoint, this project can be justified. Apart from the above mentioned tangible benefits, the implementation of the Project will also bring many intangible benefits described below;

- Benefits at the Project Area Level

  - Increased consumption and saving will ultimately improve the villagers living standard in terms of quantity and quality (nutrition, education, health etc.)

  - Implementation of the Project will facilitate the efficient use of water and establishment of drainage associations, which will certainly improve communication among the farmers influencing the technical upgrading of crop cultivation and farm management.

  - Drainage improvement will reduce water-borne diseases like diarrhea, skaris etc.

  - New employment opportunities in farming works will be created.

  - The improved O&M roads will also function as connecting road network among the villages, between villages and urban areas for various purposes such as communication, commerce etc.

  - Conservation of the environment of Mariut Lake and its vicinity (water level and quality).

- Benefits at the National Level

  - Introducing and encouraging upland cropping in the Area will stabilize the supply of fresh and cheap farm products to Alexandria city.

  - Will promote rural welfare, alleviate disparity in living standards between the regions.

The subject Project, which is a Farmland Environmental Improvement Project emphasizing on drainage improvement will increase agricultural production and farmers' cash income, and also will improve the living standards in the region. Therefore, an early implementation of the Project is strongly recommended.

13. Project Engineering, Implementation and Project Evaluation for Priority Development Project

13.1 Project Engineering

The project facilities for Priority Development Project are the Omoum main drain, discharge-channel and El-Max pumping station (No.1).

<u>Omoum Main Drain</u>

The following are the items in relation to the improvement of Omoum main drain.

- Construction of Separation Dike for the part within Mariut Lake

  In order to separate Omoum main drain from the Lake a separation dike from the El-Max to Hares pumping station (L=10 km) is proposed. Design discharge will be 150.0 - 82.0 cu.m/sec and suction water level of the El-Max pumping station will be (-)3.25 m.MSL. Elevation of the dike will be (-)0.90 m.MSL considering wave height of 1.50 m and (-)2.40 m.MSL as Lake water level.

- Provision of Gates (with attached Weirs) in the Dike

  Number of sets of gates and weirs in the dike will be seven, which is decided for conserving Lake water quality. Particulars are given below;

		Gate	Weir
Type	:	Roller gate type	Overflow type
Elevation	:	(-) 3.60 m.MSL	(-) 2.50 m.MSL
Size	:	B 3.0 m × H 2.0 m × 2 vents	10 m × 2 nos.

- Improvement of Nubariya Siphon

  Although the main parts of the siphon are in good condition, damaged manholes and loss of capacity due to deposition of sand and silt are observed. Therefore, to control the sediment material from entering the siphon a settling basin at the siphon entrance including some facilities for periodic cleaning of the siphon are proposed. The design discharge is fixed as 86.0 cu.m/sec and inside velocity as 1.05 m/sec.

Discharge-Channel at the Downstream of El-Max Pumping Station

The capacity of discharge-channel is insufficient. In relation to the design discharge of 150.0 cu.m/sec, it has a capacity of only 60.0 cu.m/sec. Therefore, improvement of this channel is proposed. In order to protect the side slopes of the improved sections provision of revetments works are proposed. For smooth execution of this work resettlement of the inhabitants of 135 households on the banks is necessary, and EPADP is currently implementing a resettlement plan.

El-Max Pumping Station

As it is explained earlier that the El-Max pumping station (No.1) has a great importance as a drainage facility in the Study Area. As a matter of fact it has become very old and lost its capacity. Moreover, to cope with the floods during the winter seasons, MED has been thinking for an early replacement of this station with bigger pumps.

Under these circumstances, replacement of the El-Max pumping station (No.1) including pumping house is proposed. The dimensions are as follows; Total discharge would be 87.5 cu.m/sec (existing is 62.5 cu.m/sec), and after a comparative study the type and number of the pumps are selected as seven units (including one stand-by unit) of axial flow pumps with a power output of 900 KW.

13. 2 Project Implementation and O & M Plan

Executing Agencies

The executing agencies for the improvement works of Omoum main drain and discharge-channel will be EPADP and for the El-Max pumping station (No.1) MED will be responsible.

Implementation Plan

Improvement of Omoum main drain, discharge-channel and El-Max pumping station (No.1) which are the components of the Priority Development Project is designated as an emergency project for the Study Area and an early implementation is expected. Therefore, implementing period for the Project is set same as the Priority Development Area, i.e. seven years between 1996 to 2000 years.

The realization of benefits will not be an independent one as in the case of Priority Development Area and simultaneous implementation is prerequisite for realizing full benefits from the Project. Therefore, it can be said that Priority Development Project and Priority Development Area are not separate rather a package of two projects.

13. 3 Project Costs

Estimation of the project costs for Priority Development Project was done following the same conditions as in the case of Priority Development Area. The estimated costs are 198.2 million LE. and the costs without considering price escalation is 151.8 million LE.

13.4 Project Evaluation

Since the project facilities are located in the extreme downstream reaches of the Study Area, project evaluation should be analyzed based on the expected project benefits obtained from the whole Study Area. The assumptions and procedure for the analysis are same as in the case of Priority Development Area.

Project Benefits

The main benefits from Priority Development Project are crop production increase and flood damage reduction benefits. Although project benefits of each block will reach its full target from the 4th year after completion of the project, partial benefits will be realized at the beginning of 2003. The reason is the lowering of Omoum main drain water level up to 50-60 cm compared with present water level, which will surely result in partial drainage improvement at farm level of each drainage block. The projected benefits are as follows;

- Benefits from crop production increase	:	242.9	million LE/year
- Benefits from flood damage reduction	:	3.2	
Total	:	246.1	

Economic Project Costs

The economic project costs are estimated at 812.63 million LE. In this estimation, construction costs for the El-Max pumping station (No.1) and discharge-channel are allocated to the Project based on the sharing of drainage discharge for agricultural sector (70 percent of total annual discharge).

Economic costs for O&M and equipment replacement are estimated at 12.26 million LE.

Internal Rate of Return

Economic internal rate of return (EIRR) is estimated taking into consideration of the above mentioned costs and benefits. The estimated value is 17 percent. Financial internal rate of return (FIRR) is estimated at 15 percent.

Sensitivity Analysis

Sensitivity analysis was performed for three cases such as decrease in project benefits, delay in implementation and increase in project costs. The results of the analyses are given below;

		FIRR (%)	EIRR (%)
- In case of 20% decrease in project benefits	:	11.9	13.7
- In case of two years delay in implementation	:	11.9	13.3
- In case of 20% increase in project costs	:	12.3	14.1

13. 5 Justification of the Project

Economic internal rate of return (EIRR) of the Project is estimated at 17 percent, which is bigger than 12 percent, the opportunity cost of capital in Egypt. Therefore, implementation of this Project may be justified from both technical and economic point of views.

As explained in the previous paragraph, the El-Max pumping station (No.1) has become very old and can not play its important role for the area, so that an urgent improvement of the station is essential.

14. Environmental Study for Hares Area

14. 1 Present Condition

The Project Area is located on the left bank and downstream of Omoum main drain. The farmland of the Area needs to be developed urgently due to unfavorable environmental conditions caused by inefficient drainage. The Master Plan Study has selected this Area as Priority Development Area and the Area has the following characteristics;

- Loamy soil with high salinity
- Low-lying flat land with lack of drainage (needs subsurface tile drain)
- Arid region lacking irrigation

- Flood prone area
- Area with poor road networks
- Absence of efficient drainage and presence of epidemic disease

14. 2 Description of the Project

The Project aims at upgrading of the rural living standard through improvement of the rural environment with drainage systems and activating the farming productivity. The Project includes the following features;

- Project Area	:	63,330 feddan (26,600 ha)
- Pumping facility improvement	:	one site
- Improvement of main drain	:	24.0 km
- Improvement of branch drains	:	112.6 km
- Introduction of subsurface tile drains	:	22,400 ha
- Improvement of roads		
Gravel pavement	:	99.0 km
Asphalt pavement	:	26.0km

14. 3 Future Environmental Conditions with the Project

The Project will impact the rural environment positively. In many ways it will improve the agricultural production activities in the Area. However, the areas where this Project will have an impact are outlined below;

- Improvement of environment related to water in the whole Study Area
- Improvement of farmland through reduction of salinity by controlling groundwater table
- Reduction of flood damages
- Improved social life by means of good road networks

14. 4 Environmental Study

The Project has only positive impacts on the local environmental conditions and will never give adverse effects to the local natural and social environment. Although the Project will give the positive impacts there are some problems in the field of environment need to be solved as described below;

- Control of epidemic disease of Bilharzea.
- Effects of withdrawal of reuse water and relationship with Mariut Lake water quality.

Regarding both problems, the Ministry of Health (MOH) and Drainage Research Institute (DRI) are taking countermeasures such as,

- Oral dosing of pills, reduction of chemicals in deparasiting shellfish, agricultural field etc. by MOH, and
- Keeping continuous monitoring on salinity contents and SAR in irrigation and drainage water by DRI.

RECOMMENDATIONS

1. Recommendations for Project Implementation

- Justification of the Project

  It is clear that the construction of project facilities for the Priority Development Area and Project will impact positively on the rural environment, crop production, farmers' income and regional economy. On the other hand, EIRR of these Projects are 19 and 17 percents respectively, and are also higher than 12 percent, the Egyptian opportunity cost of capital. From the above mentioned facts the Projects are justified to be feasible from technical and economical viewpoints. Therefore, an early implementation of the Project is recommended.

- Urgency and Implementation Priority for Priority Development Project

  In order to realize project benefits, construction of the separation dike within Mariut Lake and improvement of discharge-channel are prerequisite. Therefore, implementation of Priority Development Project should be considered as a first priority, and the implementation ranking for facility improvement would be as follows; the El-Max pumping station (No.1) be first implemented, followed by discharge-channel and Omoum main drain in third, from view point of urgency and necessity for facility improvement. It is worth to mention that MED is preparing all formalities in order to replace the El-Max pumping station (No.1).

2. Recommendations for Detail Design and Construction of the Project

The subject Feasibility Studies have been carried out based on the topographic map with the scale of 1/50,000 and various data/information collected during the field works. The detail design and implementation of the Project should be carried out emphasizing on the following matters;

- Coordination among the Implementing Agencies

  EPADP and MED are the two main implementing agencies for the subject Projects. For an efficient implementation of detail design and construction, close coordination of these two agencies as well as Ministry of Agriculture, Land Reclamation and Fishery (MALRF) is essential.

- Additional Survey, Investigation and Data Collection

  During the detail design stage, following additional survey, investigation and more data collection will be required.

  - Preparation of topographic maps and longitudinal and cross section maps
  - Geological investigation
  - Soil survey

- Design of Subsurface Tile Drains

  The design of subsurface tile drains such as spacing of lateral drains, location of collector drains and selection of suitable envelopment materials should be made based on the research results at Hares Pilot Area under DRI.

- Implementation of West Nubariya Agricultural Intensification Project

  In order to achieve targeted agricultural crop production increase in the Project, it is essential that effective water utilization and appropriate water management in the Area should be performed together with the drainage improvement. Under the circumstances, implementation of West Nubariya Agricultural Intensification Project aiming at improvement of irrigation systems in the area should be implemented simultaneously during the drainage improvement period of the Project.

- Improvement of Discharge-Channel

  The improvement of discharge-channel immediately downstream of El-Max pumping station will require the resettlement of 135 households living on the banks of the channel. In order to implement the resettlement works smoothly and effectively, understandings by these inhabitants on the banks are essential, which will be obtained through sufficient explanation of the objectives of the Project.

3. Recommendations on Raising Project Benefits

During and after implementation of the Project, the following conditions should be fulfilled for raising the project benefits smoothly and steadily.

- Effective Utilization of Irrigation Water Sources

The areas covered by Nubariya main irrigation canal, in which the Project Area is included, are considered to have periodical water shortage area even in future, so that it is essentially required to improve irrigation facilities inclusive of the on-farm level such as subsurface tile drains for reaching the target of agricultural production through successful water source utilization under effective and efficient water management. Regarding the training these water management, relevant farmers' groups should also be involved.

- Type of Discharge Control Facilities and Operation Rule

For the purposes of discharge control for water level and water quality conservation of the Mariut Lake, seven discharge control facilities are proposed in the Project. The structures of the facilities are orifice type equipped with gates and weirs considering their easy operation and maintenance. Although seasonal operation rules of these facilities are proposed as a basic criteria applicable for normal year, according to circumstances such as abnormal flood and drought years, more frequent operation should be done on the basis of 10-day or bi-weekly.

- Development of Upland Farming Technology

Following items for upland farming technology should be developed to attain project target effectively.

- Improvement of salinized and sodicated soils with monitoring the progress of improvement,
- Fertilizer requirements on the basis of nutrient deficiency and improvement of cultivation method,
- Crop rotation systems for cultivation of vegetable and other crops to avoid growth retardation by continuous cropping.

- Provision of Agricultural Supporting Services

Egyptian Authority of Drainage Project (EPADP) and Ministry of Agriculture, Land Reclamation and Fishery (MALRF) have to provide/organize the following agricultural supporting services;

- Farmers' participation in drainage improvement project by establishing and managing Drainage Users' Associations from the planning stage of subsurface tile drains,

- Training of MFLRF agricultural extension staff on the technology to develop farm production through improvement of drainage and soil conditions,
- Improvement of marketing systems of agricultural crops inclusive of farmer's group marketing.

- Monitoring of Water Quality of Omoum Main Drain and Mariut Lake

According to the Omoum Drain Project, which is one of the major reuse project in the vicinity of the Project Area, about 996 MCM of drainage water from the Omoum main drain will be utilized as irrigation water sources in the West Nubariya area. In that case, it will be necessary to monitor the volume and quality of the reuse drainage water.

PART I MASTER PLAN STUDY

CHAPTER I.   INTRODUCTION

CHAPTER I. INTRODUCTION

1.1 Background of the Study

Agriculture in Egypt plays a major role in the structure of the national economy, and the Government of Egypt has initiated programs of long-term agricultural production increase by means of i) a horizontal expansion through increasing the area under cultivation, and ii) a vertical expansion by increasing the yield of cultivated areas. In the current Third Five-Year Plan (1992/93-1996/97), the Government of Egypt has adopted agricultural production increase as a major national policy.

Under the circumstances, following the introduction of perennial water supply to all irrigated areas facilitated by the Aswan High Dam in 1970, double cropping as well as cultivable areas have been sharply increased. One consequence of intensified irrigation and ineffective functioning of drainage facilities has been the raising of the groundwater table and increased problems of water-logging and salinization, which, in turn, has resulted in the deterioration of both soils and crop production.

In particular, the northwestern part of the Nile Delta, in which the Study Area of Omoum is located, has been facing severe problems such as periodical inundation, water-logging and salinization due to the high groundwater table, ineffective and non-functioning water management organization, and ineffective drainage due to the timeworn drainage facilities such as pumps and drains, etc.

Under these conditions, the Government of Egypt requested the Government of Japan to extend technical assistance for the Feasibility Study on Farmland Environmental Improvement Project in the Omoum Area.

In response to this request, the Japan International Cooperation Agency (JICA) dispatched a Preliminary Survey Team in September, 1993 and on the basis of Scope of the Work of the Study, the Team made an agreement between the Egyptian Public Authority for Drainage Projects (EPADP), Ministry of Public Works and Water Resources, and JICA.

In accordance with the agreement, JICA Study Team completed the Master Plan Study for the Omoum Area during the period from the beginning of July 1994 to the end of September 1994, and the Feasibility Study on the selected priority development area and project from the middle of January 1995 to the end of March 1995, in close cooperation with EPADP and other Government agencies concerned.

1.2 Objectives and Scope of the Study

1.2.1 Objectives of the Study

The objectives of the Study are;

i) To conduct the Master Plan Study for the Omoum area, which is about 430,260 feddan (180,210 ha), located in Behera and Alexandria Governorates in the lower Nile Delta, in order to improve the farmland environmental situations in the area, mainly by amelioration of irrigation and drainage systems and facilities; and the Feasibility Study on the priority area and project which were identified in the Master Plan Study, and

ii) To transfer technology to the Egyptian counterpart personnel and staff of the Government agencies concerned through on- the-job training during the course of the Study.

1.2.2 Scope of the Study

The Study was implemented in the following two Phases;

<u>Phase-I (Master Plan Study)</u>

- Preparatory works at home office
- Field works
- Home office works

<u>Phase-II (Feasibility Study)</u>

- Field works

- Home office works
- Explanation of Draft Final Report
- Presentation of Final Report

During Phase-I Study, formulation of Basic Development Plan (Master Plan) for drainage improvement in terms of Farmland Environmental Improvement Project in the Omoum Area, and then selection of the priority development area and project for Feasibility Study were made.

In Phase-II Study, additional data collection and field works were undertaken focusing on the priority development area and project mentioned above, and the Feasibility Study on the Projects, of which the main subjects are farmland environmental improvement in the area, were made.

1.3 Implementation of the Study

Phase-I and Phare-II field works were made by the following Study Team with close cooperation from the counterpart personnel from the Egyptian Public Authority for Drainage Projects (EPADP), Ministry of Public Works and Water Resources.

JICA Advisory Committee

- Leader	Mr. Noriaki Baraki	Deputy Director, Construction Department, Chugoku-Shikoku Regional Agricultural Administration Office, Ministry of Agriculture, Forestry and Fisheries (MAFF)
- Irrigation/Drainage, Farmland Environment	Dr. Tsugihiro Watanabe	Associate Professor of Irrigation and Drainage Science, Department of Agricultural Engineering, Faculty of Agriculture, Kyoto University
- Machinery/Facility	Mr. Kichizo Yoshino	Deputy Director, Design Division, Construction Department, Agricultural Structure Improvement Bureau, MAFF

- Agriculture	Mr. Mikio Tsunasawa	Chief of Planning Sector, Biotechnology Division, Agriculture, Forestry and Fisheries Research Council Secretariat, MAFF

JICA Study Team

- Team Leader / Rural Development / Area Drainage Planning, Sanyu Consultant Inc. (SCI)	Mr. Seiji Takeuchi
- Irrigation and Drainage / Assistant Team Leader, SCI	Mr. Yoichiro Kuroda
- Meteorology and Hydrology / Hydraulic Analysis, SCI	Dr. Mahbub A.K.M . Reza
- Agriculture / Soil, SCI	Mr. Yasunori Hasegawa
- Agro-Economy / Project Evaluation, SCI	Dr. Tatsuo Tsuchigane
- Structure Planning / Design and Cost Estimation, SCI	Mr. Tatsuya Ieizumi
- Mechanical Facilities / Design and Cost Estimation, SCI	Mr. Hiroshi Hayata
- Environment, SCI	Mr. Daizo Iseno
- Supervision of Surveying, SCI	Mr. Yukihide Sugiyama

Counterpart Personnel of the Study Team

- Rural Development / Area Drainage Planning	Eng. Mina Iskander Mikhail
	Eng. Abd El Nabi Mahmoud
	Eng. Nabiel Mahrous
	Eng. Shaker Etman
	Eng. Nagwa Snedak
- Irrigation and Drainage	Eng. Khalaf Nasef Khalaf
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	Eng. Hosham Younes
- Meteorology and Hydrology / Hydraulic Analysis	Eng. Wageih George
	Eng. Ashour El Said
- Agriculture and Soil	Eng. Shaker Abd El Hamied
	Eng. Soliman El Saeid
	Eng. El Saeid El Kholi
	Eng. Saad Abo Khokha

- Agro-Economy / Project Evaluation	Eng. Mohamed Fathy Saif
	Eng. Aly Kolkela
	Eng. Kareim Atalla
	Eng. Mohammed Nagieb
- Structure Planning / Design and Cost Estimation	Eng. Ahmed El Medany
	Eng. Mostafa Mowafi
- Mechanical Facilities / Design and Cost Estimation	Eng. Mohammed Abd Alla Shabana
	Eng. Ahmed Samier
	Eng. Hosny El-Sayed Morsy
	Eng. Kamis Zaky
	Eng. Esmaeil Abed El Kader
- Environment	Eng. Nabiel Girgis
	Eng. Ahmed El Morsy
	Eng. Aly El Nenaey
- Supervision of Surveying	Eng. Mohamed Fawzy
	Eng. Eslam Badr

CHAPTER II. BACKGROUND OF THE PROJECT

CHAPTER II. BACKGROUND OF THE PROJECT

2.1 Trend of Egyptian Economy

In order to boost the national economy, the Egyptian Government has taken many steps to reconstruct its state controlled economy. For example, it has decided to release all state controlled establishments to the private sector and has recommended a free market economy which is an important key for private sector economic development, to increase incomes and to create employment opportunities.

In particular, to reduce the national deficit, steps like the introduction of a sales tax and reduction of state subsidies, and in case of money market, liberalization of interest rates and international money market have taken place. Moreover, free pricing system, liberalization of trade and transfer of public institutions to private sector are underway.

2.1.1 Trade Status and International Balance of Payment

1) Trade Status

Egyptian trade balance has been in red. Imports have exceeded exports in value. The share of exports in GDP has ranged between seven and nine percent, compared with 20 to 26 percent of imports in GDP. Most imported items are food and other consumption goods. In 1992, trade balance was minus 6,378 million US dollars, as shown below;

Trade Balance (1987 - 1992)

(unit: million U.S. $)

Year	1987	1988	1989	1990	1991	1992
Export	3,115	2,770	2,907	3,604	3,856	3,424
Import	8,095	9,378	8,841	10,303	9,831	9,802
Balance	- 4,980	- 6,608	- 5,933	- 6,699	- 5,975	- 6,378

Source; International Monetary Fund (IMF)

2) International Balance of Payments

The large deficit in the international balance of payment has been offset by the surplus funds from grants in aid and remittances from abroad. In 1990 the current balance showed as surplus attributable to huge inflow of foreign grants from the Western door countries during the Gulf War, and substantial increase in remittance from abroad.

When foreign currency market was liberalized and the market economy was set free, private enterprises and individuals began to deposit their money in the national banks instead of banks in foreign countries. This step has greatly enhanced the country's foreign currency reserve position. In 1991 Egyptian economy was backed up by the Association of Donor counties called Paris Consortium with the decision of 50 percent cut of the Egyptian debt in three stages.

Several efforts have been made in Egypt. Import substitution, enhancement of manufacturing capability, and high tariff rates on luxuries have been in effect. Nevertheless, the key to increase foreign reserves is to strengthen export-oriented industries.

2. 1. 2 Employment and Wage

As of 1991, the population of Egypt was about 55.9 million, of which the labour force totaled 15.2 million, while the number of total employed people was about 13.9 million. The rate of unemployment was nine percent. In the first half of the 1980's, the unemployment rate was low due to high economic growth and an increase in the number of workers working abroad. But recently, employment opportunities have decreased owing to the decreased development works in the oil producing countries in the Gulf, increased young population and/or stagnant economic growth. High wages in foreign countries created a shortage of skilled labor in the domestic market and disparity in the wages between public and private sectors has also brought some problems. The above factors have also caused problems such as a sudden 25 - 30 percent wage increase and shortage of labor in the agricultural sector.

2.2 National Policy of Agricultural Development

The state-run economy has also taken its toll on agriculture. Agriculture in 1986/87 accounted for approximately 16 percent of Gross Domestic Product (GDP) and decreased to 15 percent in 1991/92. Agriculture provides the single largest employment in the economy, ranging from 36 percent of total employment in 1986/87 to 33 percent in 1991/92.

Agriculture is also the single largest sector of the economy, providing 46 percent of production value in the gross domestic output in 1986/87 and 39 percent in 1991/92. Food industries and spinning and weaving products constitute the two major agriculture-related industries. Thus, agriculture is an important sector of the Egyptian economy, accounting for 15 percent of the GDP, 33 percent of employment, 39 percent of agriculture-related industrial output and employs substantial share of the work force.

The Government of Egypt has controlled agricultural production through two-year crop rotation, three-year crop rotation and sugarcane crop rotation. The Central Government has imposed its policy objectives upon Governorates which in turn passed the state-controlled quotas to their Districts and cooperatives. The farmers at the lower end had to accept what the state had predetermined.

However, recent economic situation of Egypt has been reorganized with a guidances of the International Monetary Fund (IMF) and World Bank. Under the circumstances, privatisation of public sector and liberalization of agricultural marketing have been positively promoted. Furthermore, promotion of agricultural development has been made through employment measures of young generation to agricultural sectors. In addition to these changes, Egyptian Government changed the agricultural direction from the protective policy of small-scale farm household to the enlargement policy of land holding size to be effective for increase in agricultural production, and as a result restrictions on land holding have been eased substantially.

Under the conditions, agricultural situation has changed. Namely, farmers express their wishes through their cooperatives which in turn convey their messages to the higher organizations, Districts, Governorates and the Central Government. On the other hand, the Central Government sets up its goals and objectives. Information from the top and from the bottom are discussed and debated at different levels. The final decision on of crop planting takes a variety of processes and meetings. It is called a mixed process of joint determination.

Nevertheless, the key factors of the decision-making process are the availability of irrigation water, farmers' incentives, and Government's control and allocating function at the Governorate level.

2.3 National Policy for West Delta Region

West Delta region, in which the Study Area of Farmland Environmental Improvement Project in Omoum Area is located, has been playing an important role in producing agricultural crop in Egypt. According to the Statistical Year Book, 1992/1993, CAPMAS, cropping area rates in West Delta region against whole Egypt is as follows; cereal crop (maize, wheat, paddy, others) 6.2 Percent, beans (soy bean, broad bean, others)15.7 percent, vegetable (onion, others) 28.6 percent, industrial crop (cotton, others) 11.5 percent, fodder crops (berseem, others) 10.4 percent, and fruits 11.5 percent, respectively. Particularly, as it is cleared that the rates of vegetable and beans are relatively high among various crop cultivation, West Delta region is regarded as upland crop promoting area in Egypt.

The three major subjects for development of the West Delta region taken by the Government are irrigation development, drainage improvement and agricultural improvement. Nevertheless, the most inhibiting factors to agricultural growth is the availability of water resources. Consequently, the efficient allocation of scarce water sources has important policy implications for the region. Such policy involves improvement of irrigation and system management, improvement of deteriorated rural infrastructure, removal of drainage constraints, and improvement of efficient water use on the basis of financial and economical rate of returns.

2.3.1 Irrigation Development

Agriculture in Egypt depends completely on the availability of water for irrigation. Consequently, Egyptian Government has made efforts to find available water sources, especially for the areas of newly reclaimed Western Desert. In order to cope with these situations, improvement of water management at irrigation canal systems inclusive of on-farm level has been emphasized in the area. Furthermore, the use of drainage water (reuse) from the Omoum main drain after mixing with Nubariya canal irrigation water for irrigation in the Western Desert is envisaged.

2.3.2 Drainage Improvement

The West Delta areas being situated at a low-lying elevation, below the mean sea level, have faced severe drainage problems not only in terms of agricultural crop production, but also in terms of daily living activities. Therefore, huge amounts of investment for these purposes have been made annually, especially for the maintenance of numerous drainage pumps and open drains to remove excess water.

On the other hand, at field level, the Egyptian Government has proceeded with a plan of tile drain installation to lower the high groundwater table for suitable crop cultivation, in accordance with the long-term plan up to the year 2000. But, the plan seems impossible to achieve because the budget is not sufficient to implement the plan.

The drainage improvement by means of tile drain is essential to improve crop productivity and farm income. Several studies of the tile drain indicate that crop yield was improved somewhere between 10 and 20 percent per feddan following installation of tile drain. Crop improvement may be attributable to low salinity and other factors. The applied average capital costs of tile drainage range between LE 400 and LE500 per feddan, whereas operation and maintenance cost per feddan is about LE6.0.

2. 3. 3 Agricultural Development

With the implementation of not only irrigation improvement aimed at securing stabilized irrigation water, but also drainage improvement equipped with sufficient capacity of drainage pumps, open and tile drains at the on-farm level to meet the requirements for introducing crop diversification in the areas, following integrated agricultural program has been proposed.

- To realize high productive and diversified farming on the basis of systematic water management in the fields of both irrigation and drainage.
- To strengthen agricultural supporting services and farmers' groups to cope with the above mentioned scientific integrated agriculture.
- To strengthen agricultural research and extension systems to develop farming techniques for introducing crop diversification and increasing productivities.

2. 4 Problems and Development Needs for Study Area

Technological constraints affect the productivity of traditional farming methods, as well as post harvest practices. Farming is still characterized by a relatively low level of production technology and inefficient on-farm water management. Outdated and inefficient processing technology causes post harvest losses of up to 20 percent.

The diffusion of research agendas among competing agencies prevents the Government research system from concentrating on the highest priorities. Furthermore, the agricultural research system is relatively isolated from outreach and extension mechanisms. Hence, new technologies developed have little chance of reaching farmers.

There remains the problem of water and its relationship to cultivable land. Population growth and urbanization are rapidly devouring Egypt's scarce agricultural land. In response, the Government of Egypt is reclaiming desert land, which is resulting in pressure on limited irrigation water from the Nile River. There is little scope for groundwater exploitation. Thus, the

Government and the private sector must continue to explore more efficient methods to manage existing water resources.

It was revealed through the field survey that irrigated agriculture and rural activities in the Study Area have been practiced for a long time, especially after the introduction of annual double dropping, which was facilitated by the construction of the Aswan High Dam. However, the Area is still facing severe problems mentioned below, which are deemed to be the factors constraining the agricultural activities in the Study Area.

- Improper irrigation water management,
- Deterioration of drainage facilities,
- Poor farmers' organization and agricultural supporting services
- Inadequate rural environment.
- Negative effects on crop production, due to raised water level in open drains and groundwater table,
- Deterioration of Mariut Lake water quality, and

Under there conditions, farmland environmental improvement and development with special emphasis on drainage improvement in the Omoum Area will be important and prerequisite subjects for the area.

CHAPTER III. PRESENT SITUATION IN STUDY AREA

CHAPTER III. PRESENT SITUATION IN STUDY AREA

3.1 Geography and Climate

3.1.1 Location and Geography

The Study Area is located about 220 km north of Cairo in the Western Delta within the Governorates of Bahera and Alexandria. Two very prominent canals in the Delta, namely, Mahmoudia and Nubariya form the eastern and western boundary of the area. The northern part faces Alexandria city, while the southern boundary is the same as the Shereshra drainage block boundary. The area is formed by the deposit of fertile silt brought by the Nile from the Ethiopian plateau. The area extends about 70 km in a north-south direction and 30 km in an east-west direction.

The elevation of the area ranges from six meters above mean sea level (MSL) in the south to 3.5 m below MSL in the north. A vast Lake called Mariut with a water surface area of 13,000 feddan (5,460 ha) is located in the extreme downstream of the Study Area. This Lake was formerly separated into four to five parts by the Omoum main drain and Nubariya canal. Due to the shortage of water in the Lake and deterioration of the water quality, recently the embankments of the Omoum main drain and Nubariya canal have been cut in many places not only to maintain a reasonable water depth for fish culture, but also to minimize the pollution that take place due to the emptying of primarily treated sewage water of Alexandria city into the Lake.

Most of the area is arable land where mainly cotton, rice, corn and other agricultural crops are grown with irrigation water withdrawn from the branches or sub-branches of the Nile. The Study Area, which is divided into eight drainage blocks, covers an area of 430,260 feddan (180,710 ha), as shown below;

Drainage Area in Study Area

Drainage Block	Drainage Area (ha)	(feddan)
Qalla Area	5,880	14,000
Abis Area	3,780	9,000
Hares Area	26,600	63,330
Dishudi Area	15,330	36,500
Truga Area	43,080	102,570
Shereshera Area	56,720	135,060
Abu Hommos Area	19,910	47,400
Sub-Total	171,300	407,860
Mariut Lake	9,410	22,400
Total	180,710	430,260

Note ; feddan = 0.42 ha

3.1.2 Geological Conditions

The Study Area is almost totally composed of sedimentary deposits belonging to the Quaternary. In the southwest portion of the Area locally late Tertiary outcrops are found underneath a thin cover of shifting sand and desert detritus.

The thickness of the surface exposures hardly exceeds 50 m, but as a result of boring data, subsurface thickness of the Quaternary is in excess of about 700 m. A basalt sheet is occasionally encountered below the Miocene. The geological structure of the surface including its immediate layer is rather simple and has a regional homo-clinal slope in the direction of the Delta basin. Local faulting is expected in the southwest portion of the Area.

3.1.3 General Climate and Rainfall

The climate of the Study Area can be classified as predominantly Mediterranean. The average temperature varies from 14°C in January and 27°C in the months of July and August. The relative humidity is very high, ranging from 49 to 83 percent.

Although Egypt is known as being in an arid zone with minimum rainfall (annual average 28 mm), on the other hand the Delta is blessed with about 200 mm (recorded in Alexandria) as an annual average with most rain falling between the months of November and February. But as we go to the south of the coastal area, the amount of rainfall decreases substantially. Damanhur, which is only about 60 km south of Alexandria, has only about 110 mm of annual rainfall. In recent years, the monthly highest rainfall was recorded as 167 mm in Alexandria (December 1991), where as in Damanhur it was 99.8 mm. During the same period the highest daily rainfall was recorded as 42.0 mm in Alexandria and 19.4 mm in Damanhur, respectively.

Monthly average rainfall measured in Alexandria and Damanhur is shown in the table below. Monthly, annual, daily maximum and monthly maximum rainfall is presented in Tables B-1-1 to B-1-3, Annex B.

Monthly Average Rainfall (1973 - 1994)

(unit: mm)

Month	Alexandria	Damanhur
Jan.	53.5	29.2
Feb.	30.1	20.2
Mar.	15.8	12.0
Apr.	2.3	2.4
May	0.8	1.4
Jun.	0.0	0.1
Jul.	0.1	0.0
Aug.	0.0	0.0
Sep.	0.0	0.6
Oct.	8.2	4.2
Nov.	29.2	11.4
Dec.	58.7	25.7
Ave.	198.5	107.2

Source: Egyptian Meteorological Authority

3.2 Administration and Socio-Economy

3.2.1 Administrative Division

Most of the Study Area (about 95%) is covered by the six Districts of Behera Governorate and the remaining area by the three Districts of Alexandria Governorate. The Districts in the Behera Governorate include 31 Local Units consisting of 81 villages (Sheyakha) and six towns (center of Districts). The Local Units have recently been established as a local administrative unit, which usually consists of several Sheyakhas. In general, a

Sheyakha has a population about 10,000 persons and comprises several Ezbas (small villages) having a population of about 250 persons.

3. 2. 2 Population Distribution

The Population census of 1986 shows that the above Districts/ Quarters in the Study Area had a population of 2,007 thousand. And the population has increased at a rate of 3.8 percent per year, which was estimated on the basis of the 1976 population census data. The estimated population for the year of 1993 is 2,442 thousand, which increased to 1.7 times of that of 1976 (refer to Table F-1-1, Annex F). Population in Alexandria Governorate as of 1993 is 3,353 thousand, which corresponds to 2.2 times of the population in 1960. The population and population density by District/Quarter in the Study area are indicated in the followings.

Table 3 - 1 Population Density by Administrative Division (1993)

Administrative Division	Area	Population	Popula. Density per km	Study Area		
				No. of L. U	No. of Town	No. of Village
	(sq,km)	('000)				
1. Behera Gov.						-
- Delengat	389	241	620	4	1	6
- Damangur	496	595	1,200	7	1	8
- Hosh Esa	276	152	547	3	1	9
- Abu Hommos	402	345	858	7	1	23
- Abu El Matameer	436	255	585	3	1	15
- Kafr El Dawar	595	668	1,123	7	1	20
Sub-total	2,594	2,256	869	31	6	81
2. Alexandria Gov.						
- Khorshed	66	27	409	N. A	N. A	N. A
- Abis	51	28	549	N. A	N. A	N. A
- Ameriya	570	131	530	N. A	N. A	N. A
Sub-total	687	186	279	N. A	N. A	N. A
Total	2,981	2,442	819	N. A	N. A	N. A

Source : Population Census, 1986, CAPMAS

According to the 1986 population census report, male and female literacy rates over 10 years old are 53 percent and 32 percent respectively (see Table F-1-3, Annex F). It makes clear that female illiteracy is prevalent in the villages.

About ten percent of the male population of the age group between 12 and 65 years in the rural areas of Behera Governorate are unemployed and most of them are unpaid family workers (refer to Table F-1-4, Annex F). The economically active population in the agriculture sector, above six years of age, covers 71 percent of the total economically active population (refer to Table F-1-4, Annex F).

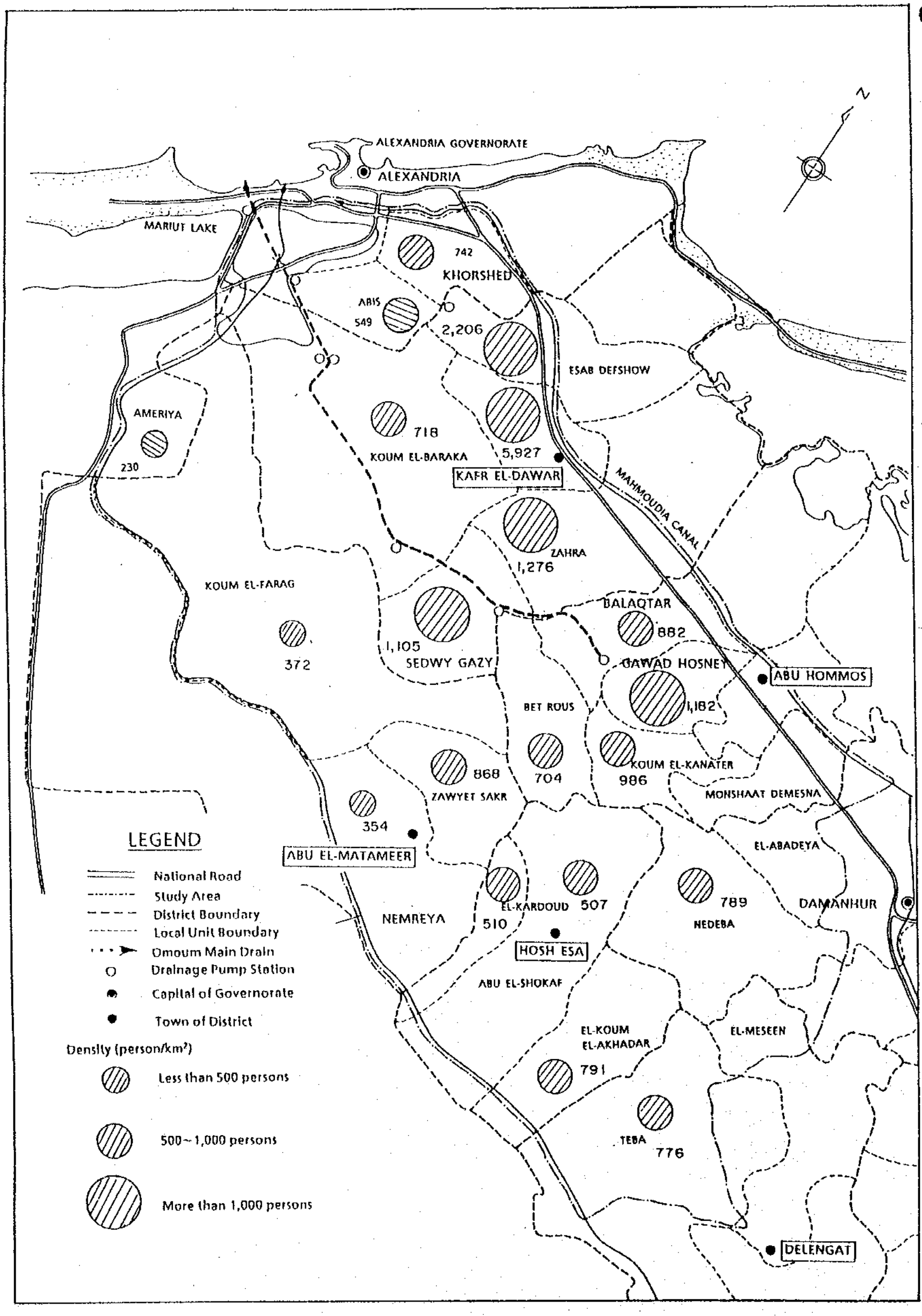
There are many densely populated villages in the upstream of the Study Area. On the other hand, the villages scattered in the downstream have lower density. The population density according to the Local Units is shown in Table 3 - 1, which reveals that the density in Hares and Truga drainage blocks is very small (see Figure 3-1).

Apart from the said population and the number of total households for the project Districts and Square, there are about 1,138 thousands of population with about 219 thousands of total households in the Study Area according to the data on the Seyakhas basis. The average number of population per family and the population density are estimated respectively at 5.2 persons and 664 persons/sq. km. There are about 79 thousands of farm households, which are equivalent to 36 percent of the total households. (refer to, Table F-1-6, Annex F.)

3. 2. 3 Socio-Economic Conditions

As part of agricultural reform, the Government has to encourage market pricing and cost recovery in sectors such as irrigation, urban utilities (water, waste water, sewerage, electricity, and telecommunication), and curative health care. The Government's longstanding practice of keeping the cost of living low through broad-based subsidies, which are enjoyed by the rich and the poor, still permeate its planning. The Government is increasingly aware that the reduction of these subsidies is necessary in order to funnel them to exclusively the very poor people. It is essential for the Government to finance the operations and maintenance programs required to sustain infrastructure and improve service quality over the long term.

FIGURE 3-1 POPULATION DENSITY IN RELATED DISTRICTS (1993)



Communicable diseases afflict the population in large numbers. In 1993, three Districts of Abu Hommos, Abu El Matameer, and Hosh Esa showed that water-borne communicable diseases afflict 4.5 percent of the population in Abu Hommos, 4 to 23 percent in Abu El Matameer, 19 percent in Hosh Esa respectively. The three major water-borne diseases are diarrhea, paratyphoid, and skaris in the Study Area.

The principal constraints to improving maternal and child health are inappropriate policies which have weakened the institutional delivery of preventive services. For example, by attempting to subsidize curative health care for the entire population, the Ministry of Health allocates much of its budget for this purpose at the expense of funding cost-effective preventive services which have the greatest impact on reducing maternal and child mortality.

The importance of potable water and sanitary drainage to the Egyptian economy and the quality of life can not be overstated. Approximately 25 percent of the population have no source of treated water in rural area and 70 percent do not have access to a sewage collection system. Pollutants in this closed system have significant environmental impact upon health and work productivity.

Although potable water is available almost 83 percent of the villages in the Study Area, Sewage water is often mixed with drain water which in turn can be utilized for domestic purposes without treatment and purification.

The waste water treatment relies almost completely on donor assistance for expansion of the large collection networks, rehabilitation of pump stations and construction of treatment facilities. Technically, construction for collection, treatment and disposal of sewerage are considered more complicated than treatment and distribution of water. Egyptians have developed little experience in large scale waste water technologies, and thus the assistance in this area will be needed.

3.3 Meteorology and Hydrology

3.3.1 Meteorology

In order to know the meteorological condition of the Study Area, data of required parameters measured in Alexandria were collected and analyzed. Monthly averages are presented below.

Monthly Average of Meteorological Parameters

Month	Temp. (°C)	Evapo. (mm/day)	Wind Speed (km/hr)	Sunshine Hours (hr/day)	Relative Humidity (%)
Jan.	13.7	4.0	4.3	6.6	66.5
Feb.	14.3	4.5	4.3	7.5	65.0
Mar.	16.0	5.2	4.5	8.3	64.5
Apr.	18.7	5.4	4.3	9.5	64.5
May	21.6	5.5	3.9	10.7	77.5
Jun.	24.4	5.5	3.9	11.9	70.0
Jul.	26.2	5.4	4.3	12.0	71.0
Aug.	26.7	5.4	4.0	11.5	71.0
Sep.	25.4	5.5	3.6	10.4	68.0
Oct.	22.6	5.2	3.2	9.3	67.0
Nov.	19.2	4.3	3.4	7.9	67.0
Dec.	15.5	3.7	4.0	6.5	67.0
Ave.	20.4	5.0	4.0	9.4	68.3

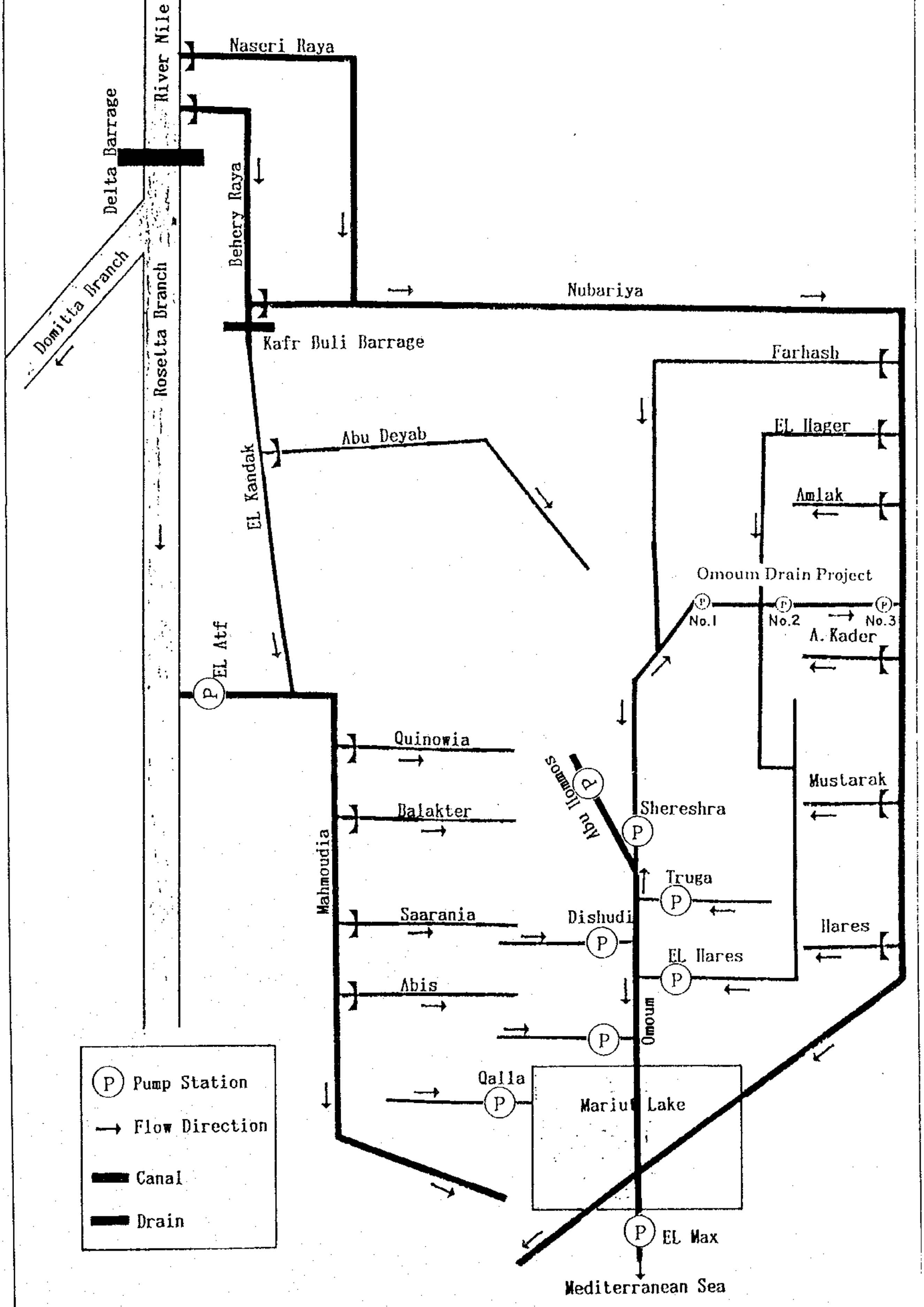
Source: Egyptian Meteorological Authority

3.3.2 Hydrology

The main hydrological features of the Study Area that control the hydrology of the area are Mahmoudia canal, Omoum main drain, Nubariya canal, Mariut Lake and the Mediterranean Sea. The above mentioned two canals serve as the conveyer of irrigation water for the area and Omoum main drain serves as the carrier of drainage water that comes from the seven drainage blocks in the area. Ultimately, this water is pumped to the Mediterranean Sea through the El-Max pumping station at the extreme downstream of Omoum main drain. Figure 3-2 shows the main hydrological features of the Study Area.

Although the main purpose of the Omoum main drain was to carry only the agricultural drainage water, the present conditions are different. In recent years the shortage of fresh water in Mariut Lake for fish culture and also the deterioration of its water quality have compelled the fishermen to cut the

FIGURE 3 - 2 DIAGRAM OF HYDROLOGICAL NETWORK IN STUDY AREA



embankments in many places of Omoum the main drain and Nubariya canal. Therefore, present hydrological conditions in the area have become rather complex.

From an agricultural point of view and for efficient drainage in the upstream area, water level at the El-Max pumping suction side should be maintained at (-) 3.25 m. MSL. On the other hand, for fish culture and for good water quality in the Mariut Lake, the Lake water level should be maintained at (-) 2.40 m. MSL. At present, as a compromise, the suction water level of the El-Max pumping station is maintained between (-) 2.80 m and (-) 2.70 m. MSL. Extreme suction and delivery water levels during 1991-1994 are presented below.

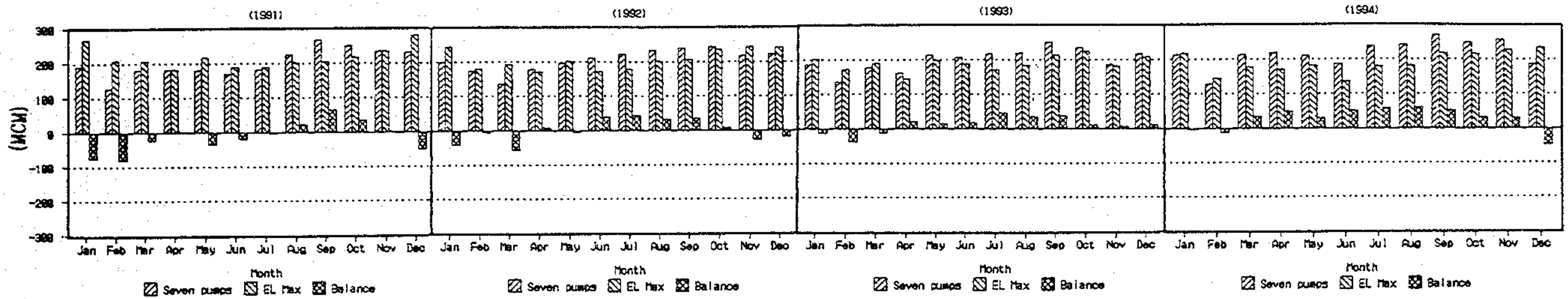
Extreme Suction and Delivery Water Levels (1991-1994)

Pump Station	Suction Level (m. MSL)			Delivery Level (m. MSL)		
	Highest (m)	Lowest (m)	Mean (m)	Highest (m)	Lowest (m)	Mean (m)
1. El-Max	(-) 1.86	(-) 2.90	(-) 2.38	0.95	0.60	0.78
2. Qalla	(-) 4.30	(-) 5.90	(-) 5.10	(-) 0.20	(-) 2.00	(-) 1.10
3. Abis	(-) 4.00	(-) 6.80	(-) 5.40	(-) 1.80	(-) 2.60	(-) 2.20
4. Hares	(-) 2.00	(-) 5.80	(-) 3.90	(-) 1.40	(-) 2.75	(-) 2.08
5. Dishudi	(-) 2.42	(-) 5.72	(-) 4.07	(-) 1.42	(-) 2.85	(-) 2.14
6. Truga	(-) 1.47	(-) 4.85	(-) 3.16	(-) 1.10	(-) 2.50	(-) 1.80
7. Shereshra	(-) 1.10	(-) 5.65	(-) 3.38	0.00	(-) 2.50	(-) 1.25
8. Abu Hommos	(-) 0.55	(-) 2.99	(-) 1.77	(-) 0.11	(-) 2.64	(-) 1.38

Source: MED, Damanhur

For a general idea, water volume that has been discharged from seven drainage blocks and the volume of water that has been pumped to the sea through the El-Max pumping station from 1991 to 1993 is presented in the Figure 3-3. Monthly average (1991-1994) inflow by seven pumping stations and outflow through El-Max is presented in the following table. Details of pump discharge (1988-1993) are presented in Table, B-1-7 to B-1-10, Annex B.

FIGURE 3 - 3 FLUCTUATION OF INFLOW AND OUTFLOW (1991 - 1994)



Source: MED, Damanhur

Monthly Average Inflow and Outflow

(unit: MCM)

Month	Qalla	Abis	Hares	Dishudi	Truga	Shereshra	Abu Hommos	Total Inflow	Out flow from EL-Max
	Inflow from Seven Pump Station								
Jan.	19.71	3.69	54.51	17.52	47.25	49.24	9.11	201.03	245.16
Feb.	20.84	2.44	37.03	13.70	28.11	25.84	6.37	134.34	180.99
Mar.	23.21	2.88	44.84	17.55	37.13	43.78	10.58	179.98	191.73
Apr.	25.89	3.84	45.16	16.71	34.31	40.96	10.39	177.25	162.47
May	28.26	4.20	49.29	19.08	38.41	41.61	9.99	190.84	186.87
Jun.	26.39	4.17	50.65	19.65	39.51	46.80	10.58	197.74	175.26
Jul.	28.55	4.68	53.58	21.65	41.57	55.49	14.00	219.52	187.11
Aug.	28.12	6.02	57.37	22.24	43.00	55.36	13.66	225.77	196.36
Sep.	27.40	5.62	60.53	26.96	53.39	62.23	15.64	251.76	213.25
Oct.	27.49	5.81	60.99	24.40	55.10	62.63	11.89	248.31	237.72
Nov.	25.46	4.81	57.95	20.39	49.41	53.28	11.74	223.03	224.85
Dec.	23.27	4.52	55.48	20.69	47.72	49.40	10.94	212.03	241.68
Total	304.60	52.67	627.38	240.54	514.91	586.63	134.86	2,461.59	2,443.45
Ave.	25.38	4.39	52.28	20.05	42.91	48.89	11.24	205.13	203.62

Note : Abu Hommos data period is 1991-1994
Source : MED, Damanhur and Reuse Monitoring Report, DRI

Another recent development in the Study Area's hydrology is the reuse of drainage water. At present there are five reuse pumps that pump drained water into the irrigation canal for reuse. According to the collected information this trend will increase substantially in the near future. Monthly average (1988-1992) of reused water that was withdrawn by five pumps for the Study Area is presented below. Detail is presented in Tables B-1-11 and B-1-12, Annex B.

Monthly Average Reuse Water

(unit: MCM)

Month	Mariut No.1	Boustain	Delingat	Edko	Delingat Extension	Monthly Total
Jan.	5.25	2.63	13.98	10.60	3.65	36.11
Feb.	3.01	2.11	10.50	2.67	2.61	20.90
Mar.	12.42	3.21	14.45	12.52	3.36	45.96
Apr.	9.95	3.32	14.70	13.18	4.31	45.46
May	11.01	3.40	14.61	11.80	4.94	45.76
Jun.	8.58	3.63	13.63	18.73	4.13	48.70
Jul.	8.13	4.49	15.03	22.62	4.97	55.24
Aug.	9.42	5.03	17.56	23.36	6.54	61.91
Sep.	10.85	5.25	17.99	23.14	6.36	63.59
Oct.	10.87	4.75	13.65	20.39	5.62	60.28
Nov.	11.43	4.36	13.86	11.06	2.75	43.43
Dec.	6.99	3.28	13.88	14.49	2.24	40.88

Annual total 568.24

Note : Data period for Delingat extension is only 1993; others are from 1988-1992
Source : MED, Damanhur and Reuse Monitoring Report, DRI

3.3.3 Groundwater

The groundwater table survey was carried out during Phase-I and Phase-II field works in 100 selected sites within the Study Area (see Figure 3-4 and 3-5). Auger-hole, tile drain manhole and deep ditches were used for measurement of groundwater table. Findings are described as follows. Details of the survey are given in Table D - 2 - 15, Annex D.

- According to the data obtained in August 1994, groundwater tables of Hares, Abis and Dishudi are areas which are located downstream of Omoum main drain are relatively high, the range is 0.2 to 1.2 m from ground surface, because the tile drain system is not yet provided in these areas.

- Groundwater tables of Shereshera and Abu Hommos areas, which have tile drains, in general, are more than about 1.1 m below the ground surface. But according to the reasons mentioned below, there are some areas with high groundwater tables.

  - To Increase paddy cultivation areas in summer season, farmers can maintain higher groundwater table by closing the outlet of collector drain.

  - Nubariya and Hager irrigation canals are operated with high water level in the canals, so groundwater tables of farmland along and between these canals are affected by the water level.

- Salinity of groundwater ranges from 1.0 to 7.5 mS/cm, and the high salinity area with EC value of more than 4.0 mS/cm is widely distributed. There are no regional features in the salinity of ground water.

- According to the survey data in February 1995, groundwater table at the lower reaches of Omoum main drain and at field located along main irrigation canals and drains is relatively high. These conditions are the same as summer season.

- Groundwater table at paddy field during the summer season was high, however, that during the winter season is lower with water table depth of more than one meter from ground surface. These situation will be related with water utilization at field.

FIGURE 3-4 RESULTS OF GROUNDWATER TABLE SURVEY IN STUDY AREA (I)
(Observation : September 1994)

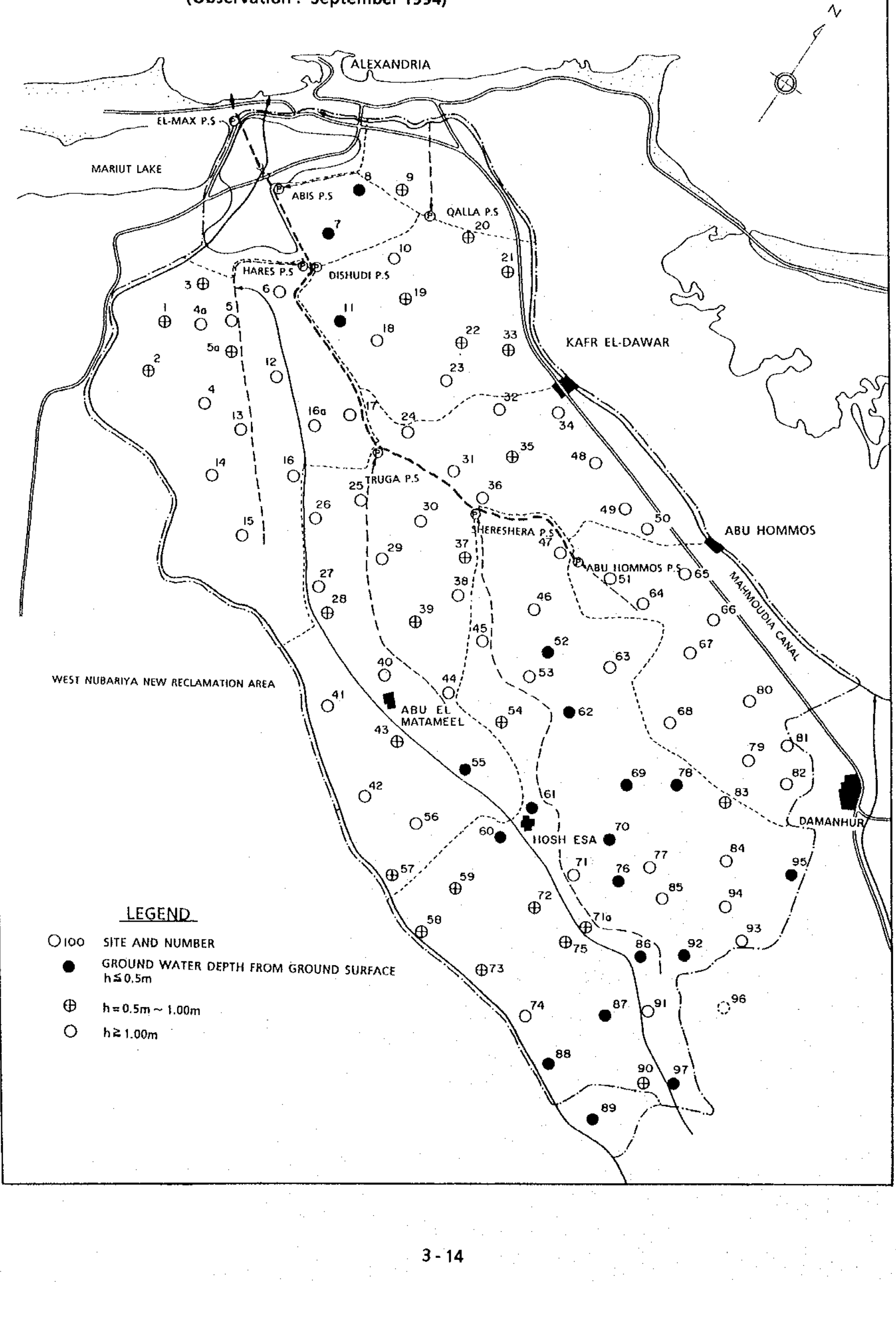


FIGURE 3-4 RESULTS OF GROUNDWATER TABLE SURVEY IN STUDY AREA (II) (OBSERVATION : FEBRUARY 1995)

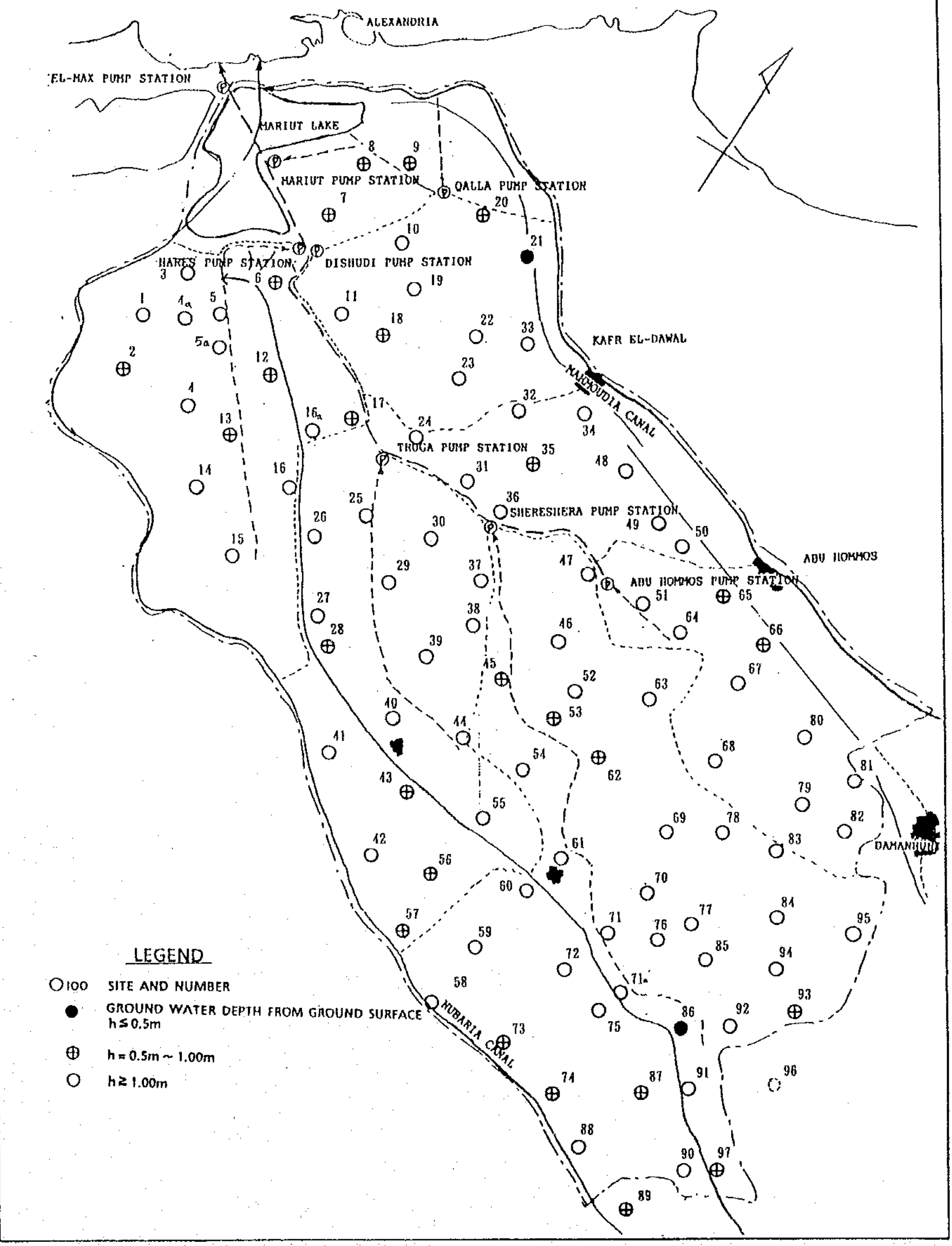
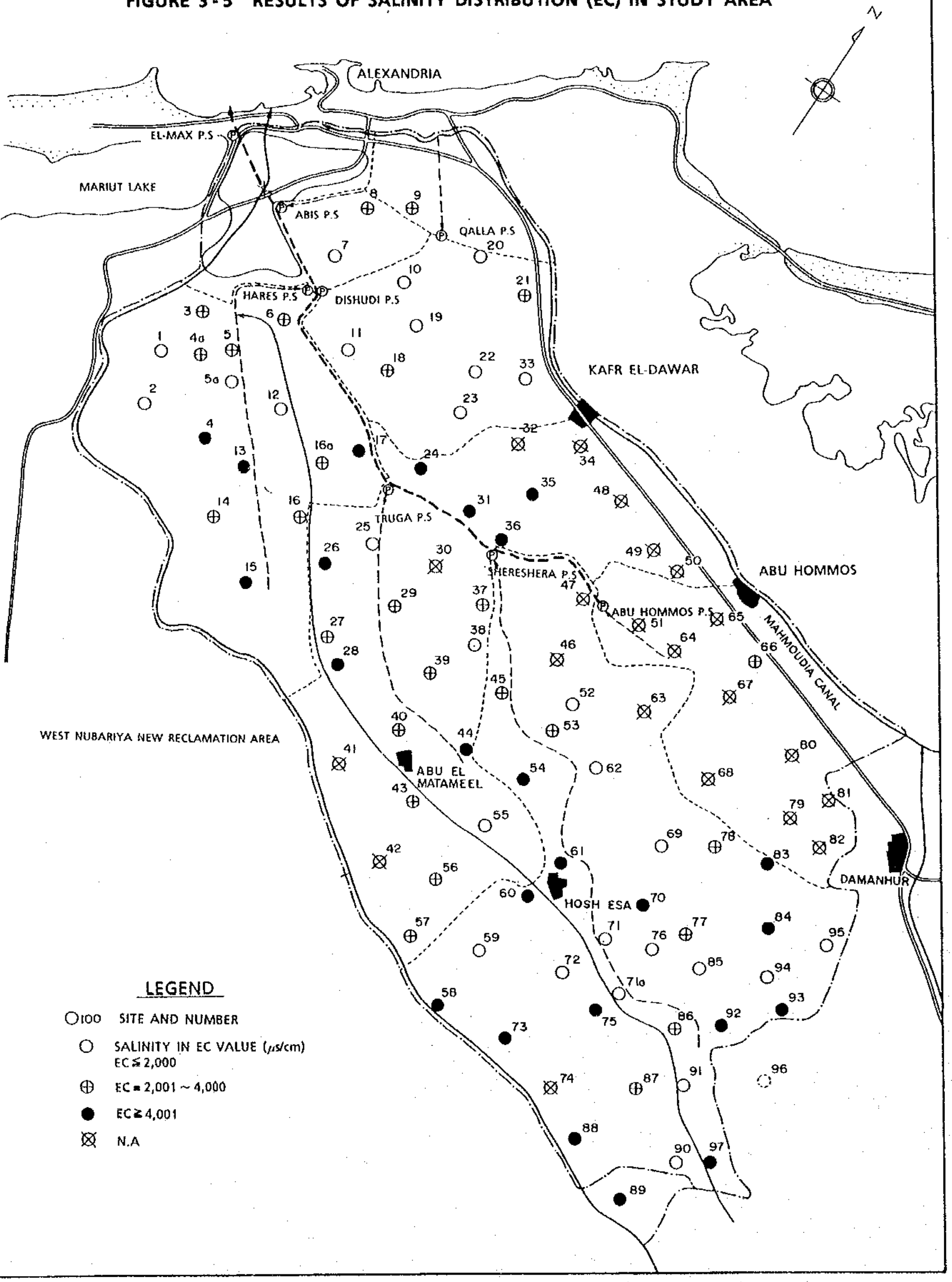


FIGURE 3-5 RESULTS OF SALINITY DISTRIBUTION (EC) IN STUDY AREA



3.4 Irrigation Water Resources

It is generally well known that eventually the only source of water in Egypt is the Nile River. According to an agreement signed in 1959 with Sudan, Egypt can withdraw annually an amount of 55.5 BCM from the Aswan High Dam reservoir. Apart from this surface water, Egypt has also some groundwater in the aquifers of the Nile valley and delta. Estimated safe yield of these aquifers could be 4.9 BCM/annum. Agriculture accounts for the largest share of water use in Egypt with about 84 percent. The other uses of water are industrial, municipal and navigation and their shares are estimated at eight, five and three percent, respectively.

The main water sources of the Study Area are the two major branches of the Nile, that is, Behera and Rosetta, as well as the Nasery canal that takes water directly from the Nile. From the Rosetta branch the Mahmoudia canal diverts water at El Atf by pumping and from Behera, while the Nubariya canal takes water from upstream of the Kafr Boleen Barrage through gravity. Water from the Nasery canal flows into the Nubariya canal. These two canals are the principal source of water for the Study Area.

Due to the expansion of arable land and limited supply of water, reuse of drainage water has becoming a common practice in the Area. The following table shows the command areas and the amount of water that was withdrawn from the Mahmoudia and the Nubariya canals in 1993.

Area and Intake Discharge of Nubariya and Mohmoudia Canals

Item	Nubariya Canal	Mahmoudia Canal	Total
Irrigation Command Area (feddan)	820,480	258,840	1,079,320
Intake Discharge (MCM)	4,777	3,013	7,790

Note: Intake discharge includes the reuse water.

It is noteworthy to mention that these water sources are not only for the Study Area. The left side command area of the Nubariya canal and the right side command area of the Mahmoudia canal are also served by these water sources.

3.5 Soils and Land-Use

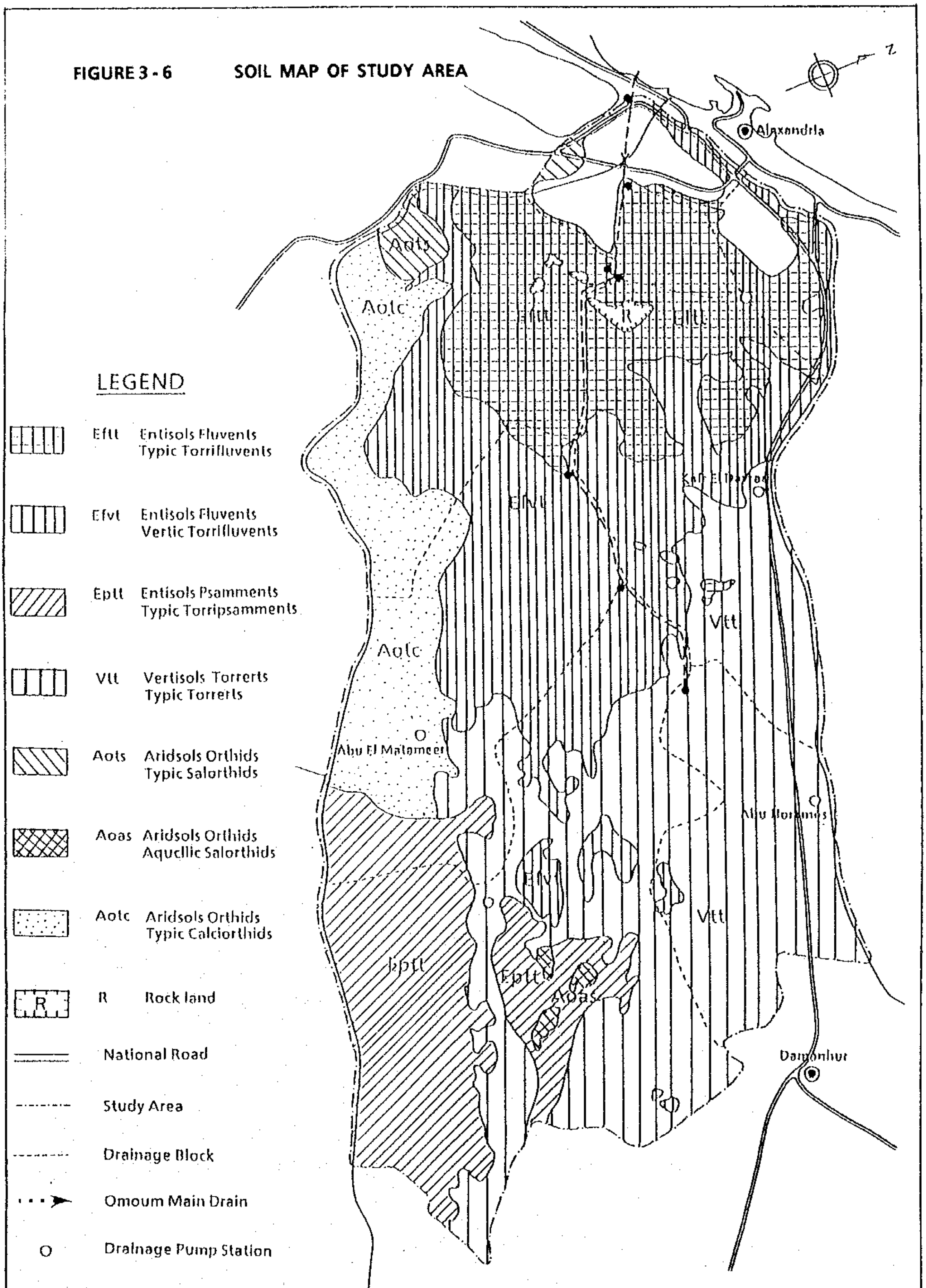
3.5.1 Soil Characteristics

About 41 percent of the Study Area is located on low land below the mean sea level (MSL) and developed from the former Mariut Lake. Hares drainage block is one of the most low-lying areas with marine snails and shells in the subsurface layers. According to the existing data of "Soil Survey of Egypt, 1957 - 1973", the soils are formed from deposits in the Lake. Most of the soils in the remaining area are of alluvium soils formed from the deposits on the Nile Delta. However, the area adjacent to the West Desert Area has two kinds of soils, namely, old sea-floor soils and wind-blown sandy soils. Excluding the wind-blown soils, most soils have clayey texture, containing more than 40 percent clay in the top soils. The texture of the soils varies from one point to another, especially in the lake-deposited soils (refer to Figure C-3, Annex C).

According to the Soil Survey Report mentioned above, almost all areas in the downstream of the Study Area have poor drainage conditions and need improvement. In particular, four drainage blocks including Hares and Truga have a very high groundwater table. A comparison of data from the above report and recent EPADP and Study Team data shows that the situation has not been changed significantly (refer to Table C-2, Annex C). The data also clarify the fact that there is a correlation between the groundwater table and level of soil salinity. According to the data, Hares drainage block has salt content of more than 16 mS/cm and in Truga and Dishudi drainage blocks also have a considerable amount of salinity. There are many other high soil salinity spots scattered throughout the Study Area (refer to Table C-3, Annex C).

The soil map presented in Figure 3-6 is a recently prepared one, applying the procedure of "USDA Soil Taxonomy (1975)", and corresponds to the soil profile characteristics map shown in Figure C-1, Annex C.

FIGURE 3 - 6 SOIL MAP OF STUDY AREA



Source: Soil Map of Egypt, 1986

3. 5. 2 Land Classification

According to the data of "Soils Survey of Egypt, 1957 - 1973", the classified areas of first to fourth class cover only 62 percent of the total area. Out of the total classified area, first and second class land covers only 18 percent of the total area. The remaining area comprises of cultivable waste areas and areas not available for cultivation. In the Districts of Abu El Matameer and Hosh Esa, the percentage of above mentioned land is 63 percent and 37 percent, respectively.

It was noticed that upstream of the Study Area, the presence of higher class land is more, while coverage by cultivable waste land is less. The main factors are consideration of groundwater level and soil salinity in the classification, as shown below (refer to Table C-2, Annex C).

Classification of Land by Soil Salinity

Land Class	Soil Salinity (mS/cm)	Remarks
1	less than 4	
2	4 - 8	
3	4 - 16	
4	16 - 30	other factors than soil salinity are also considered

The soil salinity is closely related to the depth of the groundwater table. Therefore, the lowering of the groundwater table is very important to improve the lower class land. The salinity condition of the land upstream in the Study Area have been improved to some extent by means of lowering the groundwater table through the implementation of tile drain projects. However, in the downstream area, improvements have not been taken place.

3. 5. 3 Land-Use

The present land-use pattern of the Study Districts is shown below;

Present Land-Use

Item	Area (ha)	Area (feddan)
(1) Cultivable Area		
Actual Cultivated Land		
- Annual Crops	97,310	(231,310)
- Orchard	15,820	(37,820)
- Temporary Fallow Area	11,080	(26,390)
Sub-Total	124,210	(295,520)
Cultivable Waste Area (including long term fallow)	8,510	(20,260)
Total	132,720	(315,780)
(2) Non-farmland	38,580	(92,080)
Grand Total	171,300	(407,860)

Source: The land-use of cultivable area is estimated according to the land-use based on the data in Table C-1-3, Annex C.

The rate of the actually cultivated area to the total cultivable area (cultivated area excluding the temporary fallow area / the total cultivable area × 100) is estimated at 85 percent. The remaining 15 percent of the total cultivable area is likely to be left as fallow area for a long time mainly due to the high soil salinity. The higher rate of the cultivated area is generally found in the upstream area (refer to Table C-2, Annex C). During the field survey, it was observed that there are a considerable number of uncultivated areas, but they could not be distinguished as short, long term or seasonal fallow land. According to the officers engaged in the village agricultural cooperative society, some of the land has been converted from uncultivated areas to cultivated areas. The uncultivated areas seem to prevail in the Hares and Truga drainage blocks.

3.6 Irrigation Conditions

3.6.1 Present Irrigation Systems

The present irrigation system in the Study Area consists of three irrigation networks, namely Nubariya canal, Mahmoudia canal and Khandak canal, and their proportions of irrigation area are, 54, 36 and 10 percent, respectively. The former two networks irrigate about ninety percent of the Study Area.

Nubariya canal which runs along the west side of the Study Area, is about 200 kilometers long and its irrigation command area, including West Nubariya New Reclamation Area, is about 820 thousand feddan (340 thousand hectares). The Study Area is on the right side of the canal and 221 thousand feddan (93 thousand hectares)are under its command.

Mahmoudia canal lifts water at EL Atf from the Rosetta Branch of the Nile River and runs up to Alexandria. Its total length is about 90 km. The total irrigation command area of this canal is about 260 thousand feddan (110 thousand hectares) and 147 thousand feddan (62 thousand hectares)of the Study Area fall within the left side command area. Network-wise coverage of the Study Area is presented below.

Commanded Area of Major Irrigation Canals

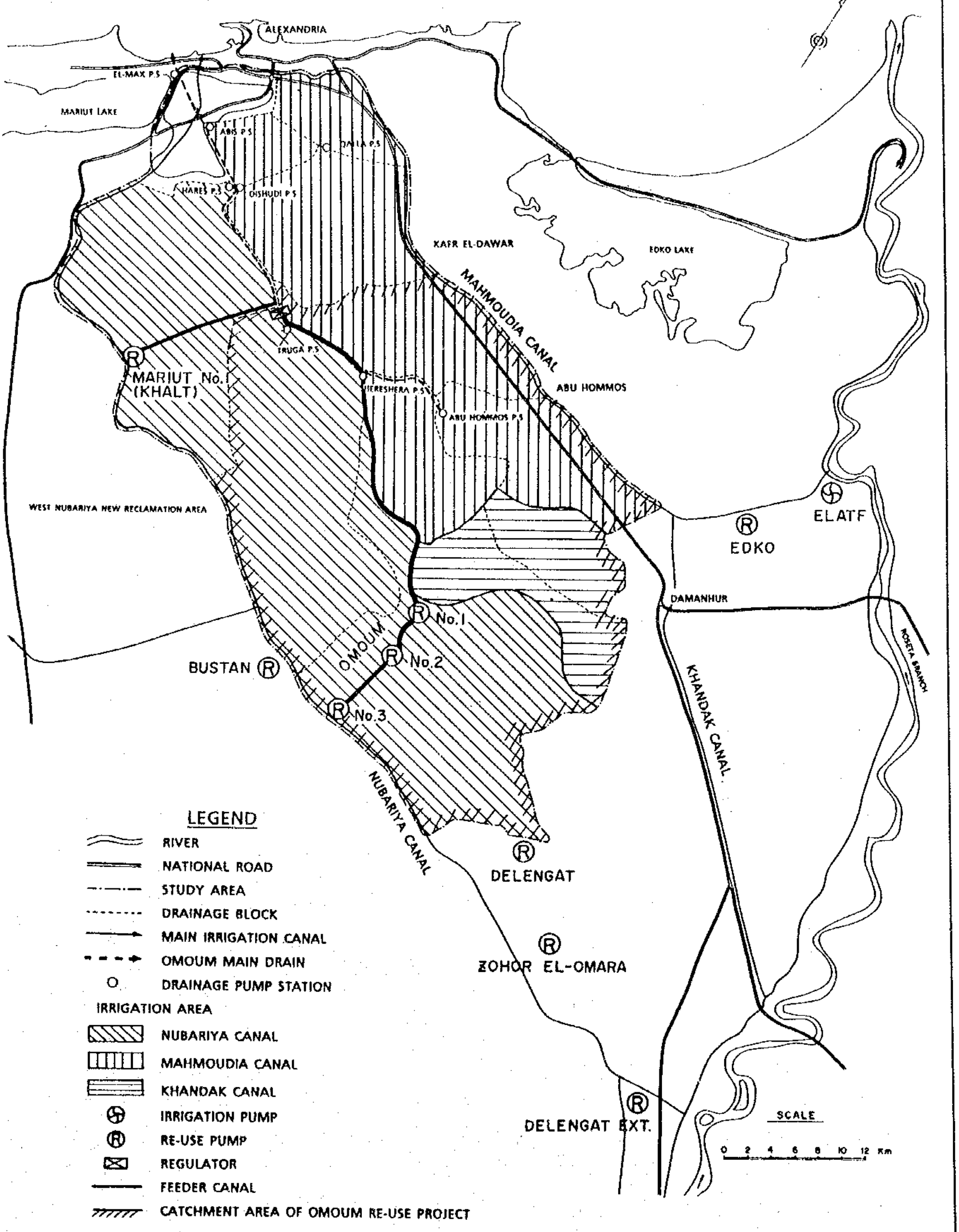
Irrigation Network	Command Area		Percent
	(ha)	(fed)	(%)
Nubariya Canal	92,880	221,140	54
Mahmoudia Canal	61,550	146,540	36
Khandak Canal	16,870	40,180	10
Total	171,300	407,860	100

Figure 3-7 shows the present irrigation and drainage networks and reuse plan in the Study Area.

3. 6. 2 Irrigation Water Rights around the Study Area

Water requirements for the command areas of the above mentioned two major irrigation networks were calculated and compared with the actual intake discharge of 1993. The results show that the intake rate of Nubariya canal could cover only 81 percent of the total requirement, which means this canal network has a shortage of irrigation water almost all year round. On the other hand, the Mahmoudia canal has 105 percent intake rate which proves that this canal network has adequate water.

FIGURE 3 - 7 IRRIGATION AND DRAINAGE NETWORKS IN STUDY AREA AND REUSE PLAN



Water Requirement and Actual Intake (1993)

Canal Name	Command Area (feddan)	Water Req. (MCM)	Actual Discharge (MCM)	Intake Rate
Nubariya Canal	820,480	5,895	4,777	0.81
Mahmoudia Canal	258,840	2,856	3,013	1.05
Total	1,079,320	8,751	7,790	Ave. 0.89

3. 6. 3 Water Supply and Management

1) Water Balance

The water balance for the whole Study Area was calculated using the irrigation intake discharge and the drainage discharge of the related pumps. The result shows that in June of the summer season the rate of intake water and the drainage are 7.1 mm and 3.8 mm, respectively. The balance of 3.3 mm could be assumed as evapotranspiration. On the other hand, in the winter season, the drainage rate is higher than the irrigation intake rate, which is considered to be due to the influence of rainfall.

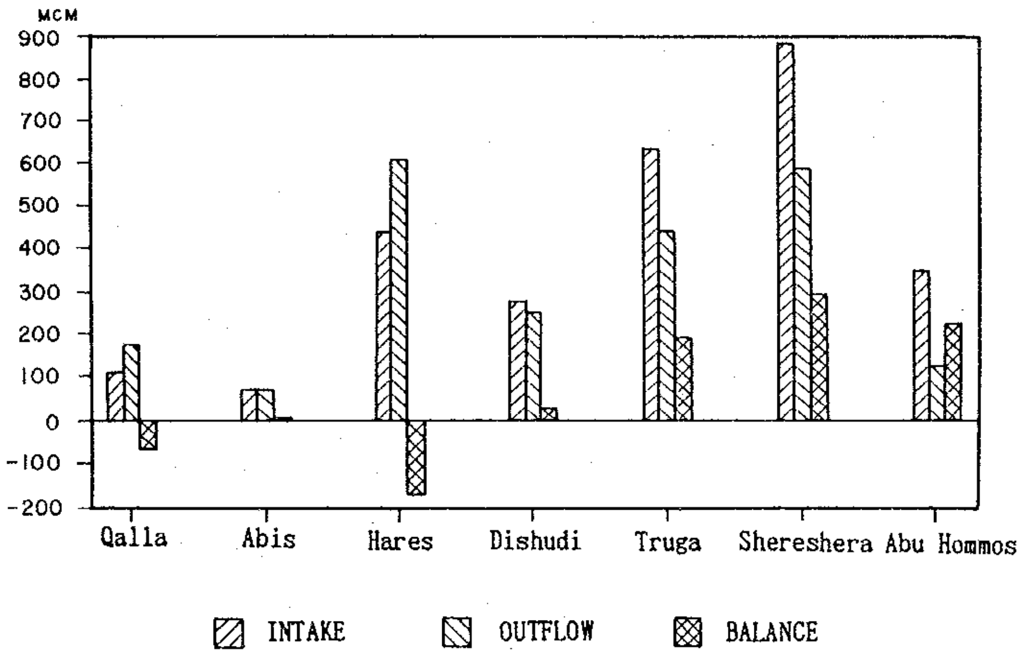
In the drainage block-wise water balance, three upstream blocks indicate that the irrigation water rate is higher than the drainage rate. Facts are shown in the following figures.

2) Water Management

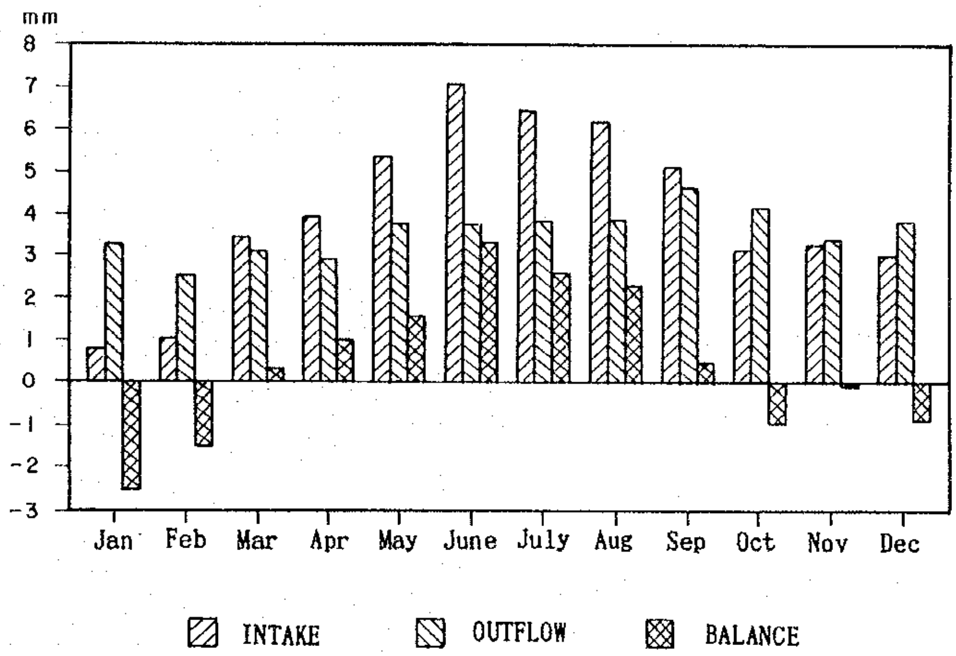
The areas served by the Nubariya canal have a rotation of 5-days irrigation and 10-days pause, while in the case of Mahmoudia canal, 5-days irrigation and 5-days pause. The latter has a high irrigation frequency because of the higher ratio of paddy cultivation.

The irrigation water is lifted from the sub-lateral canal (Mesqa) using the traditional method (Saqia) or a portable pump and is supplied to the field through the field trench Marwa). The ratio of the pump lifting has recently been about 70 percent. Because of the preference taken by the upstream users and the high ratio of pump irrigation, the present irrigation system is suffering

Water Balance of Each Block in 1993



Irrigation Water and Drainage Discharge in Study Area in 1993



from over-irrigation, which sometimes causes shortages of water downstream from the main canal.

The irrigation water from the main canal to the lateral canal is taken through the sluice gates. Some of the gates have become superannuated and do not function properly. The proposed irrigation water of each canal system is calculated on the basis of total commanded area. It seems that the net irrigated area is not well understood by the Irrigation Department.

3.6.4 Reuse of Drainage Discharge

There are seven reuse facilities in and around the Study Area. Two of them, namely, Omoum Drain Project and Zohol El-Omara are currently under construction. The present reuse quantity of drainage discharge is 570 MCM as shown in the following table.

Drainage Reuse Facilities

Project Name	Drain name	Feeding Canal	Annual Discharge (MCM)
Kheneza	Delengat Ext.	Nubariya Canal	52
Bustain	Tahady Drain	Nubariya Canal	46
Mariut No. 1	Omoum Main Drain	Nubariya Canal	108
Delengat	Delengat Drain	EL-Hagel Canal	179
Edko	Edko Drain	Mahmoudia Canal	185
Omoum Drain Project	Omoum Main Drain	Nubariya Canal	under const.
Zohol El-Omara	Sidi Aisa Drain	EL-Hager Canal	under const.
Total			570

In addition to the above motioned reuse projects, local people who experience water shortages divert drainage water directly from the Omoum main drain through gated structures or low-lift pumps into their fields.

3.7 Drainage Conditions

3.7.1 Present Drainage Conditions

1) Drainage System

The Study Area is divided into seven drainage blocks and the Mariut Lake. The total drainage area is about 430.6 thousand feddan (180.7 thousand hectares)(refer to Gigure 3-7). Each block has a drainage pumping station and the water level of Omoum main drain is maintained to the optimum delivery level at which drainage discharge from the field can be drained to the Omoum main drain, while keeping the field groundwater level lower. At the extreme downstream of the Omoum main drain, the El-Max pumping station drains all discharges that come from the seven blocks to the Mediterranean Sea.

2) Drainage Network

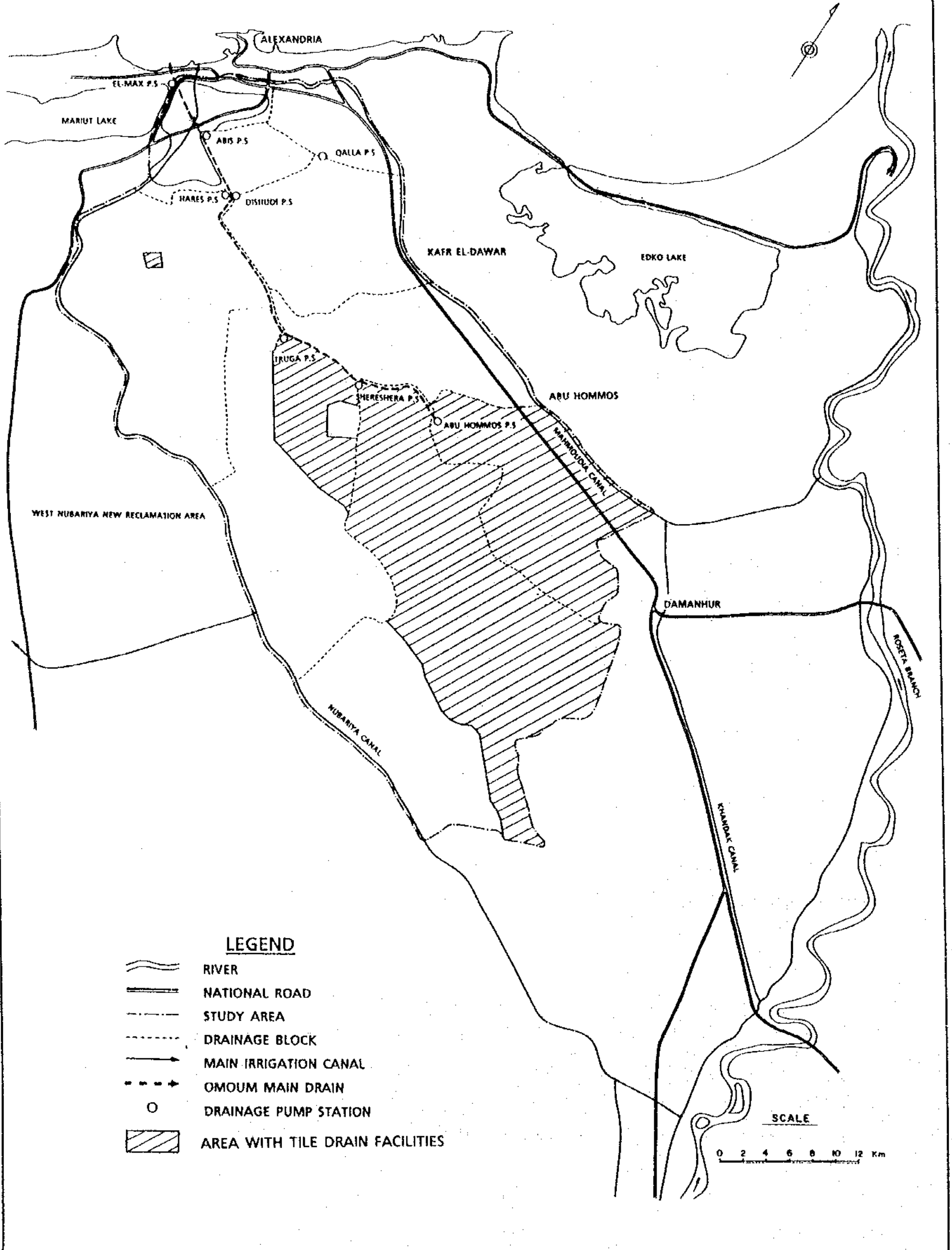
The drainage systems in the Study Area are networks of field ditches, collectors, lateral open drains, main drains in blocks and the Omoum main drain. The excess water from the field is drained by the drain ditches or the lateral drains of the subsurface drainage. To avoid water logging and salinity damage to the agricultural land, control of groundwater level through implementation of tile drain is in progress.

a) Areas with Tile Drain

In the Study Area, areas where the tile drain system has already been implemented are Abu Hommos, Shereshera and a part of Truga areas (see Figure 3-8).

All of these areas are in the upstream of the Study Area. The lateral drains of the system are made of PVC pipe, whose minimum inside diameter is 72 mm. The pipes are laid down by a mechanical method at a depth varying from 1.2 to 1.4 m below the ground surface. The collectors are mainly made of precast concrete pipes and the length varies from 500 to 3,000 m.

FIGURE 3-8 LOCATION OF INSTALLED SUBSURFACE TILE DRAIN FACILITIES



There are now two types of tile drain layout; the conventional type and the modified type, which shows a better performance to control the groundwater level. The latter type consists of a main collector drain and a number of sub-collectors. In the areas close to the paddy fields, the groundwater level seems to be higher and the modified type is better to be applied for a good management of the groundwater level. However, this types are not generally accepted by the farmers because this system needs complete avoidance of free crop cultivation to secure the benefit. Then, the conventional types are prevailing in the Study Area(refer to Figure D-2-4, Annex D)

The bottom of the collector outlet is at least 0.25 m above the flood water level in the open drain. This height is maintained for a free fall of the groundwater discharge to the drain. However, submergence of these outlets was observed in some parts of the area in which tile drains have been implemented. As the implementation of tile drains proceeds, the fields drain ditches will disappear. This may result in poor drainage of the surface runoff generated by excess rainfall during the winter season.

b) Areas without Tile Drain

The downstream areas of the Study Area, namely, Truga, Hares and Abis drainage blocks have not yet been provided with tile drains. The drainage of these areas is dependent on field ditches, or on direct infiltration to the block's open drain which has a comparatively deeper bed level of three to four meter below the ground surface.

3) Status and Reasons for Poor Drainage

a) Omoum Main Drain

The water levels in each drainage block are relevant to the water level in the Omoum main drain. They are maintained through the relationship of suction and delivery water levels of drainage pumps. At present, the water level of Omoum main drain is maintained at an elevation of (-) 2.70 m. MSL for fish culture in Mariut Lake. This water level is higher than the design water level of (-) 3.25 m. MSL Because of this, the water level of each drainage block is about 0.5 m higher than the design level. This higher level hampers the flow of collectors into the open drain and adversely affects adversely the performance of tile drain. The above mentioned situation is the main cause of the poor drainage in the Study Area.

b) Individual Drainage Blocks

Abu Hommos Area;

This area is located in the extreme upstream of the Study Area. The ground elevation is relatively high and there are some areas where gravity drainage may be possible. Tile drains have already been implemented in the entire area. Because of poor implementation methods or high water levels in the drains, performance of tile drain is low in some areas.

Shereshera Area;

This area is the biggest drainage block and occupies about 33 percent of the Study Area. Except EL-Hager canal area, the entire area of this block has been provided with tile drains. In the middle reaches of the area, there are some depressions and drainage is comparatively poor. The reasons are the same as in Abu Hommos area.

Truga Area;

Only 19 percent of this area in the middle of the block is under tile drain. The area with lowest elevation is far away from the pump station, therefore the drain bed elevation at the downstream section should be lowered from the present level. Moreover, density of drains should be increased for more effective field drainage.

Dishudi Area;

Implementation of tile drain has not yet started in this area. Due to the presence of depressions in the middle of the block, drainage is poor. Moreover, the capacity of the pump and the drains is insufficient.

Hares Area;

Apart from an area of 500 feddan (210 ha) which is a pilot project, the entire area is waiting for implementation of tile drains. The drain has enough depth but does not have sufficient cross-section to cope with the pump's capacity. Moreover, pumps and other facilities are very old. Therefore, replacement of these facilities is necessary.

Abis Area;

This area has no tile drains yet. The groundwater level is the highest in the Study Area. Therefore, in case of tile drain implementation, spacing of laterals should be shorter than in the other blocks.

Qalla Area;

This area is also without tile drains. The capacity of the open drain is insufficient. The water quality of the discharge drained from the East Treatment Plant should be improved.

However, the above mentioned facts will be verified during the Phase-II Field Study which will take place during the coming winter season.

4) Flood Season and Its Drainage

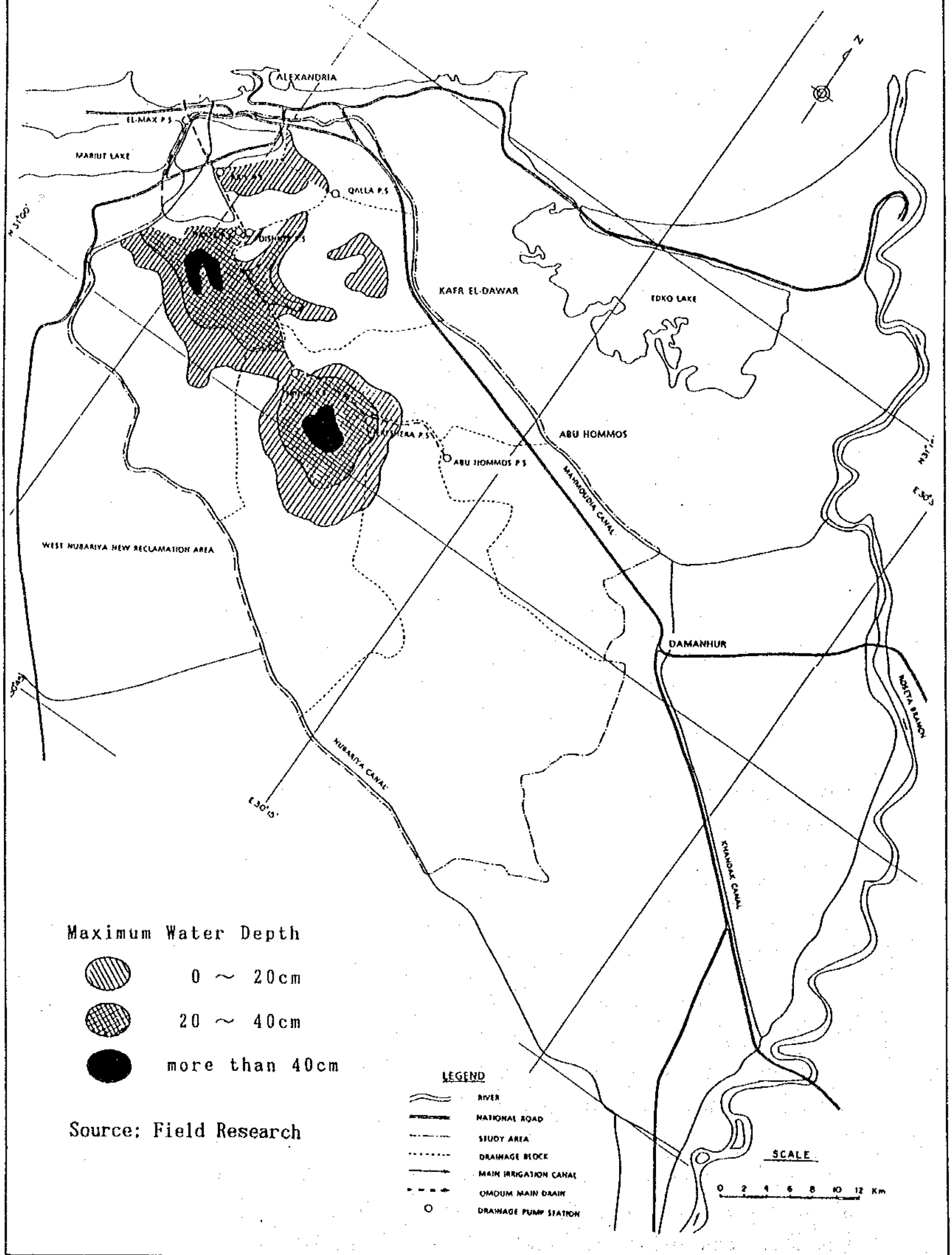
a) Characteristics of Rainfall Runoff in Semi-Arid Zone

The Study Area is located in the semi-arid zone with an annual rainfall of about 100 mm in Damanhur and 200 mm in Alexandria. In the winter season from November through March, the daily rainfall is only about 10 to 20 mm, and hardly exceeds 30 mm. Since the Study Area is very flat with a slope of less than 1/10,000, an excess rainfall inundates in the low elevated areas and the winter upland crops are frequently suffered from a long time submergence.

In December, 1991 the monthly rainfall of 167 mm is observed in the Study Area. In particular, the lower reaches of Abis, Hares, Dishudi and Trouga blocks were suffered from a big flood damages. From some hearings of the farmers the inundation period was more than one to two weeks. There were big submerged damages in the Hares and the Truga areas and the maximum water depth was more than 40 cm. This flood gave big damage in winter upland crops (potato, berseem and wheat etc.).

From the hearings at the fields and the estimation using the suction water levels of the pumping stations and the flood water level, the inundation area was estimated as shown below (Refer to Figure 3-9.).

FIGURE 3-9 INUNDATION DAMAGE MAP IN DEC., 1991 FLOOD



Inundation Damage in December 1991 Flood

Area	Drainage Area	Inundated Area	Rate	Inundation Depth	Inundation Period
	(ha)	(ha)		(m)	(weeks)
Qalla	5,880	630	0.11	0.2	0.5
Abis	3,780	1,050	0.28	0.1	0.5
Hares	26,600	7,980	0.30	0.5	1~2
Dishudi	15,330	2,100	0.14	0.3	1
Truga	43,080	7,560	0.18	0.5	1~2
Shereshera	56,720	970	0.17	0.3	0.5
Abu Hommos	19,910	-	-	-	-
Total	171,300	20,290	0.12		

Note : Above data are obtained by verbal information at field and estimated on the basis of pump suction water level.

b) Flood Situation in West Nubariya Drain Basin

The catchment area of this basin is adjacent to the Study Area. It was reported that in December 1991, about 200 houses were damaged and some parts of the area were submergenced for about ten days. EPADP took different countermeasures to avoid damage. It was reported that to get rid of excess water quickly, extra pumps were used. Diversion of the excess water to the Nubariya canal was also tried. In fact, the West Nubariya drain has a big and wide basin of 280 thousand feddan, which is equivalent to 70 percent of the Omoum drain area. Moreover, its land slope is more than 1/1,000. Due to the above mentioned reasons, the flood situation in this area is different from that of the Omoum Area. This area is basically an independent area and outside the Study Area.

3.7.2 Main Drainage Facilities

1) Drains and Related Structures

a) Omoum Main Drain and BranchDrains

Omoum Main Drain

Omoum main drain starts its upstream edge at the point of Abu Hommos pump station and located in the middle-stream of the Study Area. It crosses Nubariya navigation canal in Mariut Lake through a siphon and finally reaches the El-Max pumping station after running about 41 km (refer to Table G-1-1, Annex G).

This drain is unlined and has a eroded side slopes and sedimented bed, which is hampering its drainage capacity. Cross section of the drain is trapezoidal with a side slope of 3 : 2. The bottom width of the drain is between 10 m and 40 m. The bed slope varies from 3 to 5 cm/km (1/30,000 to 1/20,000). These criteria lead to a gentle flow velocity of about 0.5 m/sec at design discharge (refer to Table G-1-2, Annex G).

An analysis was performed using existing cross-sections with same design discharge (max. 102 cu. m/sec), and a comparison was made between the old and new water surface profiles as presented in the table below;

Comparison of Water Level

Point	Design Water Surface Profile (m. MSL)	Analyzed Water Surface Profile (m. MSL)
EL-Max	(-) 3.25	(-) 3.25
Abis	(-) 2.70	(-) 2.33
Hares	(-) 2.80	(-) 2.12
Dishudi	(-) 2.63	(-) 2.09
Truga	(-) 2.00	(-) 1.59
Shereshera	(-) 1.60	(-) 1.29
Abu Hommos	(-) 0.80	(-) 1.13

As it is seen in the above table, analyzed water surface profile is much higher than the designed one. This will affect all the pump capacity in the upstream, which means that they will not be able to drain necessary water from the respective drainage block(refer to Table G-1-2, Annex G).

During the field survey it was found that the embankments of this drain have been cut in many places, especially in a 10 km length within Mariut Lake. The purpose of these cuts is to supply water into the Lake to maintain high water level and good water quality. Therefore, it is necessary to examine the capacity of this main drain for any increase of drainage volume in the future.

Branches

There are six main branch drains connecting with the Omoum main drain, which are also unlined. The side slope of these drains is 3 : 2, and bottom width varies from 2 m to 18 m with a bed slope of 8 to 30 cm/km (1/12,000 to 1/3,000). In order to maintain water level low for tile drain systems, the drain depth is kept about five meters below the land surface and minimum design water level is kept 2.5 m below the land surface.

Existing conditions of these branch drains are also the same as the Omoum main drain with broken side slopes and sedimented bed. Moreover, floating aquatic plants are also observed in the immediate upstream section of each pumping station. These facts decrease the cross-sectional area of flow and influence the pumping operations.

Major dimensions of branch drains are summarized as follows (refer to Figure G-1-1, Annex G).

Major Dimensions of Branch Drains

Drainage Block	Mina Drain				Branches			Density of Drains
	Catchment Area	Lengh	Bed Width	Bed Slope	Length	Bed Width	Bed Slope	Length/ Catchment Area
	(ha)	(km)	(m)	(cm/km)	(km)	(m)	(cm/km)	(m/ha) (m/feddan)
Qalla Area	5,880	5.0	5.0~6.0	15	12.9	1.0~3.0	10~37	3.0
	14,000							1.3
Abis Area	3,780	5.0	3.0~4.0	33	22.0	2.0	15~20	7.2
	9,000							3.0
Hares Area	26,600	24.0	2.0~18.0	10~25	113.0	1.0~4.0	10~40	5.1
	63,330							2.2
Dishudi Area	15,330	7.8	5.0~6.0	23	57.3	2.0~6.0	10~60	4.2
	36,500							1.8
Truga Area	43,080	13.8	2.0~5.0	15	175.0	1.0~8.0	10~55	4.4
	102,570							1.8
Shereshera Area	56,720	23.8	6.0~18.0	12	153.3	1.0~5.0	10~40	3.1
	135,060							1.3
Abu Hommos Area	19,910	6.9	10.0~11.0	9	101.1	1.0~10.0	15~30	5.4
	47,400							2.3
Total	171,300	86.5			634.6			Av. 4.2
	407,860							1.8

b) Nubariya Siphon

Nubariya Siphon which is a reinforced concrete structure was constructed in the 1975s. The current condition of this siphon is good except for some portions of the manhole, stop-log gate and revetments. The main problem is the sedimentation resulting from poor maintenance. It was learnt that no maintenance work has been done during the last twenty years.

Major Dimensions of Nubariya Siphon are as follows (refer to Figure G-1-2, Annex G);

- Bed elevation : (-) 8.15 to (-) 9.60 m. MSL
- Cross section : 3.2 m × 3.2 m × 8 sections
- Length : 190 m
- Designed discharge : 93 cu.m/sec

c) Sedimentation in Drains

Since the Omoum main drain and main drains of each drainage block are unlined, erosion of the side slopes and sedimentation on the drain beds are unavoidable. Therefore, EPADP is performing some maintenance work annually, such as dredging, clearing away aquatic plants like reeds, water hyacinths and so on. This maintenance works is a prerequisite to maintaining smooth drainage flow.

d) Obstacles in Omoum Main Drain at the Vicinity of the El-Max Pumping Station

Bridge in the Immediate Upstream Section of the El-Max Pumping Station

There is a railway bridge and pipelines about 100 m upstream of the El-Max pumping station. Due to accumulation of sand and bridge piers, the hydraulic cross section at this point is narrow compared with other sections and the flow in this section becomes critical velocity. Therefore, it is essential to widen this cross section. However, another bridge is presently under construction by the Railway Department (refer to Figure G-1-3, Annex G), and it is assumed that the problem will be solved in the near future.

Discharge-Channel at Downstream of the El-Max Pumping Station

The cross section of discharge-way from the El-Max pumping station to the Mediterranean sea has been altered from the original one, which has resulted in a narrower cross section. Many houses have been built on both the banks of this discharge-channel and the inhabitants of this area are using it for boat traffic.

Although some rehabilitation work using masonry has been performed, the bottom is still unlined. According to the information/data, the El-Max pumping station could not operate to its full capacity during the flood of December 1991. The record shows that the maximum discharge was 115.0 cu.m/sec, whereas maximum capacity is 125.0 cu.m/sec. This fact leads to the conclusion mentioned above, due to the low capacity of the discharge-channel. It is assumed that Mariut Lake has acted as a flood regulation reservoir during flooding times.

Water Level in Omoum Main Drain

The existing water level of Omoum main drain is not the same as the designed water level. At present, water level in the extreme downstream section on the El-Max suction side is maintained between (-) 2.80 m. MSL and (-) 2.70 m. MSL, which seems to be a compromised water level between the agriculture and fishery sides. Due to this new water level, all upstream pumps' delivery water levels have become 30 ~ 60 cm higher than the designed water levels. The only exception is the Shereshera pumping station (refer to Figure G-1-4, Annex G).

2) Drainage Pumping Station

The Study Area covers about 430 thousand feddans (about 180 thousand hectares) and are divided into eight drainage blocks. One or two drainage pumping stations are provided in each block because the gravitational drain system can not be applied due to its topographical conditions.

The drainage water are mainly composed of an excess water from the irrigation throughout a year, although there is small rainfall during the winter season. 10 drainage pumping stations, in total, are provided in the Study Area.

The El-Max pumping station, main pumping station, is located at the lower reach of the Omoum main drain surrounded by Mariut Lake and drains the total amount of water from the Study Area into the Mediterranean Sea. All other pumping station is located along the Omoum main drain and drains directly their water into the Omoum main drain, except Qalla pumping station, which drain its water into Mariut Lake at first and into the Omoum main drain secondarily through the connection gate.

Hence, two stage pumping drainage system are applied in the Study Area. Some design features for each pumping station are shown in Table 3-2 and 24 hour operation are practiced. As a result of the review of the collected data and site survey, the followings are found out:

- Overage of Drainage Pumps

  All pumping station had been established in 1950 to 1970 although the El-Max pumping station was first established in 1888. In the end of 1980's, the mechanical and electrical equipments have been replaced at the most of pumping stations except the El-Max (1) pumping station and the Hares pumping station. The mechanical and electrical equipments for the said both stations are seen to be overage since 31 and 26 years have been passed after their first operations (refer to Figure.3-10).

- Types and Numbers of Pumps and Prime Movers
  - Two to six units of pumps are provided at each pumping station depending upon its total design discharge of 5.4 to 62.5 cum/sec.
  - Inclined shaft axial flow pump or vertical shaft axial flow pump are applied at each pump station depending upon its per unit design discharge and total head.
  - Electrical motor are applied as prime movers at each pumping station.
  - Main mechanical and electrical equipments are imported from Japan, Germany, Hungary, etc..

- Pump Operation System

  The pump operation is carried out to maintain the required suction water level by mutual agreement of various organizations involved. The pumps, overhead crane, stoplog, etc. are manually operated.

Table 3 - 2 List of Existing Pumping Stations

① Pumping Stations

No.	Name of Pump Station	Area (F)	Estab-lished	Replacement (Proposed)	Total Discharge (cu.m/s)	Nos of Pumps (sets) Total (set)	Nos of Pumps (sets) Stand-by	Power Source	Running Condition	Structure	Trash Rack	Over Head Crane	Remarks
1	EL-MAX (NEW)	300,000	1950	1983 (2005)	62.50	6	1	Electric	◎	Good	Auto	Manual 8.0	q;cum/f/d 36
	EL-MAX (OLD)		1963	Urgently	62.50	6	1	Electric	●	Good	Auto	Manual 10.0	
2	QALLA (1)	24,000	1958	1986 (2006)	10.00	3	1	Electric	○	Good	Manual	Manual 5.0	Sewage water ? 94
	QALLA (2)		1979	1990 (Not Fixed)	5.00	2	1	Electric	○	Good	Manual	Manual 10.0	
3	ABIS	8,000	1968	1990 (2010)	5.40	4	1	Electric	◎	No Pump House	Manual	Manual	58
4	HARES	65,000	1968	Urgently	24.00	4	1	Electric	●	Reinforced	Auto	Manual 7.5	32
5	DISHUDI	60,000	1958	1989 (Not Fixed)	12.00	3	1	Electric	○	Repaired	Manual	Manual 10.0	17
6	TRUGA	103,000	1967	1990 (Not Fixed)	32.00	5	1	Electric	○	Good	Auto	Manual 10.0	27
7	SHERESHERA	150,000	1977	(1998)	40.00	6	1	Electric	○	Good	Manual	Manual 10.0	23
8	ABU HOMMOS	45,000	1967	1990 (Not Fixed)	25.00	6	1	Electric	◎	Good	Manual	Manual	48

Data Source: MED Notes: ◎ Very good ○ Good at present ● Well but maintenance works are costly

② Pump Dimensions

No.	Name of Pump Station	Dimensions of Pump Facility (per one set) Capacity (cum/s)	Pump Type	Bore (mm)	Head (m)	Out Put (kw)	Power Line Voltage (kw)	Power Line Cycle	Flap Valve	Design Level (El.m) Suction	Design Level (El.m) Delivery	Static Head (m)	Product of Pump
1	El-MAX (NEW)	12.50	Inc. Axi. F	2,300	4.00	800		50	With	-3.25	0.75	4.00	Germany
	El-MAX (OLD)	12.50	Inc. Axi. F	2,300	4.00	700	66,000	50	With	-3.25	0.75	4.00	Japan
2	QALLA (1)	5.00	Ver. Axi. F	1,400	4.50	242	11,000	50	With	-6.50	-2.50	4.00	Germany
	QALLA (2)	5.00	Inc. Axi. F		4.50	315	11,000	50	With	-6.50	-2.50	4.00	Austria
3	ABIS	1.80	Ver. Axi. F		5.00	98	11,000	50	None	-7.80	-2.70	5.10	Hungary
4	HARES	8.00	Inc. Axi. F	1,800	3.20	350	11,000	50	With	-6.00	-2.80	3.20	Japan
5	DISHUDI	6.00	Inc. Axi. F		3.12	215	66,000	50	With	-5.75	-2.63	3.12	Germany
6	TRUGA	8.00	Inc. Axi. F		2.90	355	11,000	50	With	-4.90	-2.00	2.90	Hungary
7	SHERESHERA	8.00	Inc. Axi. F	1,800	2.65	236	11,000	50	With	-4.25	-1.60	2.65	Yugoslavia
8	ABU HOMMOS	5.00	Inc. Axi. F	1,400	2.10	165	11,000	50	With	-2.62	-0.80	1.82	Japan

Data Source: MED Notes: Inc. Axi. F Inclined shaft axial flow pump
Ver. Axi. F Vertical shaft axial flow pump

- Design Pump Capacity and Observed Monthly Maximum Discharge in Each Pumping Station

  The design pump capacity and observed monthly maximum discharge in each station are as follows:

Pumping Station	Design Discharge (cu.m/sec)	Observed Max. Discharge		Ratio (%)	Observed Date
		(MCM/month)	(cu.m/sec)		
	(1)		(2)	(2) / (1)	
El-Max	125.00	284.14	106.10	85	Jan. 1988
Qalla	15.00	24.15	9.02	60	Aug. 1992
Abis	5.40	8.29	3.20	59	Sep. 1992
Hares	24.00	65.75	24.55	102	Aug. 1991
Dishudi	12.00	33.01	12.74	106	Sep. 1993
Truga	32.00	79.87	29.82	93	Oct. 1991
Shereshera	40.00	68.63	25.62	64	Oct. 1990
Abu Hommos	17.06	25.00	6.58	26	Sep. 1991

  Referring to the above table, the existing monthly maximum discharge in the El-Max pumping station have been observed in January, while that in other pumping stations in August to October. It can be explained the monthly maximum discharge in the El-Max pumping station are obviously effected by rainfall. And also, it can be said that the design pump capacity in the El-Max, Hares, Dishudi and Truga pumping station live rather in needy circumstances, comparing the design pump capacity (column (1)) and the observed maximum discharge (column (2), average value).

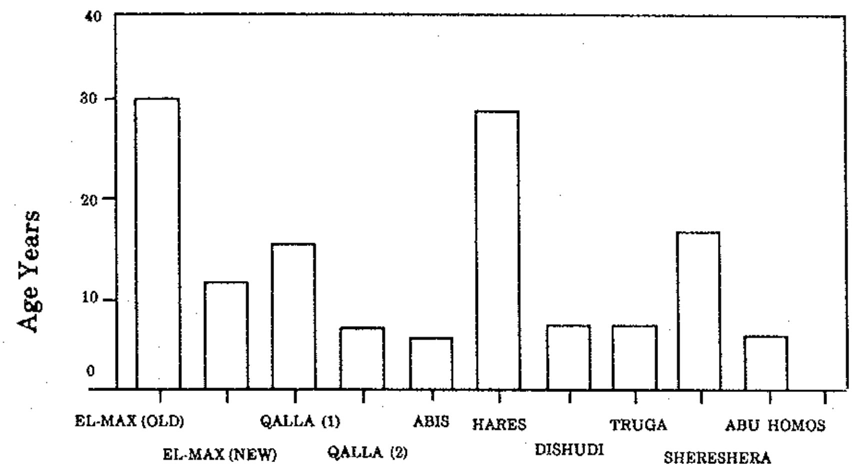
  Moreover, those drainage blocks have higher priority on the area development through the improvement of inundation conditions due to rainfall than other blocks, considering those are located in the down stream side of the Study Area. Meanwhile, the observed daily maximum discharge in the El-Max pumping station is 120.8 cum/sec in November, 1994.

- Referring to Figure 3-10, the accumulated pump operation hours up to June, 1994 in the El-Max and Hares pumping stations are more bigger than those in other stations and are shown below:

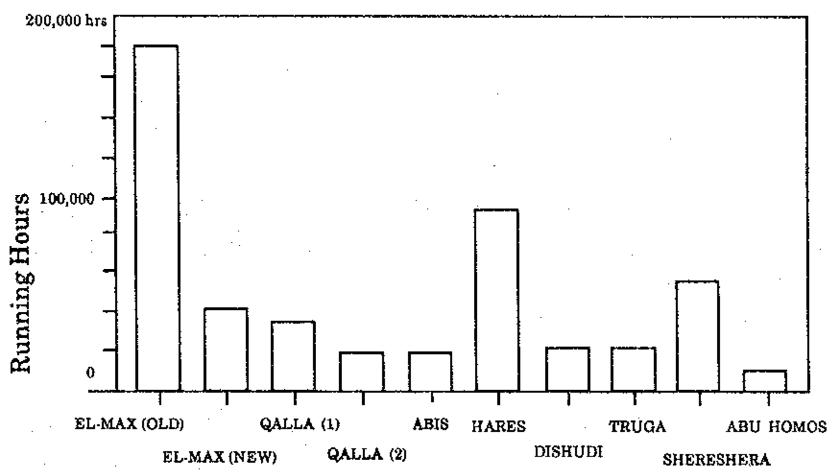
Pumping Station	Accumulated Pump Operation Hours
El-Max	144,500 ~207,400 hr/unit (1963~June, 1994)
Hares	74,000~87,000 hr/unit (1968~June, 1994)

FIGURE 3-10 AGE AND RUNNING HOURS OF EXISTING DRAINAGE PUMPS

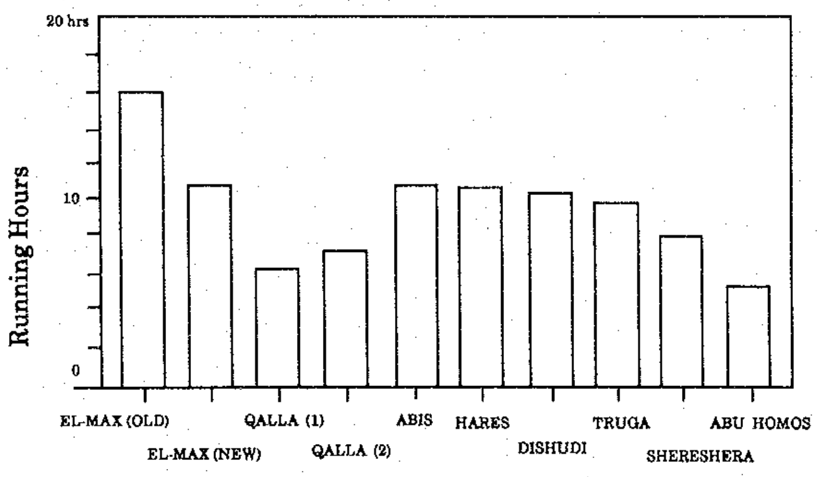
① Pump Age



② Total Running Hours (hr/set)



③ Mean Running Hours (hr/set/day)



The pumps are operated parallel in each pumping station. The daily average pump operation hours per unit in the El-Max (1) pumping station is 16 hours. Moreover, the accumulated pump operation hours of No.3 pump in the said pumping station are 32,346 hours for 4 years from 1990 to 1993 and its daily average pump operation hours per unit is 22 hours.

- The design suction water level in the El-Max pumping station was originally planned at (-) 3.25 m. MSL. However, the present suction water level become around (-) 2.70 m. MSL (Refer to Figure 3-11). The maximum suction water level in the said pumping station was (-) 1.86 m. MSL observed during the flood in December, 1991 and the perimeter of Mariut Lake were damaged by the inundation. The full pump operation including one stand-by unit were not employed at that time and the observed maximum pump discharge was 115 cu.m/sec at the delivery water level of (+) 0.95 m. MSL against the design delivery water level of (+) 0.75. m. MSL

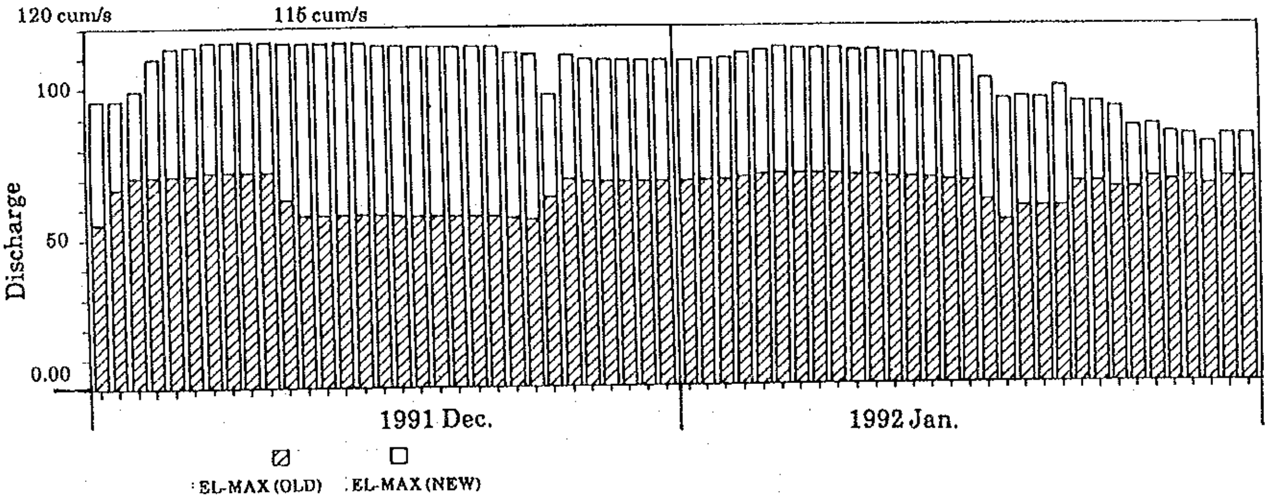
- It was observed the platform of inlet drain and outlet basin in some pumping station were under the submerged condition in order to maintain the suction water level and the delivery water level as high as possible. It makes the operation and maintenance of stop-logs, trash racks, flap valves, etc. difficult and also causes the corrosion of the said equipments.

- The El-Max (1) and Hares pumping stations have been established in 1963 and 1967 respectively. The facilities in the said pumping station have been repaired many times and some of main equipments have been already replaced. However, further repairs and replacement for the remaining facilities are required in the near future since those lifetime have been already consumed. As a result of the flow measurement, it have been observed the pump capacity in the El-Max (1) and Hares pumping stations seemed to be deteriorated at 80~85 percent of its design capacity.

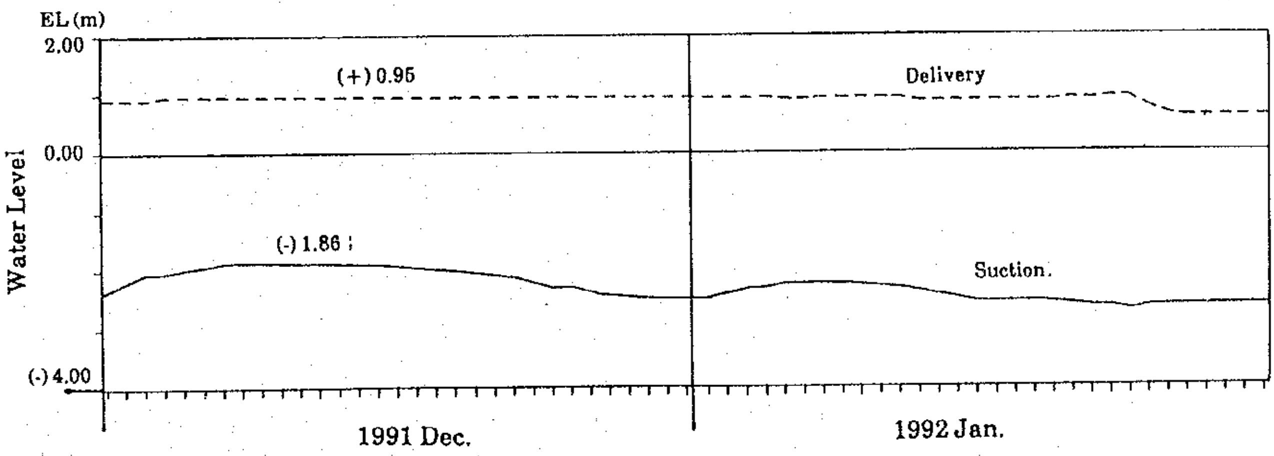
  The history of replacement for equipments in the El-Max (1) and Hares pumping stations are described below:

FIGURE 3 - 11 PUMP DISCHARGES AND WATER LEVEL AT THE EL-MAX PUMPING STATION (DEC. 1991 TO JAN. 1992)

① Discharge



② Water Level



El-Max (1) Pumping Station

1993 : Replacement of No.1 pump
1987 : Replacement of reduction gear for No.2 pump
1992 : Replacement of reduction gear for No.1 pump
1993 : Replacement of reduction gear for No.6 pump
1994 : Replacement of reduction gear for No.4 pump

Hares Pumping Station

1992 : Replacement of motor for No.2 pump
1994 : Procurement of a motor

The procurement of main equipments are rather difficult from the viewpoint of both delivery period and budgetary arrangement because those equipment are made in the foreign countries. For example, four years from 1990 to 1994 were required for the procurement and installation of No.4 pump in the El-Max (1) pumping station.

- It is observed the corrosion was developed on the casings, impellers, bearings, shaft, etc. of pumps due to the salinity and chemicals of drain water in some pumping station. Qalla pumps drains black colored sludge.

- The columns and beams of the pump house are made by the reinforced concrete, while the wall are made by the bricks. The pump house are very old except that of the Abu Hommos pumping station. The pump house in the Hares pumping station are reinforced by supporting wall against its inclination, due to uneven settlement. There is no pump house in the Abis pumping station. Generally speaking, the interior of the pump house is tidy and it is observed the reinforcement bars are exposed at the exterior surface of columns and walls in some pumping stations.

- The power supply for each pumping station are stable since last several years. Any significant voltage drop are not observed. For example, the shutdown of pump operation by the power failure in the El-Max pumping station has not been observed since 1990.

- The operation and maintenance in each pumping station are under favorable conditions.

  - The daily routine maintenance works are carried out for pump operation and the overhaul for main equipments are carried out at every 10,000 operation hours in average.

  - All the pumps in each pumping station are always ready for their operation.

  - The replacement of main equipments in each pumping station have been carried out in every 10 to 20 years. The replacement plan in each pumping station are on going except those of the El-Max and Hares pumping stations.

  - The operation and maintenance costs are composed of the power tariff and the spare part's fee. Annual power tariff and spare part's fee are LE.8,500 thousand and LE.1,000 thousand respectively for all pumping stations and the total costs are shouldered by the Government.

From the above, the problems encountered with the existing pumping stations are summarized as below:

- The El-Max pumping station, which has her long history since 1888, plays a very important role in the Study Area.

- The replacement plan for the El-Max and Hares pumping stations faces to difficulty for its realization from the viewpoint of budgetary problem, although they are urgently required for the relief of high maintenance costs including spare parts.

3.7.3 Subsurface Drainage Plan

Subsurface drainage projects in Egypt by means of tile drains were started at the beginning of the 1960's by financial assistance of UNDP and the World Bank. In 1978, the drainage policy was revised to include long-term planning until the year of 2000. According to the Government target, about 5.5 million feddan (2.3 million hectares) of land will be provided with tile drainage by the year 2000.

Out of the whole Study Area of about 430 thousand feddan (180.7 thousand hectares), cultivated land is about 138 thousand feddan (58 thousand hectare). According to the latest information, 44 percent of this cultivated area has been provided with tile drains. Block-wise implementation rate is presented below;

Area provided with Subsurface Tile Drain

Drainage Block	Cultivation Area	Tile Drain	Rate
	(ha)	(ha)	(%)
Qalla Area	5,000	0	0
Abis Area	3,210	0	0
Hares Area	22,650	210	0.9
Dishudi Area	13,030	0	0
Truga Area	32,620	6,180	18.9
Shereshera Area	38,760	34.250	88.4
Abu Hommos Area	17,360	17,360	110.0
Total	132,630 (315,800 feddan)	58,000 (138,100 feddan)	43.7

Subsurface tile drains in the Study Area have been implemented under a project, titled "Drainage Project 5". In this project plan, unit drainage discharge has been considered as 1.5 mm/day. The spacing for lateral drains has been set at between 20 to 80 m according to the soil, geographical and land-use conditions, maintaining 67 m as an average (refer to Table D-2-5, Annex D).

According to a field measurement (Aug. 1994) in Shereshera block, discharge from laterals was observed to be 1.2 mm/day (August) to 1.7 mm/day (February), additional study will be needed in the Phase-II field works, because the rate is too low. The target of tile drain was to reduce the groundwater table from 0.81 m to 1.2 m below the ground surface. But from the field investigation, it was found that the groundwater table is only about 1.13 m below ground surface, which means that the target has not been met.

3.7.4 Operation and Maintenance of Drainage Facilities

1) Operation and Maintenance Organization

Major drainage facilities in the Study Area are Omoum main drain, drains, operation and maintenance roads along drains, subsurface tile drains, and drainage pumps. Operation and maintenance (O & M) works of these facilities except drainage pumps are under the responsibility of EPADP, while those of drainage pumps are under MED, respectively.

However, actual O&M works for former drainage facilities are currently undertaken by the Nubariya Drainage Directorate under the jurisdiction of General Directorate for West Delta Drainage Region, EPADP and on the other hand, those of latter facilities are undertaken by the El-Max and Mahmoudia Directorates under the jurisdiction of General Directorate for North West Delta, MED.

According to the obtained data from the Nubariya Drainage Directorate, numbers of staffs are 57 of permanent staff and 162 of temporary staffs in 1994. In the case of data obtained from the General Directorate for North West Delta, total numbers of staffs are reported to be 1,143, and they are operating and maintaining following pumping stations, namely, 22 irrigation pumps, 19 drainage pumps, and 7 reuse pumps in 1994.

2) Operation and Maintenance Conditions

<u>Omoum Main Drain and Drains in Area</u>

The principal and periodical O&M works of the drains are excavation of deposited soils and reshaping of drain section inclusive of grass cutting of the side slopes. These works are periodically executed by EPADP once a year, as a rule, however due to the shortages of budgets and staffs necessary for these works, actual situation is once in two or three years. The excavated soils, which are usually placed on the one side of roads provided along the drains, are causing a obstruction for transportation in the areas, due to heavy rain during the winter season.

The other O&M works of the drains are elimination of aquatic plants such as water hyacinth, of which works are undertaken by clamshell type heavy equipment for drains with relatively wide width, and by back hoe type equipment for narrow drains in width. Furthermore, at a immediate upstream of each pumping station, those aquatic plants are manually removed with a floats crossing the drains. Especially, at the upstream of the El-Max pumping station large-scale heavy equipment are stationed at both the banks of Omoum main drain, and flowing massive aquatic plants are removed by the contractor at present. According to the survey, it seems operation efficiency of the works is not high, and an adequate methods should be taken to remove the plants.

Drainage Pumps

Regarding O & M works of drainage pumps at seven stations, both the Directorates of El-Max and Mahmoudia are undertaking those works, that is, O&M works of El-Max, Qalla, Abis, Hares, Truga and Dishudi pumping stations under former Directorate and Abu Hommos pumping station under latter Directorate, respectively.

Since the El-Max pump (No.1) and Hares pumps have been installed at the years of more than 31 and 27 years ago, respectively, pump operation efficiencies of both the pumps are low, and maintenance costs by means of replacement of necessary parts become large in recent years. But pump itself is relatively well-maintained by the staffs of MED. Pump housings are remarkably deteriorated because of timeworn facilities as well as insufficient maintenance due to shortages of budget.

Subsurface Tile Drains

Design and construction of subsurface tile drains at field level are basically made by EPADP, and O&M works of these facilities are used to be carried out by farmers' group themselves. However, it is reported that groundwater table at field dose not reach to the targeted level at many places, even after the installation of subsurface tile drains. Under the circumstance, it deems to be vital important for related farmers to give the opportunity for participation of planning subsurface tile drains, grasping the outline of tile drain systems to be installed and necessity of operation and maintenance of the tile drain facilities.

3) Operation and Maintenance Costs

Operation and maintenance costs for drains and pumping facilities, which were derived from EPADP and MED during the periods of two years, 1992/1993 to 1993/1994, are shown below;

Operation and Maintenance Costs

(unit :'000 LE)

Items	EPADP		MED		Total	
	1993	1994	1993	1994	1993	1994
Personnel Expenditure	55	105	369	380	424	485
Maintenance Costs	4,090	3,793	147	177	4,237	3,970
Pump Operation Costs	-	-	6,808	10,360	6,808	10,360
Total	4,145	3,898	7,324	10,917	11,469	14,815

Source;Nubariya Drainage Directorate, El-Max and Mahmoudia Directorates,
Total areas covered by Nubariya Drainage Directorate is 430,260 feddan (180,710 ha)

As is observed in the above table, average O&M costs for whole Study Area are estimated to be 13,142 thousand LE per annum, which is equivalent to 31 LE/feddan (73 LE/ha). These required O&M costs are burden by the government without charge of farmers.

3.8 Agricultural Conditions

3.8.1 Land Ownership

As of 1993, about 109,800 feddan (46,100 ha) of land have been distributed to 40,700 number of beneficiaries under various land reform laws in Behera Governorate. The average area per beneficiary is 2.7 feddan (1.1 ha) (refer to Table F-1-7, Annex F). Total number of the farmers in the Study Area including the above mentioned beneficiary farmers and their type of land ownership are presented below;

Number of Farmers by Land Ownership Type and Average Holding Size

Type of Farmer	Number of Household		Average Land Holding Size	
			(ha)	(feddan)
Farm Household	79,070	(100%)	1.6	(3.7)
- Owner	59,450	(75%)		
- Tenant	19,620	(25%)		
Landless Laborer Houshold	14,300			

Note : It is assumed that the number of landover are same to the number of the owner farm households.

Source : Zonal Agricultural Statistics Office, Behera Governorate (Ref. to Table F-1-8, Annex F)

According to the data on agricultural land ownership in Behera Governorate, the average farm size is 2.9 feddan (1.2 ha), while about 80 percent of the owner-farmers are predominant type of farmer the average of 1.0 feddan (0.4 ha) (refer to Table F-1-9, Annex F).

3. 8. 2 Cropping Pattern and Cultivated Area

The following two types of cropping pattern are practiced in the Study area. Most of the area is cultivated by summer or winter crops unless there is a problem of soil salinity and high groundwater table. A typical cropping pattern in Nile Delta is presented below;

- Three years rotation;
  wheat - rice - wheat - rice - berseem - cotton or maize;
- Two years rotation;
  wheat - rice - berseem - cotton or maize

The principal winter crops in the Study Area are wheat, berseem and beans. Cotton, rice and maize are grown in the summer season. The share of winter and summer season crops in the Study Area and the trend in the Behera Governorate over the last ten years are tabulated below;

Share of Crops and Its Trend

Season / Kind	Share (%)	Share Cropped Area	Trend of Crop Area (1984 - 1993, Behera Gov.)
Cultivated Area = 124,120 ha			
Winter			
- Wheat	28	34,750	Slightly increased
- Beans	5	6,200	Approximately constant
- Berseem, Long	15	18,610	Slightly decreased
- Berseem, Short	25	31,030	Slightly increased
- Winter Vegetables	8	9,930	Increased
Sub-total	81	100,520	
Summer			
- Cotton	22	27,300	Approximately constant
- Maize	28	34,750	Increased
- Rice	20	24,820	Slightly Increased
- Summer Vegetable	11	13,650	Increased
Sub-total	81	100,520	
- Orchard (Orange)	13	16,130	Increased
Total	175	217,170	

Note : The share of crops are estimated based on the cropped area in the project Districts.
Source : Department of Statistics, MALRE (refer to Table F-1-31, Annex F)

The area covered by fruit trees is almost same to that of vegetables both in winter and summer seasons. The share by kind of fruits is shown below;

Fruits and Their Share

Season / Kind	Share (1993)	Trend of Crop Area (1984 - 1993, Behera Gov.)
	(%)	
Orange and Lemon	8	Increased
Apple	2	Increased
Guava	2	Increased
Grape	1	Increased
Total	13	

Source: Department of Statistic, MALRF

The share of crops, namely, rice, cotton, vegetables, and fruits in Behera Governorate is larger than that of the whole country. Their shares are 14, 19, 14, and 20 percent respectively. This means that in terms of the above mentioned crops, Behera Governorate is one of the major producing areas in the country.

The Government law for crop area allotment to the farmers has been abolished completely throughout the country in 1994, and the liberalization of crop production among farmers has started. In this context, the rice cropping area in the current summer crop season is reported to exceed by some 30 percent of the officially planned area. The reason why a large number of farmers prefer to grow rice is to be able to have enough rice for home consumption as well as to obtain a higher income with rather low investment. Moreover, it is considered that the rice is grown in order to improve the saline soils, especially in places where the groundwater table is high.

3.8.3 Crop Production

To estimate drainage block-wise crop yields, no authentic data for the lower administrative levels was available. However, from the Department of Agricultural Statistics, MALRF, some data were collected and drainage block-wise unit yield was estimated. And also the crop yield data that was collected through the Farm Economic Survey (total sample farm household: 200 households), which was conducted by the JICA Study Team in 1994, are analyzed. The estimated unit yield data for different levels and data obtained from Farm Economy Survey are presented below;

Crop Yield of Major Crops in Study Area

(unit: ton/ha)

Crop	Egypt	Behera Gov.	Study Area			Without Project
			District	Local Unit	Sample Village	
Winter						
- Wheat	5.14	5.62	5.64	5.12	3.33	5.00
- Beans	3.12	2.10	2.10	2.64	2.00	2.00
- Berseem, Long	60.95	70.71	72.33	N.A	66.62	59.52
- Berseem, Short	25.95	27.88	24.50	N.A	35.76	26.19
- Potato	21.95	23.10	23.69	-	-	19.05
Summer						
- Cotton (raw)	2.62	2,79	3.09	2.60	2.67	2.62
- Maize	6.07	8.07	7.88	7.35	5.10	5.10
- Rice (paddy)	7.64	8.23	7.67	6.97	6.17	6.19
- Tomato	30.23	24.07	19.28	-	-	28.57
Perennial						
- Orange	15.16	17.14	16.81	-	-	14.76

Source : MALRF (average yield for 1991 to 1993), Farm Economic Survey (the yield for 1993). For the further detail, refer to Table F-1-12, Annex F.

As it is observed in the above table, the crop yields in the Study Area are lower than the level of the whole country as well as the Behera Governorate.

Relating to the drainage problems and the crop production in the Study Area, the following facts can be stated.

- The unit yield and quality of crops in the downstream drainage blocks are lower than the upstream blocks, in particular, in Hares and Truga areas. (refer to Table F-1-10 and F-1-11, Annex F).
- Even in the upstream drainage blocks, there are some areas with poor crop standing. This feature is found where the elevation is low and soil is saline.
- The flood in December, 1992 damaged crops severely. About 12 percent of total cultivated area were flooded and about three million L.E were paid to farmers for the crop damage in about 7,700 ha by Government.

Moreover, from the following crop yield data it can be concluded that when potentiality is considered, the subsurface drainage has a very limited effect on crop yield in the Study Area.

Crop Yield With and Without Subsurface Drainage

Crop	Without Subsurface Drain	With Subsurface Drain	Increased Ratio	Potential Increased Ratio
	(ton/ha)	(ton/ha)	(%)	(%)
Wheat	4.4	4.5	3	15
Cotton (Seed Cotton)	2.7	3.0	10	25
Rice (Paddy)	6.4	6.6	3	5
Maize	6.3	6.5	4	15

Note : Potential of yield increase ... Abel-Dayem Al-Safty, 1992 FAO/UN/World Bank, 1984 and 1991
Source : DOS, MALRF (The yield data for the past ten years since 1983, one site in Aub Hommos and two sites in Shereshera).

It is assumed that inadequate benefits from drainage improvement relates to the aforesaid insufficient reduction in depth of groundwater level. Based on the above said cropping pattern and crop yields, it is estimated that about 3,327 thousand tons of crops is produced with a total cropped area at about 517 thousand feddan (211 thousand ha) as shown in Table F-1-31, Annex F.