3.4 Irrigation and Drainage Conditions

3.4.1 Water Resources

The water resources available for the Study Area are divided into two categories; namely, Nile fresh water and drainage reuse. The latter is further divided into the official and unofficial reuse. The official reuse is from either drainage water lifted at the pumping stations then mixed into canals or gravity-taken into an extent of irrigation area, both of which are officially recognized as supplement to the insufficient irrigation water.

The reuse with mixing pumping stations can be accurately estimated according to the pump operation hours. However, it is difficult to estimate the volume of gravity-taken reuse. The unofficial reuse is such that farmers suffering from water shortage utilize drainage water from nearby open drain without notifying the relevant water district.

(1) Nile Fresh Water

The Nile fresh water, which comes by gravity, is mainly from the two canals of Raiah Abbasee and El Monofy. Raiah Abbasee is fed by Zifta Barrge while El Monofy starts at the Delta Barrage. Fresh water conveyed by Raiah Abbasee consists of the majority of water available in the Study Area, where the volume discharge at the intake can be known. The average annual discharge for the last five years from 1993 to 1997 is 4,479 MCM. Though El Monofy canal officially does not discharge irrigation water into the Study Area, a certain amount of flow comes into the Study Area at a junction point between Raiah Abbasee canal and El Monofy canal. The junction point is located 12 km downstream from the intake of Raiah Abbasee. The annual average flow from El Monofy into the Study Area is estimated at 237 MCM. Accordingly subtracting the annual flow of 1,424 MCM into Meet Yazied main canal, the total annual flow into the Study Area is estimated at 3,292 MCM.

There are two pumping stations, Balamoun P.S. and Kafr Saad P.S., both of which lift fresh water from the Damietta Branch into the Study Area. Balamoun P.S. is located near the branch point of Balamoun canal from El Sahel canal, located Km 79.5 from the intake of Raiah Abbasee, and gives the fresh water into both canals. Kafr Saad P.S. is located at Km 215 on Damietta Branch from Delta Barrage, and feeds both El Sahel and Balamon canals within Kafr Saad Water District.

The discharges for the two irrigation pumping stations are ascertained based on pump working hours. The annual average discharges for the last five years from 1993 to 1997 are 499

MCM in total (208 MCM for Balamoun P.S. and 291 MCM for Kafr Saad P.S.). However, it is difficult to determine separately the percentage of the discharged water that goes to Balamoun and El Sahel.

There are feeders in Kafr Saad Water District in Damietta Directorate, from which Nile water is gravity-taken into some irrigation canals. The volume of fresh waters gravity-taken from the feeders are not known but the areas served can be approximately known. The feeders are El Nile canal, which feeds about 54,000 feddan, and Feeder Km 220 which gives fresh water to about 8,000 feddan at the tail portion of both Balamoun and El Sahel Canals.

(2) Drainage Reuse

There are two mixing pumping stations; East El Monofia and Hamoul mixing pumping stations. East El Monofia M.P.S. lifts drainage water from the Karene drain, upstream of Gharbia drain, and discharges it into Raiah Abbasee. The catchment area of the mixing pumping station is not large. The annual average drainage amount mixed for the last five years from 1993 to 1997 is 57 MCM. Hamoul M.P.S. takes drainage water from Gharbia drain, and then discharges it into Bahr Tera canal. The pump station is located at Hamoul City, and serves a large area located in Hamoul, Mansour and Balteem Water Districts. According to pump operation, the annual average for the last five years from 1993 to 1997 is 321 MCM. Hence the total amount of drainage reuse is 378 MCM.

Apart from the drainage water mixed by the pumps, there are extent of areas over the Study Area, which officially receive drainage water by gravity. These areas are located in Balteem District and Hamoul District, both in Kafr El Sheikh Directorate and Zahraa District and Basandila District, both in West Dakahlia Directorate. It is also well known that farmers often install their engine driven pump near open drain and lift the drainage water into their farms. The unofficial reuse is often reported, however this type of reuse does not consist of the majority of whole drainage reuse since only farmers who practice farming at the nearby drain, usually located at the tail area of the canal, can rely on the reuse.

(3) Total Available Water Resources

After all the total amount of available water resources is estimated at 4,169 MCM. Subtracting the municipal water and industrial use of 143 MCM, the total available water for agricultural use is estimated at 4,026 MCM.

3.4.2 Irrigation Conditions

(1) Irrigation Network

The Study Area has a large extent of irrigation network composed of principal, main, branch and delivery canals. The definition of the canals in this Study are as follows;

Principal Canal;	conveys Nile fresh water into the Study Area; namely, two canals of Bahr Shebin and Raiah Abbasee.
Main Canal;	branches from the principal canals and commands a certain extent of irrigation area. It also includes an extension part of the principal canals; namely, Meet Yazied, Bahr El Mallah, Bahr El Sahel, Bahr Tera, Raiah Bilqas, and Bahr Basandila (extension of Bahr Shebin).
Branch Canal;	branches from the main canals above and commands a lesser extent of irrigation area with a continuous flow (not rotational); namely, El Balamoun, Bahr El Maasara, Bahr El Banawan, and Bahr Hafir Shehab El Deen. Though tail parts of these canals are often operated with rotational irrigation, the parts are also categorized into branch.
Delivery Canal;	branches from the above canals categorized into three and is operated under rotational irrigation. This includes Ganabia that runs parallel the higher rank canal from which Ganabia branches. In other words, all remaining canals, under the control of MPWWR, other than the above three categorized canals are defined as delivery. Its branches are named as 2nd, 3rd, and 4th delivery according to the order.

Besides the principal canals specified above, Omar Pick and G. Dahtourah canals take Nile fresh water from Damietta Branch near the intake of Raiah Abbasee, and feed the area Bahary Zifta Water District in Gharbia Directorate. Because of these canals' small command areas, Omar Pick is categorized as main canal and G. Dahtourah as delivery canal, both of which are not in the category of principal.

Also, there are two canals that start from the upstream of the meeting point of Monofy and Raiah Abbasee that enter the Study Area. These are El Korashia canal feeding West El Mahallah Water District, and Bahr Shershaba canal feeding a part of Bahary Zift Water District. Both are categorized as delivery canal (refer to Table 3.4.1 and Figure 3.4.1).

(2) Canal Physical Feature

The total length of principal canals in the Study Area is 65.8 km, composed of 12.0 km of Raiah Abbasee and 53.8 km of Bahr Shebin. Main canals' total length is worked out at 248.3 km, including 13.7 km of Omar Pick and 14.6 km of Meet Yazied (length in Gharbia Directorate only), while the branch canals' total length is 94.8 km. The total length of Bahr Shebin is worked out to be 88.3 km. Its extension, the Basandila canal has a length of 34.5km.

The longest main canal is El Sahel, with a total length of 87.6 km (composed of three parts as El Olia, El Wosta, and El Softa). The second longest main canal is Bahr Tera with a length of 63.7 km. The longest branch canal is El Balamoun with a length of 39.5 km, followed by 31.3 km of Bahr El Maasara and its two extensions (refer to Table 3.4.1).

Delivery canals are extensively networked covering all Study Area. The total number of delivery canals is 357, with a total length of 1,714 km. The average length per delivery canal is 4.8 km. The 1st delivery total number is 220 with a total length of 1,090 km, from which 5.0 km is given as the average length per 1st delivery. For 2nd delivery, the total number is 108 with a total length of 474 km. The average length of 2nd delivery is 4.4 km. As to 3rd and 4th deliveries, total number of both canals is 29 with a total length of 150 km, and an average length per canal of 5.2 km (refer to Table 3.4.2).

(3) Waste Spillage

Though waste spillage from the tails of the terminal and delivery canal are often reported most of water district engineers do not report any considerable waste spillage. They notify some canals from the tail when excessive water goes into the drainage. However, this is limited to winter season only and the number of the canals is not many. The number of canals with negligible waste spillage was reported to be 26 (7 % to total 357). At summer season, reports of waste spillage in the delivery canal are negligible.

Also, there are number of delivery canals where the tail is connected to another canal, causing excessive water into the canal located downstream. These canals acts as feeder to the downstream canal. 90 deliveries were reported to have such connection, and these number consists of 25 % of the total 357 deliveries. These canals have no waste spillage.

There are difficulties of accessing the tails of some deliveries. Also, the spillage at night has not been yet confirmed. Considerating the above information, it could be inferred that no noticeable waste spillage prevail within the Study Area's irrigation system as far as

Government-controled projects are concerned.

(4) Area Served

The total Study service area is 751,223 feddan (315,514 ha) including the new reclamation area of 56,000 feddan (23,520 ha) which has not yet been officially commissioned (still under the Horizontal Expansion Sector). The area excluding the reclamation area is 695,223 feddan (291,994 ha). This is managed by 17 relevant Water District Offices; 5 in Gharbia Directorate, 4 in Kafr El Sheikh Directorate, 7 in West Dakahlia Directorate and 1 in Damietta Directorate (refer to Table 3.4.3 and Figures 3.4.2 & 3.4.3).

With respect to areas served by principal and main canals, Bahar Shebin commands a total area of 641,397 feddan (269,387 ha), excluding new reclamation area, supplemented by drainage reuse and irrigation pumping stations as Balamoun P.S. and Kafr Saad P.S. Of the total area, 67,080 feddan (10%) is served by Bahr El Mallah, 163,665 feddan (26%) by Bahr Tera, 149,709 feddan (23%) by Raiah Bilqas, 59,137 feddan (9%) by Basandila, and 120,762 feddan (19%) by El Sahel. The remaining 81,044 feddan (13%) is the direct command area (refer to Table 3.4.4).

Areas served by branch canals relevant to the principal and the main canals are; 32,280 feddan by Bahar El Maasara, 5,698 feddan by Bahr El Banawan El Alaa, 31,481 feddan by Bahr Hafir Shehab El Deen, and 67,460 feddan by Balamoun, with some supplements from drainage reuse and irrigation pumping stations (refer to Table 3.4.4).

A total area of 617,069 feddan (259,169 ha) is served by 357 number of delivery canals. This consists of about 89 % of the total area of 695,223 feddan. The rest of the 11 % is served directly by branch canals, main canals, and principal canals. The overall average area per delivery is worked out to be 1,728 feddan (726 ha) (refer to Table 3.4.5).

The total land of 695,223 feddan is served by either fresh water, mixed or otherwise drainage water only (Drainage water mixed by El Monofia M.P.S. at a location on Raiah Abbasee is not counted in considering the fresh water). The area irrigated by mixed water is 84,755 feddan (35,597 ha), and this area is served by Hamoul M.P.S. The total area irrigated by drainage only is worked out to be 61,644 feddan (25,890 ha), which are located in the delivery canals of Bahr Tera, and tail portions of Basandila, El Nile and El Eslah canals. Of the 61,644 feddan, 34,414 feddan (14,454 ha) are usually irrigated by drainage only but sometimes mixed with fresh water according to the water level balance between the feeder drainage and the irrigation canal conveying water from the upstream (refer to Table 3.4.4).

(5) Irrigation Practice

The water distribution is carried out by the relevant directorates in a complex framework of rotation based on the extent of delivery canal system. The rotation mostly practiced in the Study Area is 5 days-on and 5 days-off during summer season and 4 days-on and 8 days-off during winter season. Under this system, all delivery canals are divided into two groups during summer and three groups during winter season. According to the rotation schedule, intake gates of the grouped delivery canals are opened and closed.

Farmers in the Study Area receive irrigation water in Meskas or in delivery canals about one to half meter below the elevation of the farm land, so that the farmers have to lift up the water to Marwa from Meska. The means of lifting the water used to be the animal driven Sakia (water wheels). However, today almost all farmers use diesel engine driven pump or diesel engine driven Sakia.

On-farm irrigation is mostly practiced with basin irrigation or furrow irrigation, both of which fall under the category of surface irrigation. Sprinkler and drip irrigations are becoming prevalent but the practice is still limited to newly reclaimed areas opened in deserts but not in the Study Area. It is observed that farmers are generally engaged in irrigation by as much as 16 to 18 hours during peak irrigation period and in some places a number of pumps remain functioning throughout night. The latter case often takes place in case a pump serves a number of farms collectively.

3.4.3 Drainage Conditions

(1) Drainage Network

The Study Area is demarcated by Damietta Branch at its eastern side and Gharbia drain at its western side. In between the Damietta Branch and Gharbia drain, there are number of main open drains. The drainage system is under the control of Drainage Authority. The Study Area is divided into 15 drainage centers called "Drainage District". Each drainage district covers a certain area of drainage system. The drainage water has to be discharged finally into either the Mediterranean Sea or Burullus Lake by pumping which is controlled by Mechanical and Electrical Authority (refer to Figure 3.4.4).

As one comes closer to the Mediterranean Sea, these drains are merged into two major drainage systems; namely, Drain No.1 & No.2 system and Gharbia drain system. The Gharbia drain system occupies more than one-third of the Study Area (refer to Figure 3.4.5).

(a) Drain No.1 & No.2 System

The drain No.1 and No.2 system is located in the eastern part of the Study Area. It is composed of two sub systems; one served by Lower P.S. No.1 and the other by Pumping Station No.2. Although Upper P.S. No.1 used to discharge part of the drainage water into Damietta Branch, the pump station is now not operational since the drainage water has poor quality that a nearby municipal water may be affected (refer to Figure 3.4.6).

The discharges of P.S. No.1 and P.S. No.2 merge into a drainage channel, leading to the Mediterranean Sea. The channel has a weir, called Gamasa, equipped with four gates to prevent seawater intrusion when the drainage water level is low. At present, the gates are always open since the drainage is sufficient enough in amount so that seawater is pushed out. The weir raises the water level in the drainage, so that the drainage water can flow back to the tail portion of Basandila canal, about 12,000 feddan, by gravity, and goes into the new reclamation area, Zayan and Kalabsho & Abomady (not yet transferred to West Dakahlia Irrigation Directorate). The drainage water is to be a part of the irrigation water to be required for the reclamation area.

(b) Gharbia Drainage System

All catchment in the Gharbia drain system are drained by means of pumping. The drainage system is very complicated, and composed of eleven pumping stations, of which seven pumping stations are in the Study Area. Among the eleven pumping stations, there are three mixing stations lifting the water into relevant irrigation canals, of which two stations are related to the Study Area. These are 1) Hamoul Mixing Pumping Station. that lifts the Gharbia drain water into Bahr Tera canal, and 2) El Monofy M P.S. that lifts the drainage water upstream into Raiah Abbasee canal (refer to Figure 3.4.7).

P.S. No.5 and No.6 discharge the drainage directly, or through a channel, into the Gharbia drain. Beyond Hamoul mixing P.S., a side branch conveys the discharge of the P.S. No.3 and No.4 into the Gharbia drain. The side branch also feeds El Eslah canal within the Zahraa district. The Gharbia drain is closed by weir equipped with four gates, named Khashaa, to prevent sea water intrusion. These gates are mostly closed throughout year. At the upstream of the gate, there is a feeder conveying Gharbia drainage water into Bahr Tera on condition that the water level of the drain is higher than that of the Bahr Tera.

The last pumping station is Hafir Shehab El Deen, and the drainage water is delivered into El Nile canal via a feeder. Beyond the feeder, the rest of the drainage water, lifted by Hafir Shehab El Deen P.S. flows into the Mediterranean Sea or into the Khashaa fish farm via another feeder. Since the Khashaa weir is almost closed, the drainage water in the Gharbia drain is mostly re-used by Hamoul mixing P.S., Bahr Tera canal, and to a lesser extent unofficial re-use by the farmers. It is therefore thought that no additional re-use potential of the Gharbia drain is expected.

(c) Other Open Drain System

Besides the two major drainage systems, there are three drainage systems that are small in scale compared with the above two. There are Sanania, Burullus and Tera drain systems, the drainage areas of which are 24,000 feddan, 15,000 feddan, and 72,000 feddan respectively. Sanania drain is located in Kafr Saad District in Damietta Directorate. Burullus drain is in Balteem District and Tera is in Mansour District. Sanania P.S. discharges the drainage water into the Mediterranean Sea, while the other two pumping stations discharge the drainage into Burullus Lake (refer to Figure 3.4.4).

(2) Drainage Rate

Drainage rate is defined as a drainage-water depth per day that is drained at a pumping station; namely, the drainage amount at the pump station divided by the drainage area served. Drainage rate increases as one goes closer to the Mediterranean Sea. With reference to the pumped discharges given by the Mechanical and Electrical Department, responsible for all pumping stations, the drainage rates relevant to the Study Area have been estimated (refer to Table 3.4.6).

Annual average drainage rate in the southern part of the Study Area is relatively small; namely, 1.51 mm/day at Sagaaya D.P.S. and 1.12 mm/day at Mahallah El Kubra D.P.S. Samatay D.P.S. and No.5 D.P.S., located mid of the Study Area, give 2.73 mm/day and 1.74 mm/day drainage rates respectively. No.6, No.4 and No.3 drainage stations show an annual average rates as 2.58, 3.38, and 3.39 mm/day, respectively with these monthly maximum of 4.01 mm/day in July, 5.15 mm/day in July and 5.00 mm/day in September.

The stations located at the northern most part of the Study Area has an annual average and monthly maximum rates; 3.48 mm/day (4.77 in August) at Lower D.P.S. No.1; 3.55 mm/day (5.7 in September); 2.44 mm/day (3.13 in September) at Burullus D.P.S.; 4.46 mm/day (6.66 in September) at Tera D.P.S.; and 3.92 mm/day (5.29 in September) at Hafir D.P.S.

With respect to drainage amount, Lower No.1 D.P.S. discharges the biggest average annual volume, among the relevant pumping stations, at 881 MCM. the No.2 D.P.S. discharges an annual average of about 343 MCM. A part of both drainage discharged feeds the tail portion of Basandila canal, approximately 11,694 feddan (4,911 ha), and part of the New Reclamation Area though not yet officially commissioned. The remaining volume goes into the Mediterranean Sea. Two drainage pumping stations, Burullus D.P.S. and Tera D.P.S., discharge an annual average of 56 MCM and 492 MCM, respectively, into Burullus Lake (refer to Table 3.4.6).

Considering the large amount of discharges lifted annually and high drainage rates for the drainage pump stations located northern part of the Study Area, there is a possibility that return ground-flow, originating the upstream part including even Monofy Directorate, contributes to the large discharge as one goes to the downstream part. Sea water intrusion into these drainage canals is also suggested since the bed levels are lower than mean sea level.

(3) Subsurface Drainage

As to subsurface drainage in the Study Area, an area already implemented is 380,514 feddan and under-implementation is 32,700 feddan. The sub-surface drainage has already covered almost lower half of the Study Area, West El Mansour Drainage District, and a part of Kafr Saad Drainage District. The under-implementation area is East Bilqas Drainage District that is located between Bahr Hafir Shehab El Deen and Basandila Canals. The areas to be covered within the Five Year Plan (1997/78-2001/2002) are the drainage districts of El Hamoul, East Bilqas (refer to Figure 3.4.8).

3.4.4 Ratio between Area served by Fresh Water and Area by Drainage Water

Of the whole 641,397 feddan of Bahr Shebin command area, 61,644 feddan is, at maximum, irrigated by drainage water only. This consists of 9.6 % of the whole area. The rest of the 579,753 feddan is divided into two as; 566,745 feddan commanded by Bahr Shebin and 13,008 feddan commanded by the feeders from Damietta Branch.

The 566,745 feddan is irrigated by a known amount of 4,026 MCM, mentioned in "4.3 Development Plan on Irrigation and Drainage", which is composed of 378 MCM of drainage water provided by East El Monofy M.P.S. & El Hamoul P.S. and 3,648 MCM of fresh water (after subtracting municipal and industrial uses). The amount of 378 MCM consists of 9.4 % of the 4,026 MCM. This percentage is about 8.3 % to the whole area of 641,397 feddan. Therefore, a total of 18 % (= 9.6 + 8.3) of the whole Bahr Shebin area is, at the maximum, considered to be irrigated by drainage water.

3.4.5 Overall Inflow & Outflow Balance on Bahr Shebin Command Area

The overall balance between inflow & outflow for the Bahr Shebin command area of 641,397 fed (269,387 ha), is assessed. Inflow is composed of flows from two principal canals of Raiah Abbasee and El Monofy, two feeders from Damietta Branch, two irrigation pumping stations lifting Nile fresh water at Damietta Branch, and discharges from the two mixing pumping stations of East El Monofia and Hamoul. The flow into Meet Yazied canal has to be subtracted.

With respect to outflow, no waste spillage from irrigation canals outside the Study Area has been reported. Therefore, outflow is composed of drainage generated by drainage pumping stations. There are some cases that part of the drainage water, after being lifted, is reused before entering Mediterranean Sea or lakes located at north. In this case, an annual water consumption of 1.7 m is assumed. The volume worked at by multiplying the served area is subtracted from those lifted by the drainage pumping stations.

By doing the above, the overall inflow is estimated at 4,099 MCM, while overall outflow at 1,948 MCM. The ratio between outflow and inflow is 48 %. Taking into consideration the present irrigation practice, it is reasonable that a certain amount of groundwater return and/or sea water intrusion contribute to the outflow rather than just about half the amount of the inflow that goes out of the Study Area. With an annual crop water consumption of 1.7 m and an assumed irrigation efficiency of 0.57, an amount of 462 MCM is estimated as the probable return and sea water intrusion (See Figure 3.4.9).

3.4.6 Subjects of Irrigation and Drainage

To grasp the present constraints and problems relevant to the irrigation and drainage system in the Study Area, the following activities were undertaken;

- Workshop; Workshop type meetings were held from May 12-14, 1998 with relevant irrigation officers (directors, inspectors and district water engineers) to identify current problems and recommend measures.

- Questionnaire; A questionnaire was provided to the 17 relevant water district officers, inquiring present condition, as water shortage and the reason, drainage reuse, tail condition and waste spillage from the tail, intake condition, domestic wastes and washing practices in the canals.

- Field observation; Field observations had been done throughout the study period.

- Others; Discussions and assessment with relevant officers based on available data.

The major constraints and problems identified by the irrigation officers are mainly concern facility – related issues and agreement controlled system, however with limited issues on on-farm level constraints & problem.

(1) Overall and localized Constraints and Problems

Summarized below are the major and locally identified constraints and problems mostly prevailing in the Study Area;

- Water shortages at the tails of delivery canals during summer season due especially to illegal rice cultivation. This sometimes shows up even at delivery canal located in the upstream of the Study Area.

- Domestic wastes and garbage disposal thrown into canals. This gives not only environmental problems but also gives additional losses especially in the section lessened by the wastes.

- Submerged weeds. This gives additional losses, so that design flow cannot be attained with the designated water level. This problem becomes severe during winter season when water level is low.

- Poor maintenance of Meskas, associated with waste disposal and weeds. This gives environmental problems and lessens the flow to the downstream portion. Meskas are not under the control of Government. It is difficult to maintain the Meska without responsible proper group or association.

- Direct individual pumping. As diesel engine driven pump becomes popular, illegal direct pumping also becomes common. This leads to excessive water dosage thereby lessening of the water to be conveyed at the downstream.

- Poor communication between water district office and directorate office (only one telephone and one shared wireless available for the water district), and also between gate keepers and the water district engineer responsible for the keepers. Gate keepers are not usually provided transportation other than walking or bicycle.

- Poor on-farm water management associated with low-level land leveling. This leads to excessive water dosage. Also, often observed is the spillage over rice field ridge into field drain.

- Dilapidated Rahbeen Regulator. The regulator was originally constructed in 1919 and renovated in 1966. The hydraulic loss reaches 20-30 cm when the lock is opened and as much as 70 cm when the lock is closed. Already encountered is the scarring reaching as deep as 6 m, at the right downstream of the regulator, due to increased flow required by a new reclamation area in Zahraa and Hafir Districts.

- Large hydraulic loss at such bridges as Shesita located at 11.5 km from Raiah Abbasee intake, and Nabroh located at 55.7 km of Bahr Shebin.

- High bed level and gate level for some delivery canals, giving difficulty to intake designed flow with the designated water level. This problem is mainly associated with the branch or main canal from which the delivery canal branches. These branch and main canals' bed levels were lowered as a result of periodic maintenance using excavator or drag-line.

- Suspension of Hamoul M.P.S. when the water level in Gharbia drain is low. When Hamoul M.P.S. stops, Bahr Tera has to convey additional 1 MCM/day. This causes dispute among Gharbia, West Dakahlia and Kafr Sheikh Directorates. Also, some sections of Bahr Tera, especially between Abshan Regulator and Hamoul City, are not sufficient to convey the additional flow.

- Saline groundwater coming into such canals as Burullus and Balteem, downstream of Bahr Tera main canal. Also, the canal bed composed of pure sand between Km 59 and Km 64 of Tera, leads to high seepage and soil erosion making it difficult to reform the section.

- Narrowed road due to scarring and illegal cultivation on the bank along El Sahel and Balamoun canals, making maintenance work difficult.

- Water quality associated with drainage reuse, especially in areas that use drainage water only as the irrigation water. The areas irrigated by drainage water are located mostly at the terminal places of the Bahr Shebin irrigation system. Though parts of the areas are sometimes provided fresh water from the upstream according to the water levels balance, the drainage irrigated area reaches as much as 61,644 feddan (25,890 ha) at the maximum. This area is equivalent to about 10 % of the whole Bahr Shebin command area of 641,397 feddan.

(2) Water Shortage and Inequitable Distribution

There is an inequitable water distribution over the Study Area, and water shortage becomes frequent and severe as one goes to the tail portion of the irrigation system. This applies to the whole Bahr Shebin irrigation system as well as to the small part of the system. The latter case is shown in canals which has long reach and/or has high bed level.

As an example, Bahr Biyala with a length of 13.72 km and Ashan with a length of 17.4 km, both of which are delivery canal in Biyala Water District under Kafr El Sheikh Irrigation Directrate, suffer from water shortage during summer season especially at the downstream reaches. This water shortage is further deteriorated by illegal rice cultivation practiced with individual direct pumping.

As to the whole Bahr Shebin command area, the following water districts suffer from water shortage, all of which, except Bishbeeth, are located at the downstream of the irrigation system;

- Bishbeeth under Gahrbia Directorate
- Balteem, Mansour, and Hamoul under Kafr El Sheikh Directrate
- Hafir, Massara, Basandila, and Sherbin under West Dakahlia Directorate
- A part of Kafr Saad under Damietta Directrate

Though Zahraa is located at the terminal part of Bahr Shebin, no noticeable water shortage is reported since this area receives drainage water from Hafir Shehab El Deen Drain. The channel fed by Drains No.3 and No.4., Basandila District also suffer from water shortage but not at its tail portion because this area is given drainage water lifted from drainage pumping stations No.1 and No.2. Kafr Saad also lacks water but not El Sahel canal since this part is well gravity-fed from Damietta Branch.

Of the above-mentioned areas, the most severe water shortages occur in the underlined three districts of Balteem, Mansour, and Hamoul, which are fed by Bahr Tera canal under Kafr El Sheikh Irrigation Directorate. These areas suffer from water shortage even during winter season but to a lesser extent. According to the 1993 – 1997 discharge records at the intake of Bahr Tera, an average of 830 MCM is taken annually. Also, mixed at Hamoul M.P.S. is 321 MCM, the annual average based on the last five years (1993 – 1997) pump operation records. Based on the above findings, the following are noted;

Total area served; 163,665 feddan

64,360 feddan by fresh water

84,755 feddan by mixed water (149,115 feddan; + above)

14,550 feddan by drainage water only

Annual unit consumption by 163,665 feddan (68,739 ha); 1,674 mm (7,033 cu.m/fed)

Annual unit consumption by 149,115 feddan (62,628 ha); 1,838 mm (7,719 cu.m/fed)

From the above, it can be observed that the whole Bahr Tera command area, is not less as compared to the other areas (Bahr Shebin's overall unit consumption is worked at 1,495 mm against 1,674 mm above and 1,697 mm against 1,859 mm above). Despite the fact that Bahr Tera has conveyed reasonable amount with Hamoul M.P.S., noticeable water shortage was reported due to the following;

- Illegal rice cultivation practiced at the upstream area. The permitted rice cultivation area is 50 %, as against the 70 % that is currently being practiced, thereby decreasing water volume that has to be conveyed to the downstream.
- Sub-surface drain already installed over Biyala District. This contributes to excessive seepage than the designed since most farmers do not make stoppage during rice cultivation.
- The long length and large command area, giving difficulty to water management and distribution. The length of 63.7 km is the second longest main canal next to 87.6 km of Bahr Sahel (Bahr Sahel is supplemented by Nile fresh water by two irrigation pumps and a feeder). The command area is 163,665 feddan (68,739 ha) which is the biggest among main canals.
- Illegal direct pumping commonly practiced in the area, leading to excessive water dosage and resulting in waste spillage from the field. Waste spillage associated with poor on-farm water management. Often observed is the spillage over the rice field ridge, getting into the field drain.
- Suspension of Hamoul M.P.S. when the water level in Gharbia drain is low. This creates water shortage for a time period. It also creates a psychological pressure in the area supplemented by Hamoul M.P.S.
- Soil over Hamoul and Balteem Districts is sandy, so that canal section easily deteriorates. This makes the managing of water distribution in the districts difficult. Also, the soil is so saline that needs certain amount of leaching.

(3) Individual Direct Pumping other than Meska

Prevailing over the Study area are individual direct pumping from delivery canals and sometimes even from the main canals. These are of two types; legal and illegal. With the introduction of the diesel engine pump, illegal direct pumping has become prevalent not only in the Study Area but also over the country. Even a farmer, who practices farming upstream of a Meska, prefers pumping water from the delivery canal to taking water from the Meska.

Though it is very difficult to have accurate data for Meska, an inquiry had been made to the relevant water district engineers and cooperatives in the Study Area during Phase I field survey, asking the number of Meskas and the command area the basis of delivery canal. Also, an inventory survey for Meskas in the Priority (feasibility study) area was carried out during phase II field survey. The result from the inquiry revealed that only 31 % of areas served by deliveries are commanded by Meska system. The inventory survey made known that 48 % of the total Priority Area is covered the Meska System (See Tables 3.12.1 in Part I & 1.5.1 in Part II).

Though discrepancy shows between the two results mainly because of inaccuracy of the inquiry survey, it could be concluded that as much as half of the irrigation area depends on individual direct pumping. This situation suggests that measures, not only of improving conventional Meska but also of dealing with individual pumping, shall be undertaken in improving the irrigation system.

Table 3.4.1 Classification, Location and Length of Major Canals in the Study Area

Principal	Main Name	Main Km*	Branch Name	Branch Km**	Delivery 1st	Delivery 2nd	Delivery 3rd	Length km	Remarks
Canals fed by either Bahr Shebin or Raiah Abbasee									
Raiah Abbasee		0						12.0	
Bahr Shebin								53.8	Length including Raiah Abbasee
	Bahr El Mallah	33.2						24.5	
	Bahr El Sahel El Olia	36.8						42.7	Total of El Sahel 87.6 km
			El Balamoun	42.7				39.5	
	Bahr El Sahel El Wosta	79.5						25.4	Extension of B. El Sahel El Olia
	Bahr El Sahel El Softa	104.9						19.5	Extension of B. El Sahel El Wosta
	Bahr Tera	47.2						63.7	
	Raiah Bilqas	65.8						9.7	
			Bahr El Maasara	9.7				7.7	
			Bahr El Banawan El Alaa	17.4				13.9	Extension of B. El Maasara
			Bahr El Banawan El Asfal	31.3				9.7	Extension of B. El Banawan El Alaa
			Bahr Hafir Shehab El Deen	9.4				24.0	
	Bahr Basandila	65.8						34.5	Extension of Bahr Shebin
Canals fed by El Monofy, upstream of Bahr Shebin, or River Nile									
	Omar Pick	0						13.7	from River Nile
					G. Dahtourah			9.5	from River Nile
					Bahr Shershaba			18.4	from El Monofy
					El Korashia			23.1	from El Monofy
Others (to outside Study Area)									
	Meet Yazied							14.6	from Bahr Shebin, length in Gharbia only

Note1; * Km from the intake of Raiah Abbasee. ** Km from the intake of the canal preceeding to.
Note2; Three canals of Bahr El Sahel El Olia, Bahr El Sahel El Wosta and Bahr El Sahel El Softa is called "Bahr El Sahel".

Table 3.4.2 Summary of Delivery Canal Length by Water District

Directorate	Water District	Canal	1st Delivery length, km	1st Delivery No	1st Delivery Avrg	2nd Delivery length, km	2nd Delivery No	2nd Delivery Avrg	3rd & 4th Delivery length, km	3rd & 4th Delivery No	3rd & 4th Delivery Avrg	Remarks
Gharbia	Bahary Zifta	Bahr Shebin	31.07	11	2.8	1.98	1	2.0				
		Omar Pick	32.78	5	6.6	31.24	9	3.5				
		G. Dahtoura	9.50	1	9.5							
		Bahr Shershaba	9.50	1	9.5	16.15	3	5.4				
	Samanoud	Bahr Shebin	41.40	7	5.9	2.43	1	2.4				
		Bahr El Mallah	4.37	1	4.4							
		El Sahel	18.25	4	4.6	3.35	1	3.4				
	Bishbeesh	Bahr El Mallah	60.98	9	6.8	21.50	6	3.6				
	East El Mahallah	Bahr Shebin	11.02	4	2.8	15.14	3	5.0	6.00	2	3.0	3rd includes 3.0 km of 4th
		Bahr El Mallah	4.60	1	4.6	37.74	4	9.4	3.62	1	3.6	
	West El Mahallah	Bahr Shebin	8.61	3	2.9							
		El Korashia	23.13	1	23.1	20.02	2	10.0	26.03	5	5.2	3rd includes 3.2 km of 4th
Kafr El Sheikh	Balteem	Bahr Tera	47.07	13	3.6	9.39	4	2.3	2.40	1	2.4	
	Mansour	Mansour	24.10	1	24.1	49.01	8	6.1	34.74	8	4.3	3rd includes 9.85 km of 4th
	Hamoul	Bahr Tera	71.96	18	4.0	12.06	3	4.0				
	Biyala	Bahr Tera	69.32	14	5.0	27.77	7	4.0				
West Dakahlia	Hafir	El Nile	22.75	1	22.8	5.05	2	2.5				
		El Eslah				9.65	1	9.7	35.77	4	8.9	
	Basandila	Bahr Shebin	9.25	2	4.6							
		Bahr Basandila	149.32	31	4.8	24.39	8	3.0				
	Bilqas	Bahr Shebin	9.65	2	4.8							
		Raiah Bilqas	36.35	8	4.5	10.20	3	3.4				
		Bahr Hafir Shohab El Deen	62.64	13	4.8	18.08	6	3.0				
	Maasara	Raiah Bilqas	2.44	1	2.4	3.45	1	3.5				
		Bahr El Maasara	52.06	10	5.2	38.60	10	3.9				
		Bahr El Banawan El Alaa	7.50	2	3.8							
	Zahraa	El Nile	18.25	2	9.1	18.45	4	4.6				
		El Eslah				3.03	1	3.0	31.55	5	6.3	3rd includes 4.9 km of 4th
	Talkha	Bahr Shebin	88.61	20	4.4	24.64	6	4.1				
		El Sahel	16.40	4	4.1	1.85	1	1.9				
	Sherbin	El Sahel	23.02	7	3.3	10.35	3	3.5				
		Balamoun	34.80	7	5.0	14.90	3	5.0				
Damietta	Kafr Saad	Balamoun	66.91	11	6.1	43.87	8	5.5	9.80	3	3.3	
		El Sahel	15.35	5	3.1							
		Nile canal	7.10	1	7.1							
Sum & average of above			1,090.06	220	5.0	474.29	108	4.4	149.91	29	5.2	
Total length of delivery, km			1,714.26									
Total number of delivery			357									
Overall average length, km/delivery			4.80									

Table 3.4.3 Area Served for Relevant Water Districts

Directorate	Inspection	Water District	Area, feddan	Area, ha	Remarks
Gharbia	El Mahallah El Kubra	Bahary Zifta	42,696	17,932	
		Samanoud	27,790	11,672	
		Bishbeesh	39,190	16,460	
		East El Mahallah	34,345	14,425	
		West El Mahallah	23,400	9,828	Part of the whole 45,030 feddan
		Sub Total	167,421	70,317	
Kafr El Sheikh	Biyala	Balteem	37,605	15,794	
		Mansour	45,700	19,194	
		Hamoul	41,855	17,579	
		Biyala	38,505	16,172	
		Sub Total	163,665	68,739	
West Dakahlia	Bilqas	Hafir	30,602	12,853	
		Basandila	62,162	26,108	
		Bilqas	46,469	19,517	
		Maasara	40,478	17,001	
		Zahraa	35,400	14,868	
		Sub Total	215,111	90,347	
	Talkha	Talkha	47,934	20,132	
		Sherbin	42,812	17,981	
		Sub Total	90,746	38,113	
	New Reclamation Area*		56,000	23,520	
Damietta	Damietta	Kafr Saad	58,280	24,478	
	Total		751,223	315,514	Conversion to ha: 0.42

Note: *This new reclamation area is to be transferred to West Dakahlia Directorate after the completion.

Table 3.4.4 Area Served with Respect to Major Canals

Princial	Main	Branch	Delivery	Area, fed	Br'k Dwn	Area, ha	Remarks
Bahr Shebin				641,397		269,387	
				81,044		34,038	
	Bahr El Mallah			67,080		28,174	
	Bahr Tera			163,665		68,739	
					64,360	27,031	
					39,065	16,403	Mixed with Drainage
					3,250	1,365	Drainage only
					11,300	*4,746*	*Drainage only**
			El Mansour		45,700	19,194	Mixed with Drainage
	Raiah Bilqas			149,709		62,878	
					14,248	5,984	
		Bahr El Maasara			32,280	13,558	
		Bahr El Banawan El Alaa			5,698	2,393	
		Bahr Hafr Shehab El Deen			31,481	13,222	
			El Nile		11,621	4,881	
					23,980	10,072	Drainage only
			El Eslah		18,981	7,972	
					11,420	*4,796*	*Drainage only**
	Basandila			59,137			
					47,443	19,926	
					11,694	*4,911*	*Drainage only**
	El Sahel			120,762		50,720	
					46,902	19,699	
					1,000	*420*	*Feeder Km 220***
		Balamoun			60,852	25,558	
					6,608	*2,775*	*Feeder Km 220***
			Nile Canal		*5,400*	*2,268*	*Feeder from Damietta B.***
	Omar Pick			23,626		9,923	
			G. Dahtoura	2,000		840	
			Bahr Shershaba	7,100		2,982	
			El Korashia	21,100		8,862	
Total				696,223		291,994	

Note; Total area does not include New Reclamation Area.

Break Down of Bahr Shebin

	Area, fed	Break down, fed		Area, ha	Remarks
Bahr Shebin	641,397			269,387	Total of Bahr Shebin
		494,998	481,990	202,436	Fresh Water
			13,008	*5,463*	*Feeder fr Damietta Branch***
		84,755		35,597	Mixed with Drainage
		61,644	27,230	11,437	Drainage only
			34,414	*14,454*	*Drainage only**

Note: * (*Italics*) means area usually fed by dranage only but sometimes mixed with fresh water a/c to the water balance.
Note: ** (*Italics*) means area usually fed by Damietta Branch but sometimes fed from upstream.

Table 3.4.5 Summary of Area Served by Delivery Canals

Directorate	Water District	Canal	1st Delivery feddan	1st Delivery No	1st Delivery Avrg	2nd Delivery feddan	2nd Delivery No	2nd Delivery Avrg	3rd & 4th Deliveries feddan	3rd & 4th Deliveries No	3rd & 4th Deliveries Avrg	Remarks
Gharbia	Bahary Zifta	Bahr Shebin	9,400	11	855	570	1	570				
		Omar Pick	10,121	5	2,024	9,845	9	1,094				
		G. Dahtoura	2,000	1	2,000							
		Bahr Shershaba	1,750	1	1,750	5,350	3	1,783				
	Samanoud	Bahr Shebin	17,920	7	2,560	550	1	550				
		Bahr El Mallah	1,300	1	1,300							
		El Sahel	4,780	4	1,195	1,760	1	1,760				
	Bishbeesh	Bahr El Mallah	25,490	9	2,832	7,930	6	1,322				
	East El Mahallah	Bahr Shebin	2,795	4	699	4,860	3	1,620	100	2	50	
		Bahr El Mallah	635	1	635	19,835	4	4,959	1,600	1	1,600	
	West El Mahallah	Bahr Shebin	2,300	3	767							
		El Korashia	2,000	1	2,000	8,800	2	4,400	10,300	5	2,060	
Kafr El Sheikh	Balteem	Bahr Tera	20,655	13	1,589	5,150	4	1,288	1,000	1	1,000	
	Mansour	Mansour	5,300	1	5,300	24,200	8	3,025	16,200	8	2,025	
	Hamoul	Bahr Tera	32,755	18	1,820	6,000	3	2,000				
	Beila	Bahr Tera	24,642	14	1,760	8,110	7	1,159				
West Dakahlia	Hafir	El Nile	6,340	1	6,340	5,281	2	2,641				
		El Eslah				3,038	1	3,038	15,943	4	3,986	
	Basandila	Bahr Shebin	3,025	2	1,513							
		Bahr Basandila	43,796	31	1,413	7,314	8	914				
	Belkas	Bahr Shebin	3,240	2	1,620							
		Raiah Belkas	9,568	8	1,196	2,180	3	727				
		Bahr Hafir Shehab El Deen	25,509	13	1,962	3,550	6	592				
	Maasara	Raiah Belkas	1,200	1	1,200	1,300	1	1,300				
		Bahr El Maasara	19,089	10	1,909	11,977	10	1,198				
		Bahr El Banawan El Alaa	686	2	343							
	Zahraa	El Nile	5,271	2	2,636	18,709	4	4,677				
		El Eslah				0	1	0	11,420	5	2,284	
	Talkha	Bahr Shebin	29,609	20	1,480	6,675	6	1,113				
		El Sahel	2,710	4	678	430	1	430				
	Sherbin	El Sahel	7,384	7	1,055	3,120	3	1,040				
		Balamoun	15,435	7	2,205	3,865	3	1,288				
Damietta	Kafr Saad	Balamoun	28,128	11	2,557	8,958	8	1,120	5,616	3	1,872	
		El Sahel	5,300	5	1,060							
		Nile canal	5,400	1	5,400							
Sum & average of above			375,533	220	1,707	179,357	108	1,661	62,179	29	2,144	
Total area served of delivery, feddan			617,069									
Total number of delivery			357									
Overall average area served, feddan/delivery			1,728									

Table 3.4.6 Summary of Mean Drainage Rate and Mean Annual Discharge based on 1993 - 1997 Operation Records

Drainge P.S.	Suction	Delivery	Max Rate mm/day	Month	Annual Avrg mm/day	Annual Dis. MCM	Remarks
Sanania	Sanania	Mediterranean	0.72	Aug	0.49	18	
Lower No.1	Drain No.1	Mediterranean	4.77	Aug	3.48	881	Partly reused into Basandila canal (11,694 fed, 4,911 ha)
No.2	Drain No.2	Mediterranean	5.70	Sep	3.55	343	-do- & also into New Reclamation Area
Burullus	Burullus Drain	Burullus Lake	3.13	Sep	2.44	56	
Tera	Tera Drain	Burullus Lake	6.66	Sep	4.46	492	
Su total of above						1,790	
Hafir Shehab El Deen	Hafir S. El D. Drain	Gharbia Drain	5.29	Sep	3.92	412	Partly reused into Nile canal (23,988 fed, 10,072 ha)
No.3	Drain No. 3	Gharbia Drain	5.00	Sep	3.39	291	Partly reused into El Eslah canal (11,420 fed, 4,796 ha)
No.4	Drain No. 4	Gharbia Drain	5.15	Jul	3.38	342	-do-
No.6	Drain No. 5	Gharbia Drain	4.01	Jul	2.58	136	
No.5	Drain No. 5	Gharbia Drain	2.69	Sep	1.74	195	
Samatay	Samatay Drain	Gharbia Drain	3.60	Jul	2.73	230	
Mahallah El Kubra	Omar Tosson Drain	Damietta Branch	1.66	Sep	1.12	74	
Sagaaya	Sagaaya Drain	Gharbia Drain	2.56	Sep	1.51	173	

Source; Computer Center, MED, Kafr El Sheikh

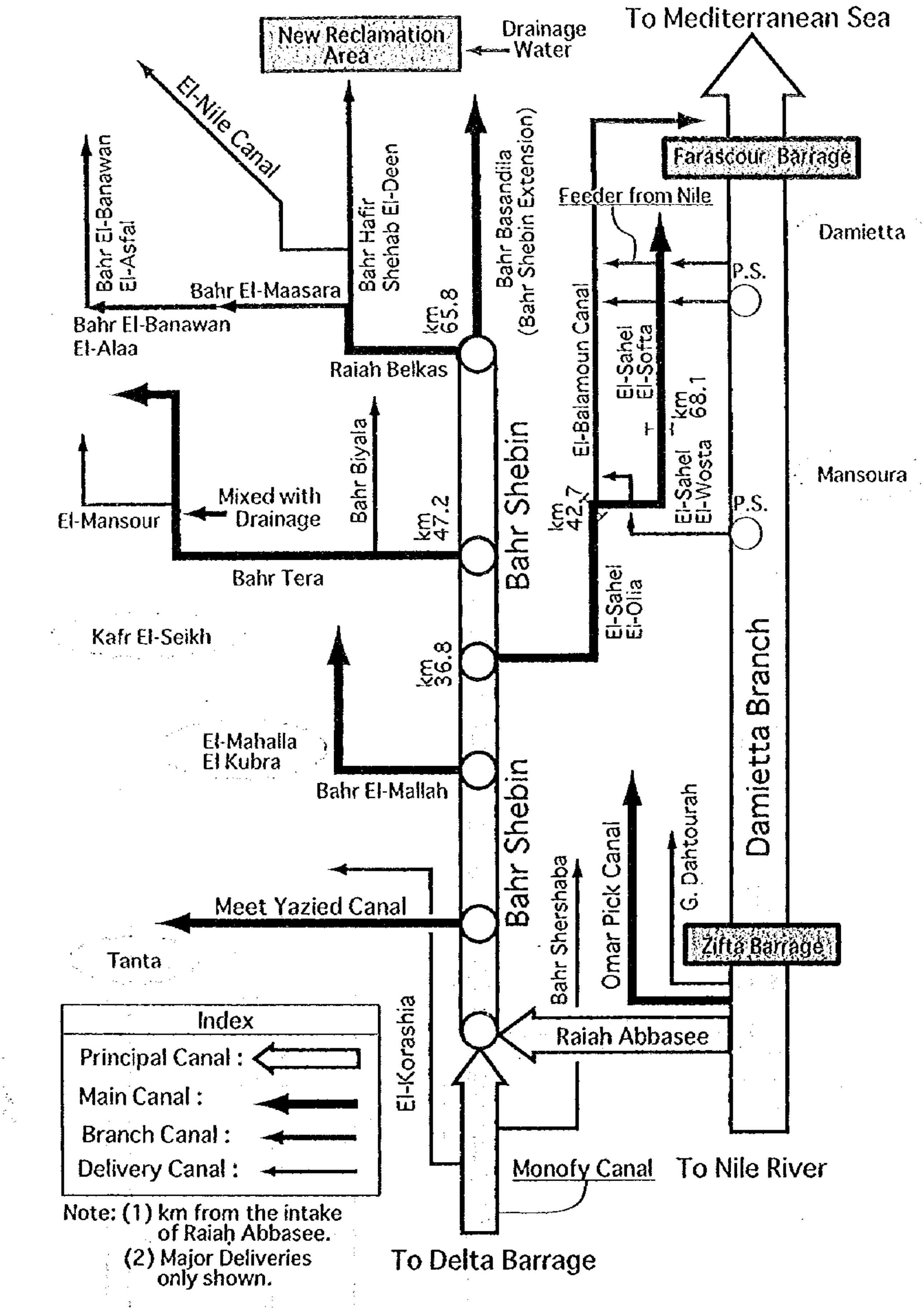


Figure 3.4.1 Irrigation Canal System Diagram

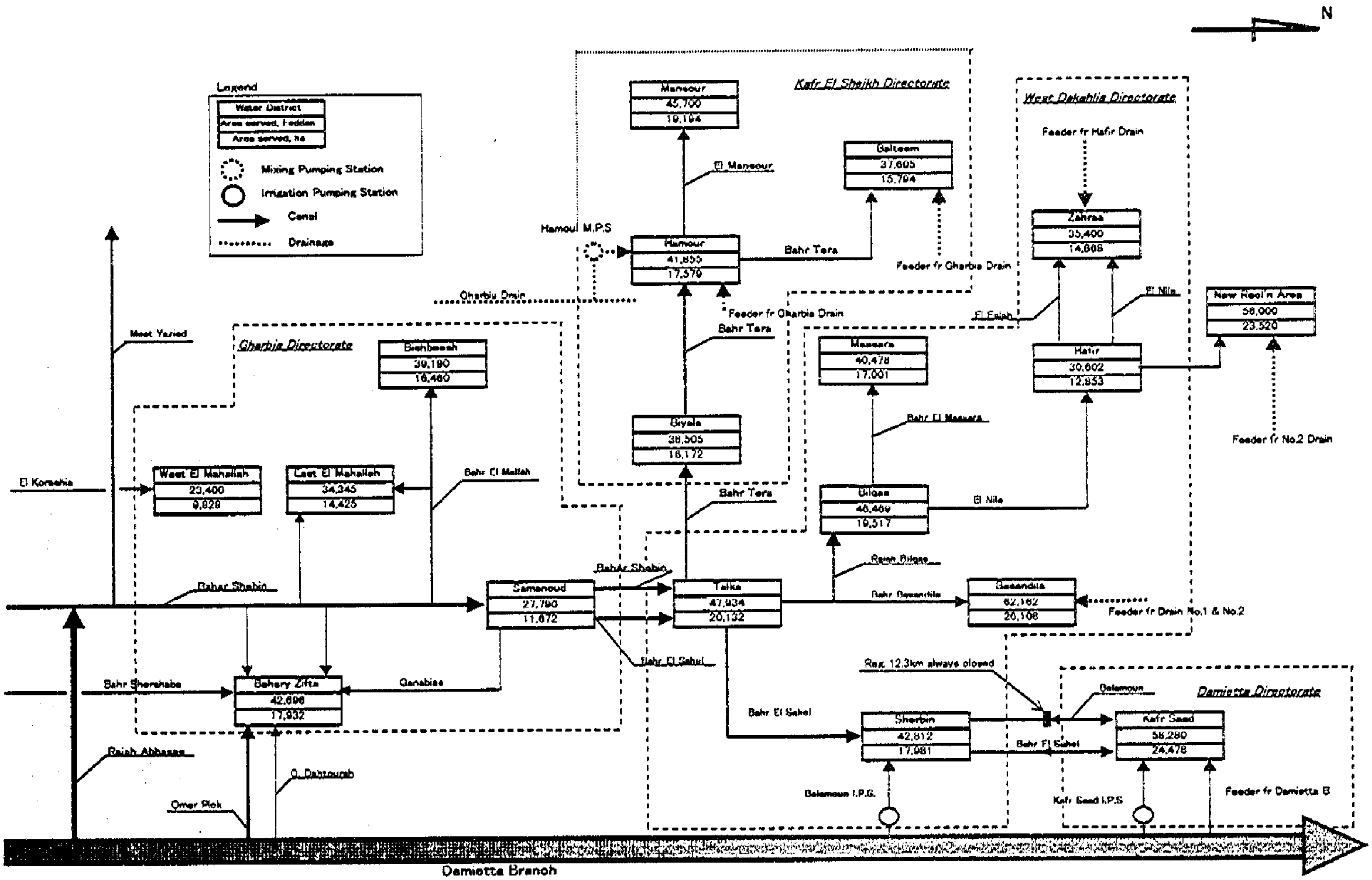


Figure 3.4.2 Schematic Diagram showing Relationship Between Major Canals and Water Districts

Figure 3.4.3 Irrigation Area served by Major Canals

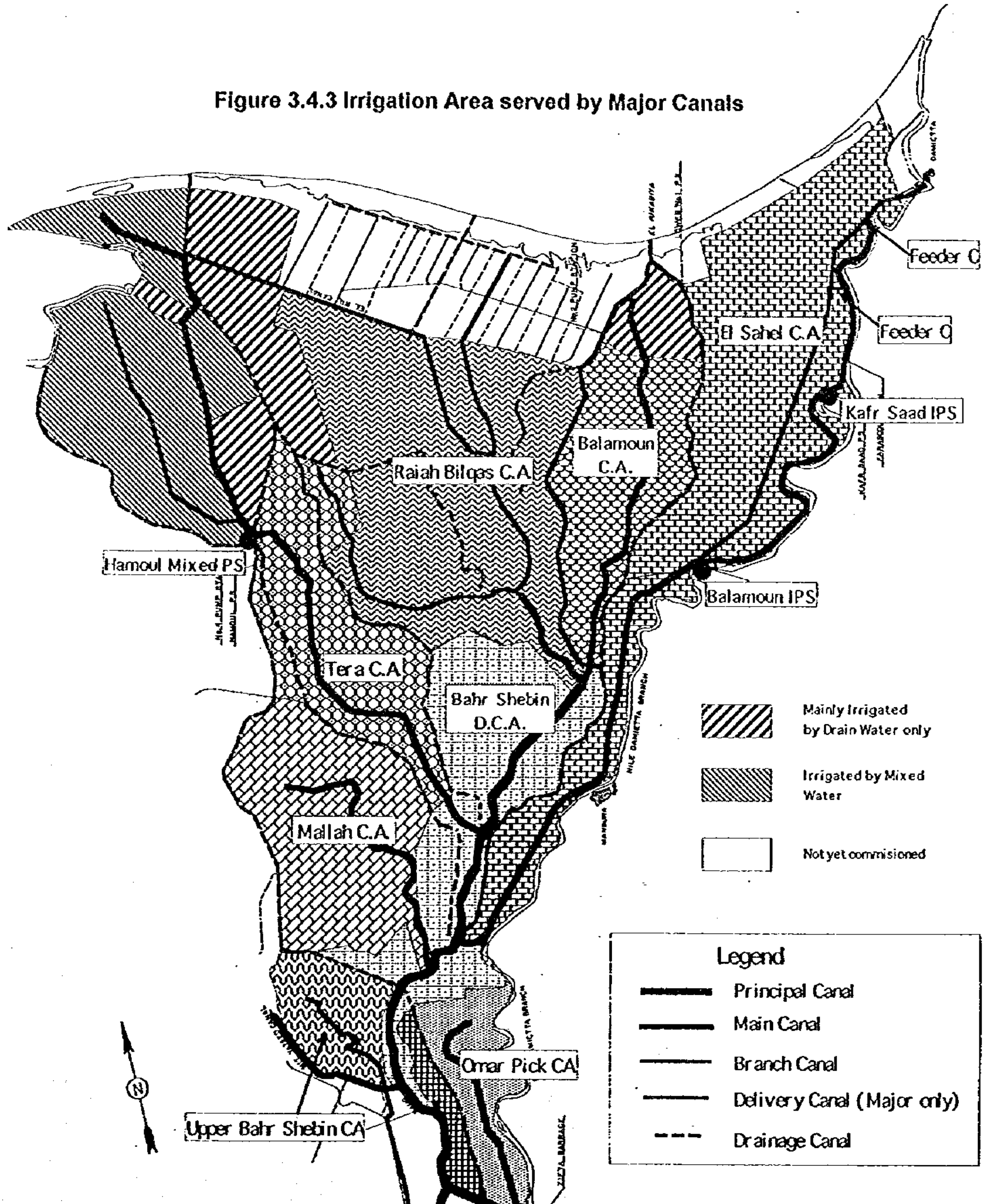
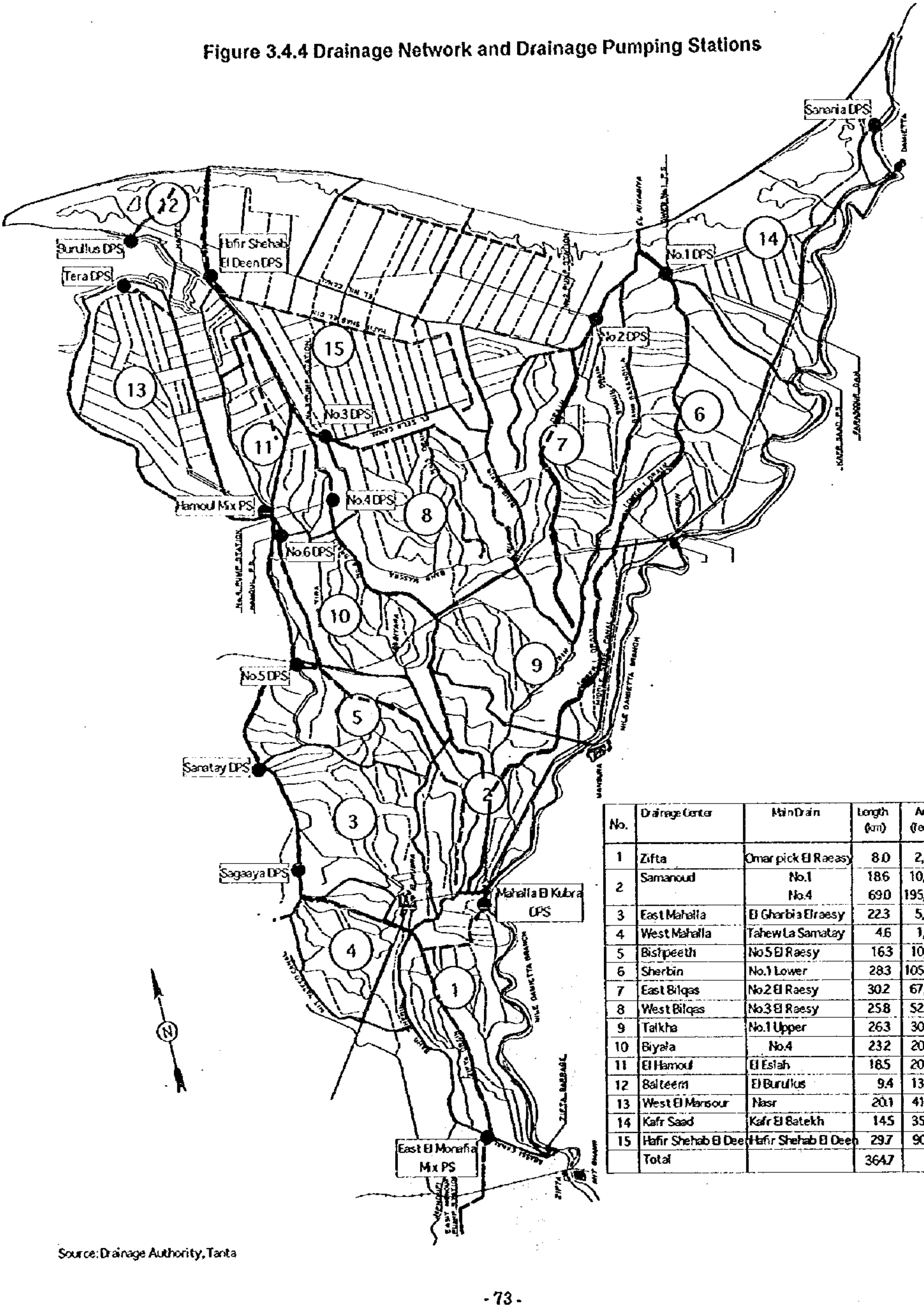


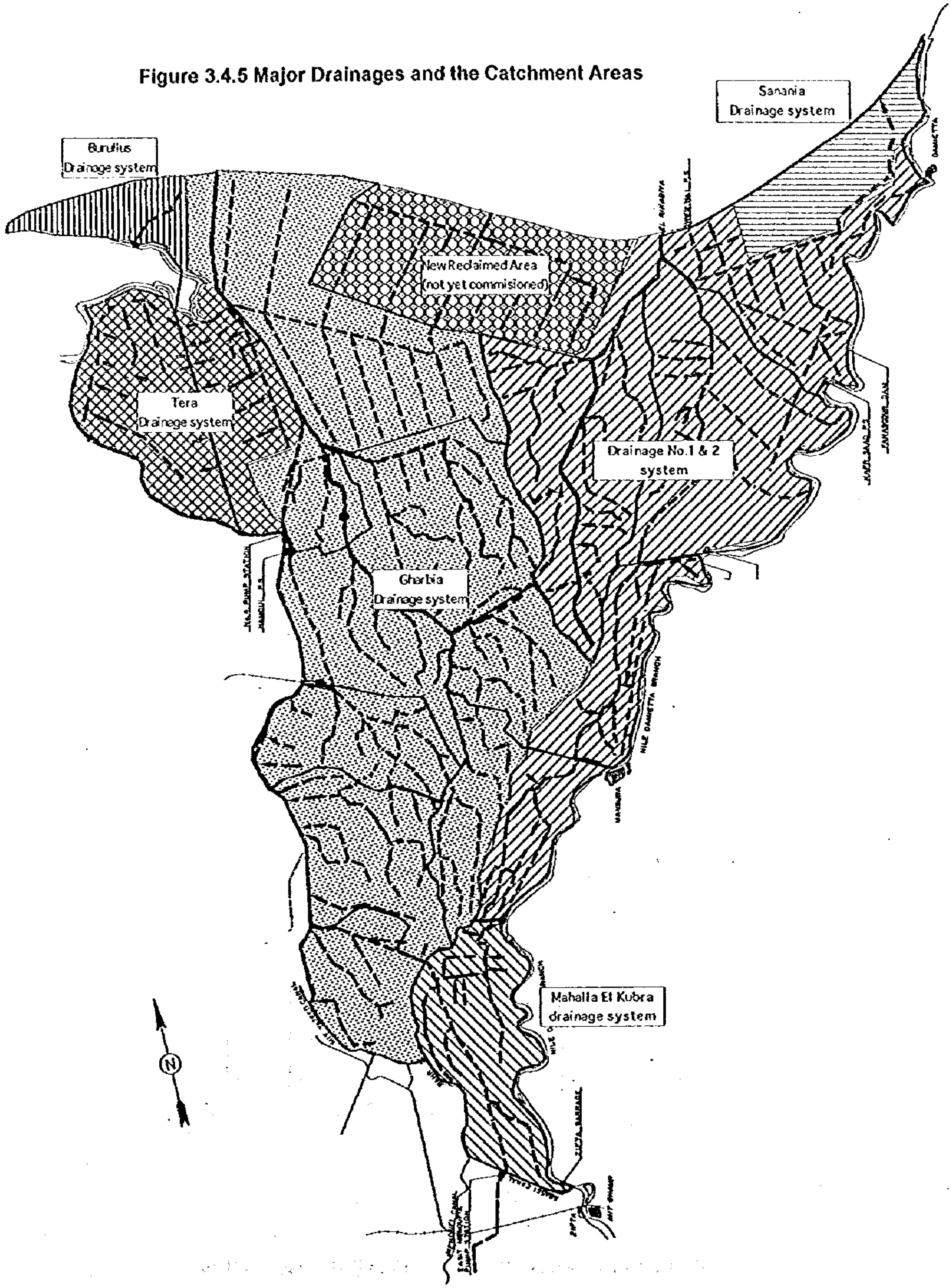
Figure 3.4.4 Drainage Network and Drainage Pumping Stations



No.	Drainage Center	Main Drain	Length (km)	Area (feddan)
1	Zifta	Omar pick El Raeasy	8.0	2,400
2	Samanoud	No.1	18.6	10,640
		No.4	69.0	195,000
3	East Mahalla	El Gharbia Elraesy	22.3	5,000
4	West Mahalla	Tahew La Samatay	4.6	1,200
5	Bishpeeth	No.5 El Raesy	16.3	10,500
6	Sherbin	No.1 Lower	28.3	105,000
7	East Bilqas	No.2 El Raesy	30.2	67,000
8	West Bilqas	No.3 El Raesy	25.8	52,700
9	Talkha	No.1 Upper	26.3	30,000
10	Biyala	No.4	23.2	20,000
11	El Hamoul	El Eslah	18.5	20,000
12	Balteem	El Burullus	9.4	13,100
13	West El Mansour	Nasr	20.1	41,000
14	Kafr Saad	Kafr El Batekh	14.5	35,100
15	Hafir Shehab El Deen	Hafir Shehab El Deen	29.7	90,000
	Total		364.7	

Source: Drainage Authority, Tanta

Figure 3.4.5 Major Drainages and the Catchment Areas



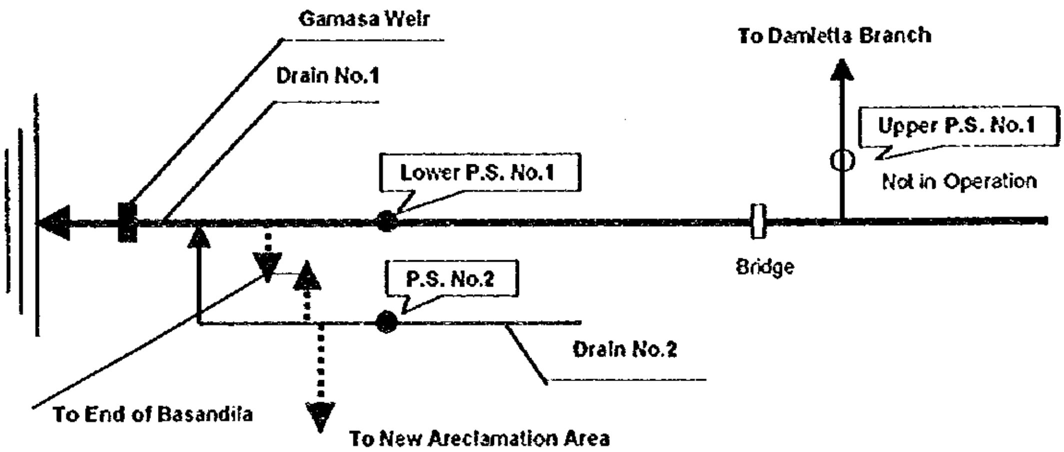


Figure 3.4.6 Schematic Diagram of Drain No.1 & No.2 System

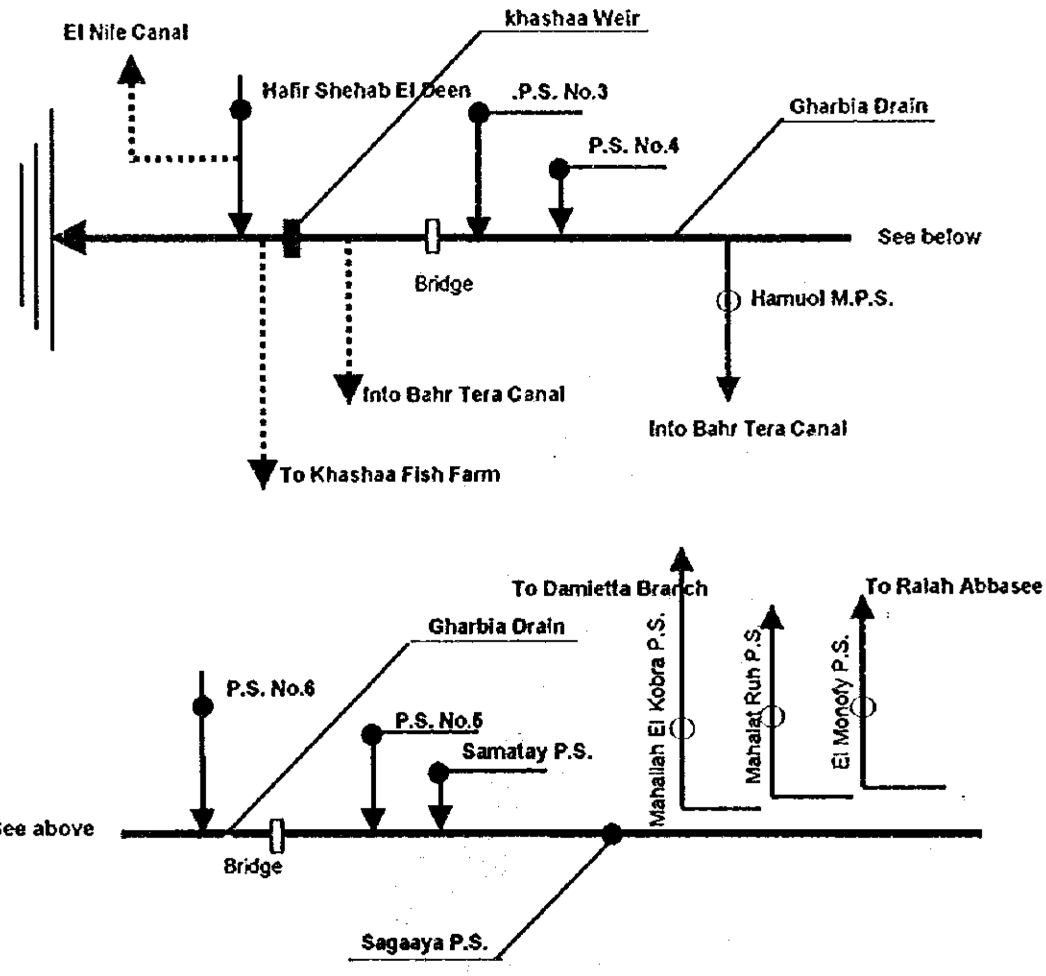


Figure 3.4.7 Schematic Diagram of Gharbia Drainage System

Figure 3.4.8 Subsurface Drainage Area as of May, 1998

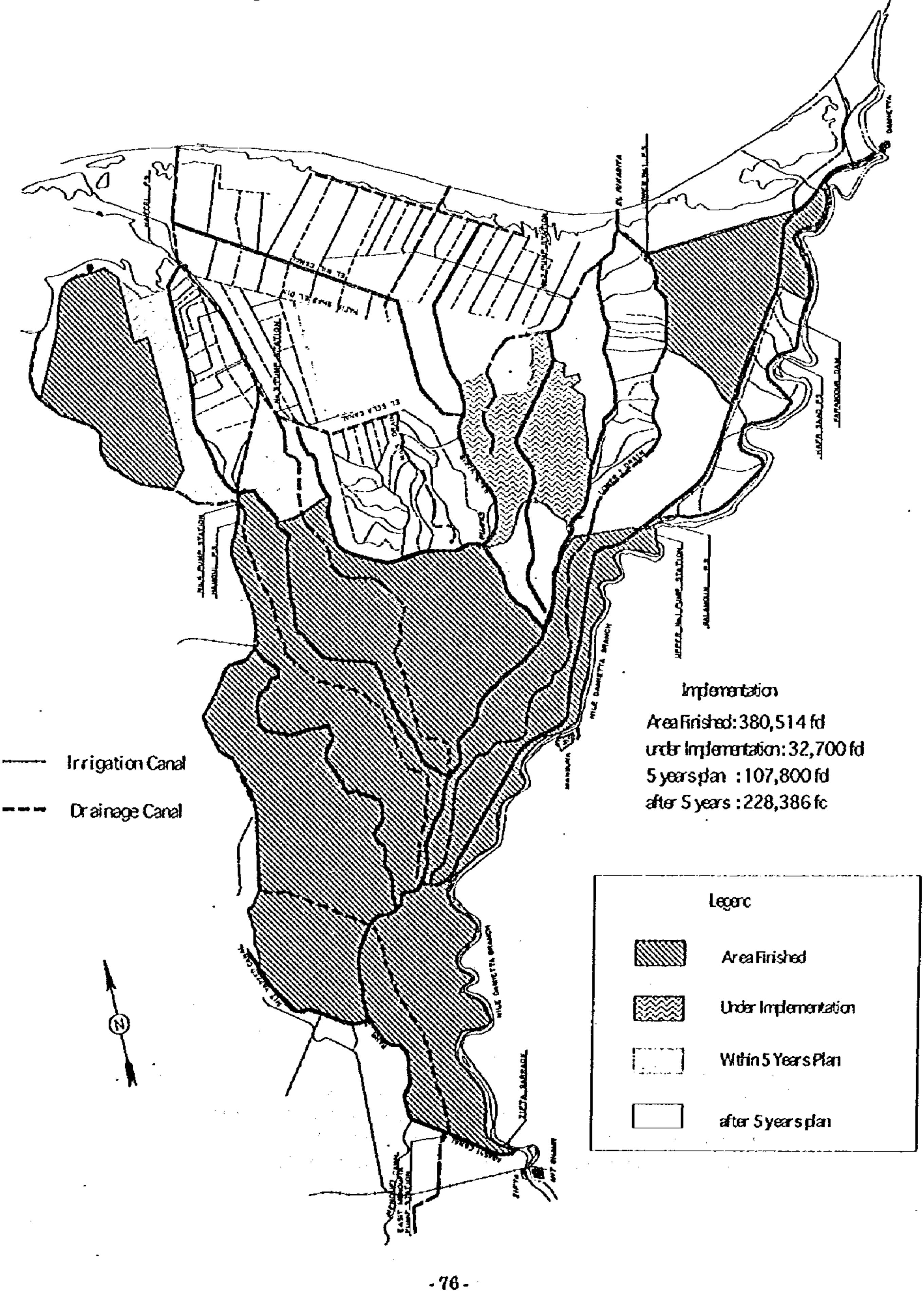
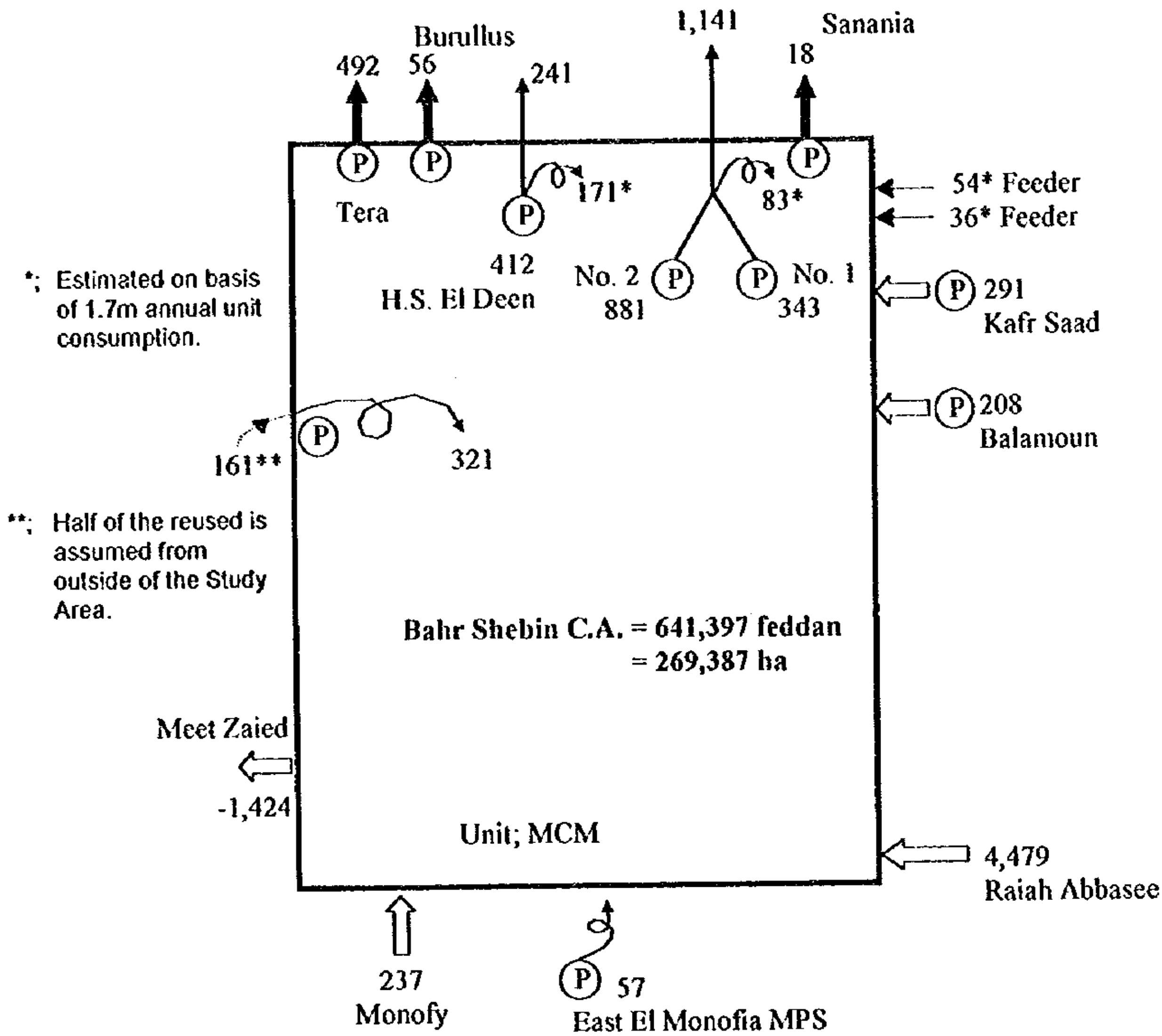


Figure 3.4.9 Overall Inflow & Outflow Balance in Bahr Shebin C.A.



Total Inflow; 4,479 + 237 + 57 + 161 – 1,424 + 291 + 208 + 54 + 36 = 4,099 MCM

Total Outflow; 492 + 56 + 241 + 1,141 + 18 = 1,948 MCM

Diff.; 4,099 – 1,948 = 2,151 MCM

Outflow/Inflow; 1,948 ÷ 4,099 = 48%

...... Cannot be reasonably accounted without groundwater return or sea water intrusion into the drainages.

Estimation of Return Flow;

Probable net consumption;	**1.7m x 0.66 (Ep) = 0.952 m**
	0.952 x 269,387 / 100 = 2,565 MCM
Volume net consumed;	**4,099 – 2,565 = 1,534 MCM**
Minimum probable return;	**1,948 – 1,534 = 1,534 MCM**

3.5 Irrigation and Drainage Facilities

3.5.1 Present Condition of Irrigation Facilities

(1) Water Intake Work and Principal Canal

The Zifta barrage was the first major structure built on Nile River to control and operate water in the Study Area through the water canal network. The canal to introduce water to the beneficial area with intake structures were implemented in three (3) parts (G. Dahtourah, Omar Pick and Raiah Abbasee canals) installed with a total of ten (10) gates. One of the principal canal (Raiah Abbasee) was constructed with 287 cu.m/sec design capacity including 270 cu.m/sec from the Zifta Barrage and 17 cu.m/sec from the Monofy canal coming from the Delta Barrage. These three (3) parts water intake structures are equipped each with a leaf gate of vertical operation by manual hoist system.

(2) Main Irrigation Canal Networks

The design capacity of 287 cu.m/sec in the Bahr Shebin principal canal has been allocated to the Meet Yazied main canal (90 cu. m/sec), Bahr El Malah main canal (25 cu. m/sec), downatream reaches of Bahr Shebin canal (regulator: 150 cu.m/sec) and Sahel main canal (22 cu.m/sec).

These canal networks were implemented without lining except for a few part of villages and transformed into flood trace routes during the previous years. The canal type is trapezoidal in form with long width and shallow depth. The design water level in all the canal networks are normally set below ground level of about 1.0 m. It is said that the reason for the water level is to control ground water level and to prevent over irrigation. Weeds grown inside the canals and on the canal shoulders are disturbing discharge and stable slopes.

(3) Irrigation Water Supply at Terminal Area

In relation to the main canals, the water supply canal networks composed of 357 delivery canals (including branch and /or tertiary canals) and the water is supplied from the delivery canals through Meska to farm lands. The design water level is below the ground level up to Meska. Mobil small pumps with diesel engine are used to lift the water from Meska onto a farm land. Inside a farm land, the water is distributed through Marwa, a small water way temporary made. The power of the traditional Sakiya, operated by animal power is a half of the small pump.

(4) Water Operation and Control Devices

Water supply is controlled by a regulator along the major canal, water intake structures at each water diversion work and/or turn out structures along the branch and delivery canals. These structures have been installed with Fahmy Henien gates with manual hoists. These hoist gate are not equipped with gate opening meters and discharge gauges. However, several regulators and diversion structures along the main canal have been equipped with water level measuring device at the upper and lower streams locations for monitoring of water levels. Water level monitoring system has been adapted by a Very High Frequency (VHF) radio transmission for data transfer system between each site and water operation and monitoring room at the IIP in Mansoura and Tanta.

3.5.2 Present Condition of Drainage Facilities

The drainage system in the Study Area consists of two (2) types, which are open drains and sub-surface drains. The field sub-surface drainage system consists of collector drains and sub-lateral drains. A collector drain is a concrete pipe from 15 cm to 40 cm bore set in average depth of 1.35 m and 40 to 60 m interval. Manholes with 1.0 m across are set every 180 m of the collector drain. As for a sub-lateral drain, corrugated PVC tubes of 80 mm bore is set in 20 to 30 m interval according to the ground condition. The drainage lines are connected to a main open drainage canals and part of the drain water collected was released by drainage pumping stations toward the Mediterranean Sea.

3.5.3 Irrigation and Drainage Pumping Stations

In the Study Area, there exist 15 irrigation and drainage pumping stations. The drainage pumping station located at the left bank of the Nile River is not operational at present because there is an intake for municipal water downstream and the drainage water quality is not acceptable for it. The five (5) irrigation pump stations located along the main drainage canals are operated to control the water level of drains more than 50 cm from the outlets of sub-surface drains. These stations have four (4) pump sets and the capacity for a pump is 3.0 to 7.5 cu. m/sec.

Above all, the Hamoul Mixing Pumping Station is so old that the lowering pumping function is reported (pumping efficiency has been decreased to less than 0.3). Also the operation is often suspended due to the risk of cavitation when the water level in Gharbia drain is low. This causes water shortage in the area of 84,755 feddan (35,597 ha) served by the mixing water in the downstream reaches leading to the low cropping intensity and low unit yield in the area.

3.6 Water Management and O&M

3.6.1 National Level

(1) Institution and Operation

MPWWR is responsible for the overall water administration in the Republic of Egypt and its organization chart is shown in Figure3.6.1. The systematic management of the precious Nile water characterizes water administration in the Republic.

The Irrigation Department is the responsible organization for water management. There are 24 Irrigation Directorates under the Department for local administration as per Figures3.6.2 and 3.6.3. Four Irrigation Directorates are involved in the Study Area as indicated in Figures 3.6.2 and 3.6.4. Meanwhile, as far as water distribution is concerned, the shaded organizations in Figure 3.6.1 are directly involved. MPWWR is also supported by the National Water Research Center as presented in Figure 3.6.5. The Water Management and Irrigation Systems Institute under the Center is closely related to the scope of the Master Plan Study.

The operational water management basically follows the diagram illustrated in Figure 3.6.6 which indicates information flow in terms of request, instruction, notification, reporting, monitoring and verification. The release amount from Lake Nasser (also called the Aswan High Dam Reservoir) is stipulated by an agreement with Sudan with an amount of 55.5 billion MCM per annum, considered as a given condition for the water operation in the Republic. (See Figures 3.6.7.)

The water distribution of the above amount has been conducted under the initiative of the Irrigation Sector except the strategy crops such as rice, cotton, wheat and maize. Since many farmers want to plant rice during the summer season, the Governorate level Committee composed of MPWWR and MALR coordinates the rice cultivation area prior to commencement of rice planting.

Computer processing has been undertaken by MPWWR headquarter or by each Irrigation Directorate to estimate the amount of water distribution by canal or by Water District. (See Figure 3.6.4) The nationwide water requirement estimation for water distribution is as mentioned in the following (2). The water requirement estimation in the Study Area is presented in 3.4. It is noteworthy that MPWWR has already accumulated sufficient experiences in terms of the information management.

To monitor the distributed water, the Telemetry Project, a part of the Irrigation Management System (IMS), has been under operation at 830 hydraulic observatories over the Nile water courses since 1991. There are 200 sites of Meteor Burst Data Collection System (MBDCS) and 630 sites of Voice and Data Communication System (VDCS) or 830 sites in total from where the hydraulic data are transmitted to the Master Station at the Delta Barrage site via Submaster Stations through VHF. The Master Station is directly connected to the MPWWR headquarter with the Local Area Network (LAN) to share the data. The location of the monitoring sites in the Study Area are shown in Figure 3.6.8.

(2) Nile Water Distribution

The Nile water distribution is based on the procedure shown in Figure 3.6.9. The water requirement is calculated following the example of the West Dakahlia Irrigation Directorate as per Appendix Tables H.1.1 (A) to H.1.6 (DT). (Hereafter abridged (A) or (DT))

The entire land is divided into three Water Duties Regions. The water duties in the Region Delta are applied to the Study area. The water requirement estimated for the 44 crops with ten-daily computation interval are shown in (A). The cropped area in the Directorate is arranged by canal as shown in (B). The cropping pattern by canal are estimated from (A) and (B) as presented in (Dn). (DT) means summation of (Dn) indicating the cropping pattern of the entire specific Irrigation Directorate.

The water requirement by canal is shown in (Cn) and estimated as products of (A) and (B). (CT) denotes the total water requirement in the specific Irrigation Directorate. Further, the municipal and industrial water, drainage reuse amount, groundwater amount, augmentation factor and conveyance loss are also considered to estimate the release amount from Lake Nasser to the specific canal as shown in the upper right of Figure 3.6.9. The sum of the 38 principal canal corresponds with the annual release amount from the Lake and is identical to the sum of 24 Irrigation Directorates.

The estimation method so far stated is illustrated in Figure 3.6.7 in case of 1989/90. The rectangular frames in Figure 3.6.7 demonstrate the summation of the horizontal ovals indicating the flow amounts. The navigation water is separately treated from the irrigation water and M&I water as is evident from Figure 3.6.7. It is conceivable that there works a hydraulic mechanism as depicted in Figure 3.6.10 behind "the Annual Water Balance in Egypt" shown in Figure 3.6.7. The constraints identified from the above estimation of the water distribution are described in 3.12.4.

3.6.2 Irrigation System in the Study Area

The irrigation system in the Study Area is as shown in Figure 3.6.11 and consists of barrage, irrigation canal, regulator and pumping plant. The irrigation canals are widely developed over the area playing a pivotal role among the system. The irrigation canals are classified into principal canal, main canal, branch canal, delivery canal, Meska and Marwa. MPWWR manages canals up to the delivery canal while farmers group manages Meska and Marwa.

The principal canals in the Study Area refer to Monofy Canal, Raiah El-Abbasee and Bahr Shebin as indicated by thick line in Figure 3.6.11. The main canals branch off from the principal canals and are identical to Meet Yazied, Bahr El-Mallah, El Sahel, Bahr Tera, Raiah Belkas and Bahr Basandila (or Bahr Shebin Extension) as presented by medium line in Figure 3.6.11. Further, the branch canals denote branches from the main canals and is shown by fine line in Figure 3.6.11. The delivery canals branch off from the branch canal and are operated under rotation irrigation practices with four day-on and four day-off during the summer season.

Regulators are placed on the principal canals. Rahbeen regulator between Bahr El-Mallah and Bahr Tera, and Demara regulator between Bahr Tera and Raiah Belkas are the representative ones. Among the irrigation facilities, several regulators and intake gates are seriously deteriorated so that it is difficult to ensure the design water level in the downstream section of the canals. Further, at several places, canal banks are eroded. The eroded soils are deposited at the canal bottoms hindering smooth canal flow. In addition, trash are thrown into the canals obstructing the canal flow bringing about social problems for proper maintenance operation and water quality control.

3.6.3 Drainage System in the Study Area

The drainage system in the Study Area is presented in Figure 3.6.11 and comprises drainage pumping plant, drain and tile drain playing significant role over the downstream zone of the Delta. The main drainage canals are aligned between the main irrigation canals in general and emptied into the Mediterranean Sea joining several main drainage canals. Weirs are also provided across the drainage canals to dam up released water that is pumped up for irrigation reuse. The Hamoul mixing pumping plant is a typical case in the Area.

The reuse of drained water is preferable from the viewpoint of effective use of water resources. In the meantime, due attention is called for the reuse of drained water because it involves the following serious problems. That is, repetitive uses of drained water within the closed basin cause the deterioration of soil texture in the field. This trend has been accelerated in the recent years due to drain water contamination and introduction of powerful vertical pumps in the downstream reaches of the drainage canals.

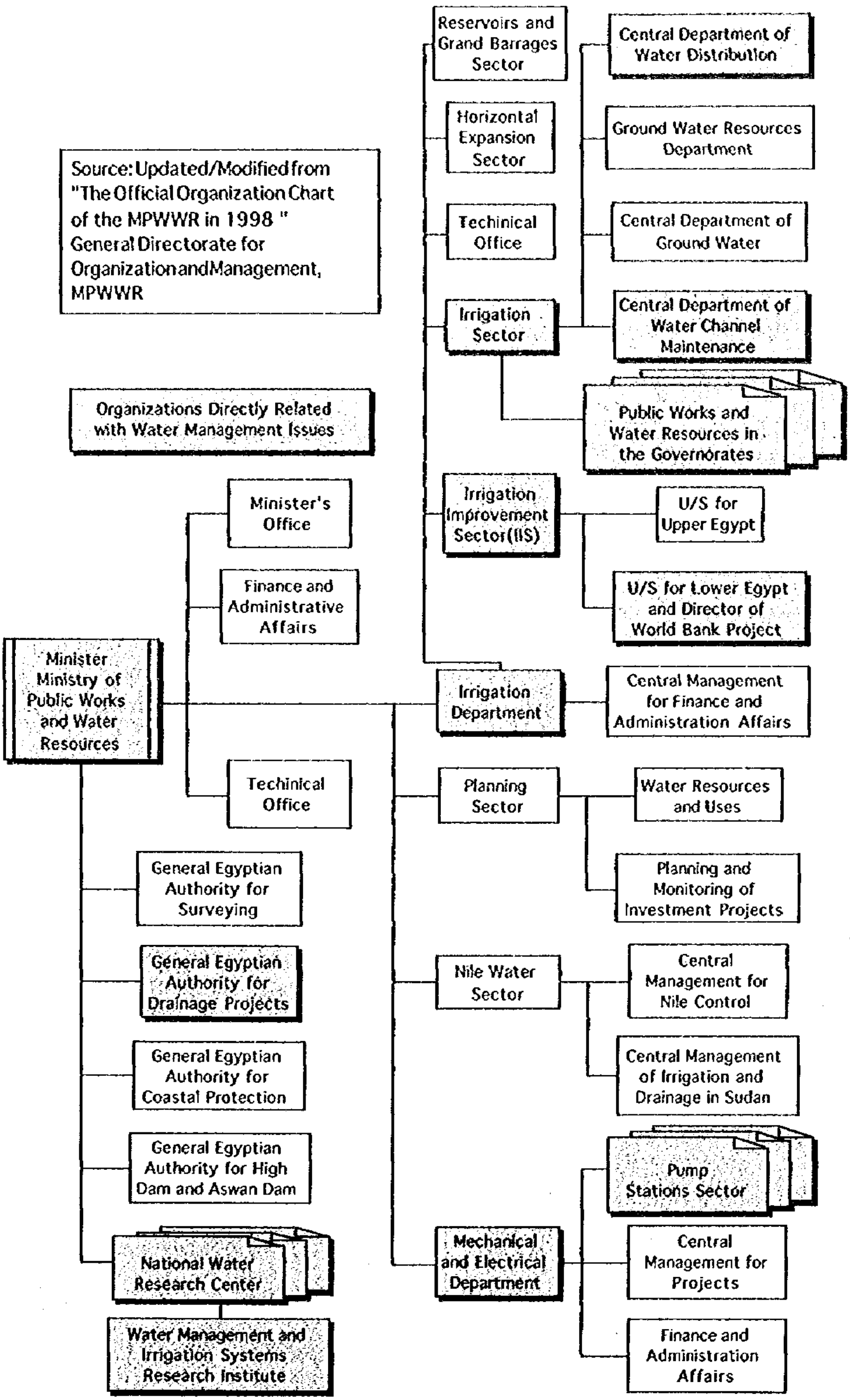


Figure 3.6.1 Organization Chart of MPWWR

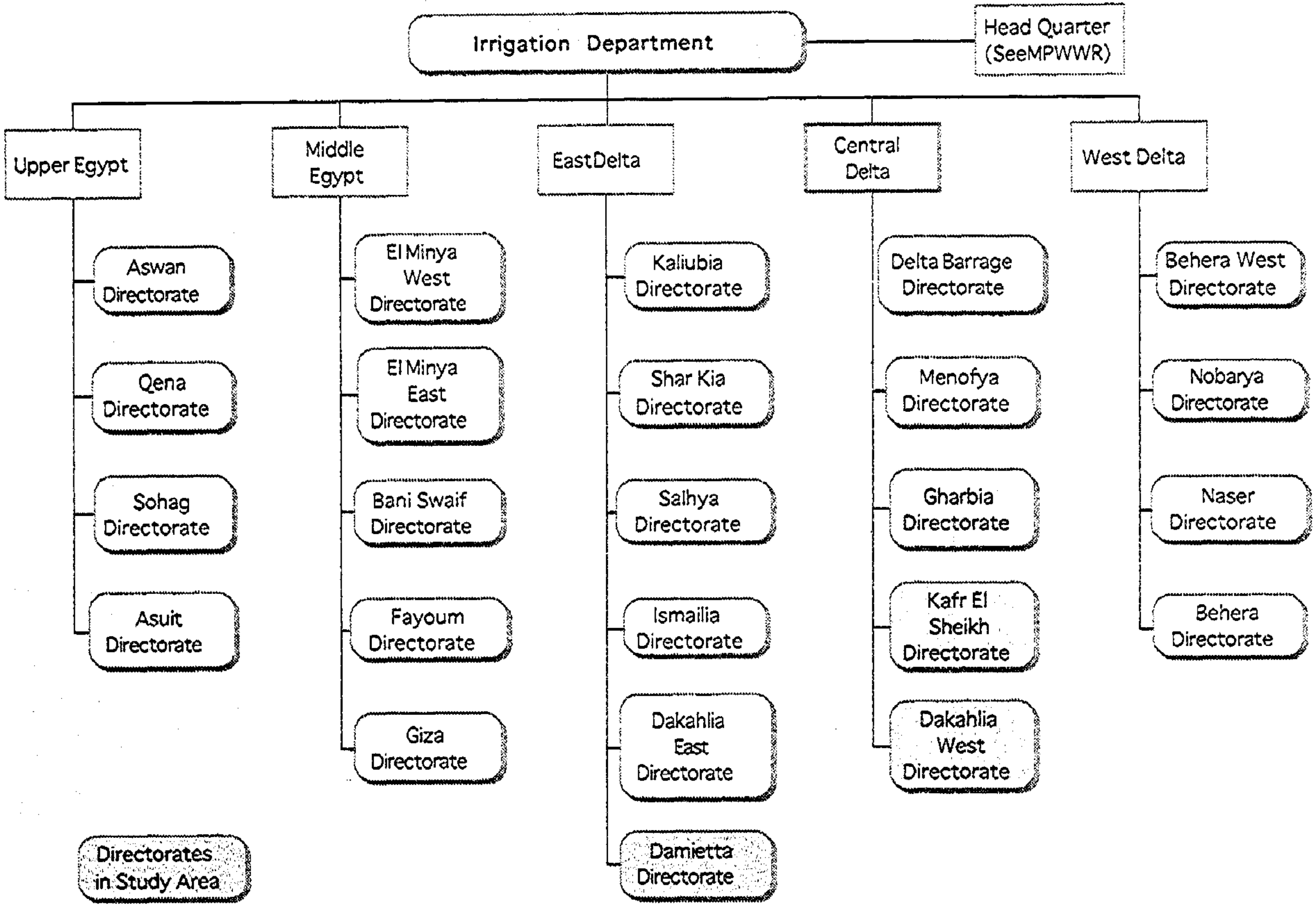


Figure 3.6.2 Irrigation Directorates

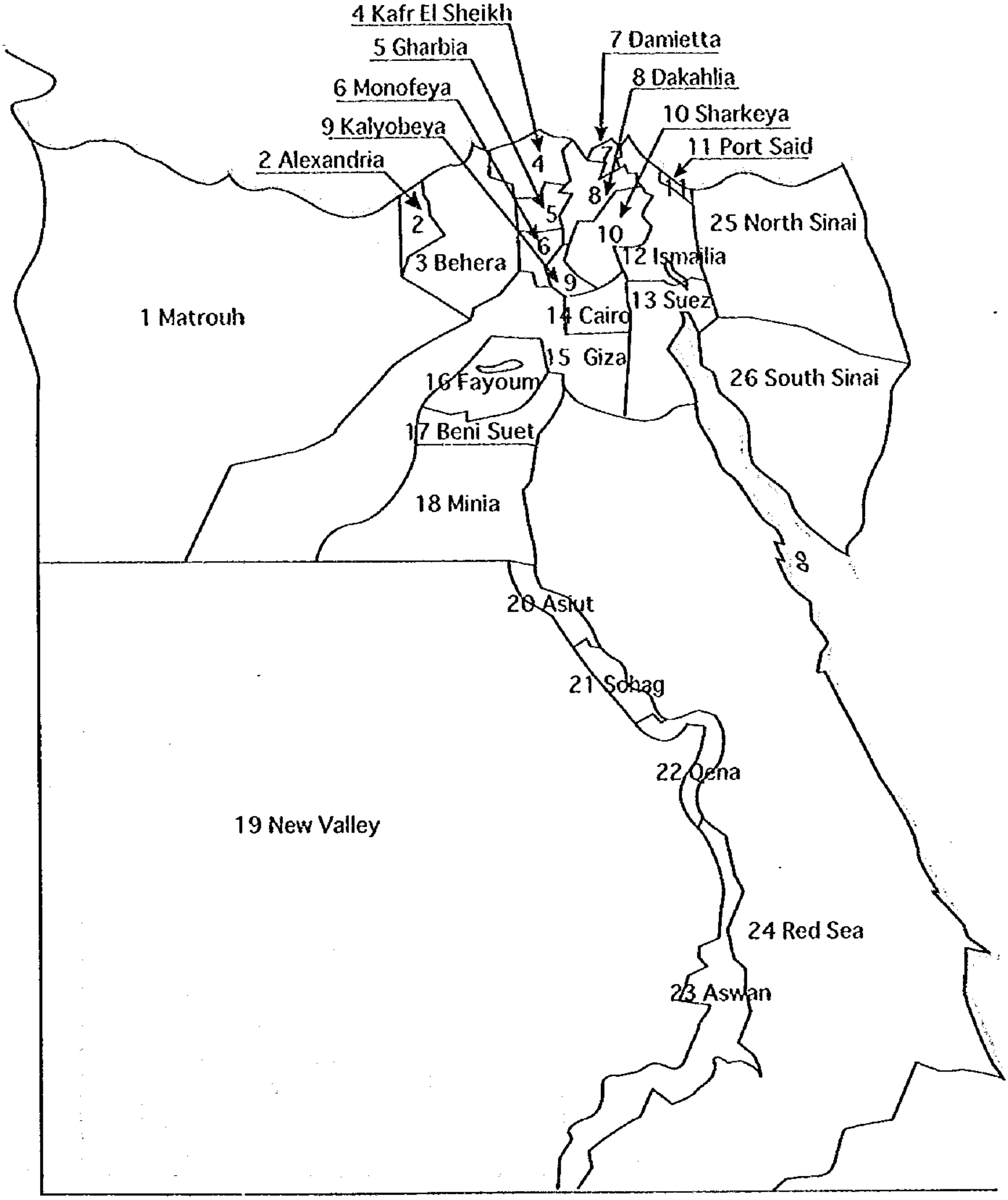
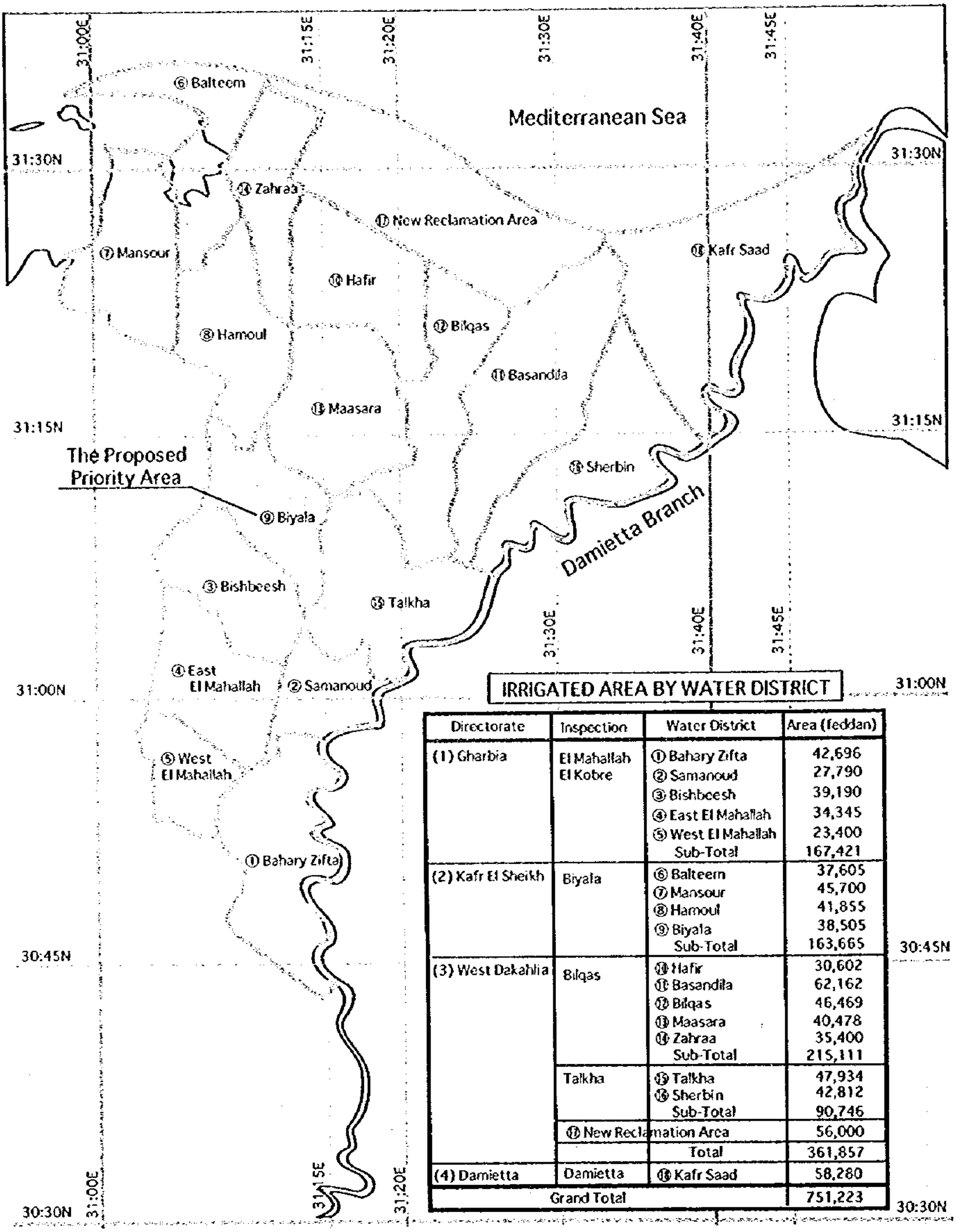


Figure 3.6.3 Governorate Map



IRRIGATED AREA BY WATER DISTRICT

Directorate	Inspection	Water District	Area (feddan)
(1) Gharbia	El Mahallah El Kobre	① Bahary Zifta	42,696
		② Samanoud	27,790
		③ Bishbeesh	39,190
		④ East El Mahallah	34,345
		⑤ West El Mahallah	23,400
		Sub-Total	167,421
(2) Kafr El Sheikh	Biyala	⑥ Balteem	37,605
		⑦ Mansour	45,700
		⑧ Hamoul	41,855
		⑨ Biyala	38,505
		Sub-Total	163,665
(3) West Dakahlia	Bilqas	⑩ Hafir	30,602
		⑪ Basandila	62,162
		⑫ Bilqas	46,469
		⑬ Maasara	40,478
		⑭ Zahraa	35,400
		Sub-Total	215,111
	Talkha	⑮ Talkha	47,934
		⑯ Sherbin	42,812
		Sub-Total	90,746
	⑰ New Reclamation Area		56,000
		Total	361,857
(4) Damietta	Damietta	⑱ Kafr Saad	58,280
Grand Total			751,223

Figure 3.6.4 Location Map of Water District

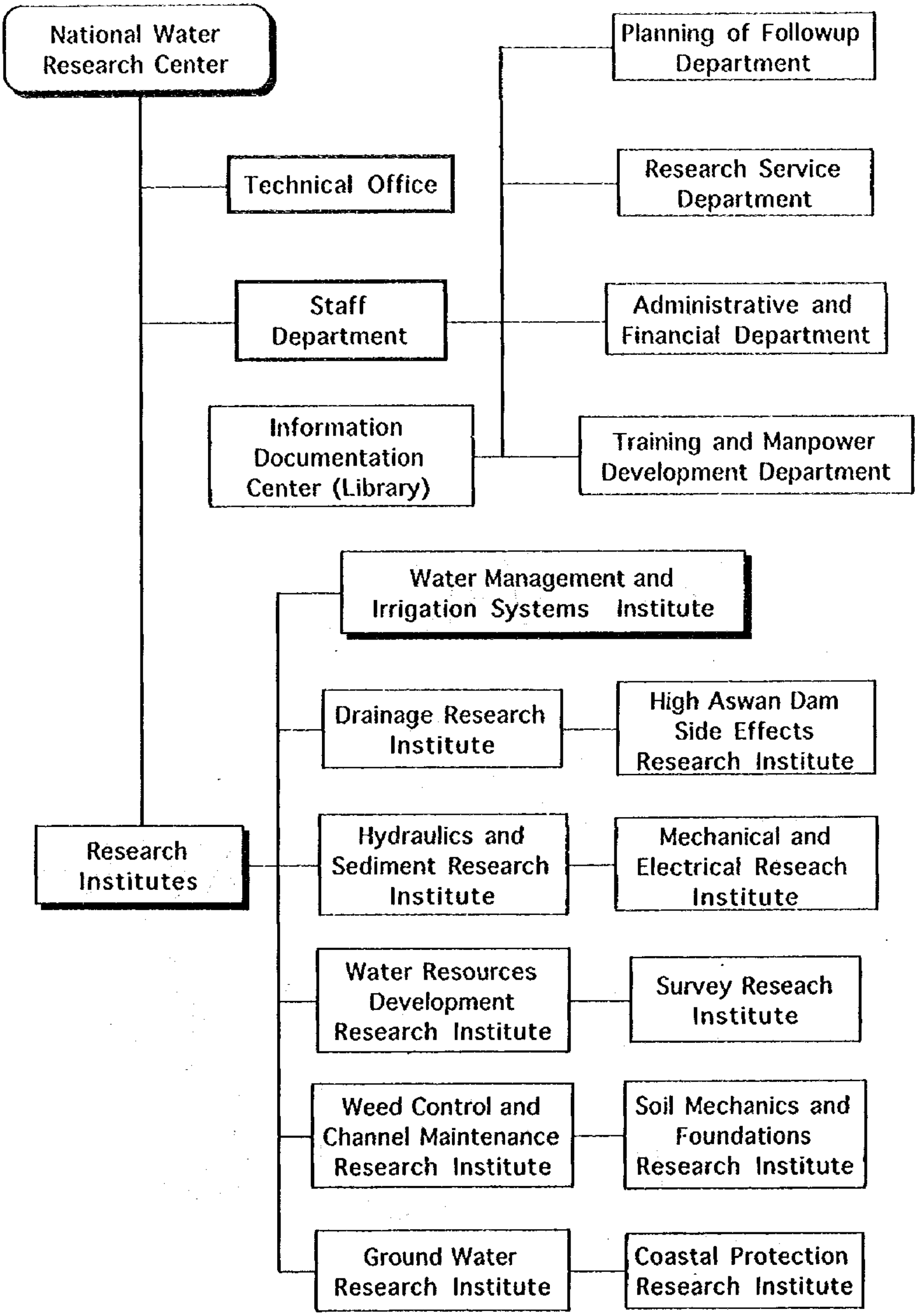


FigurE 3.6.5 Organization of Water Research Center

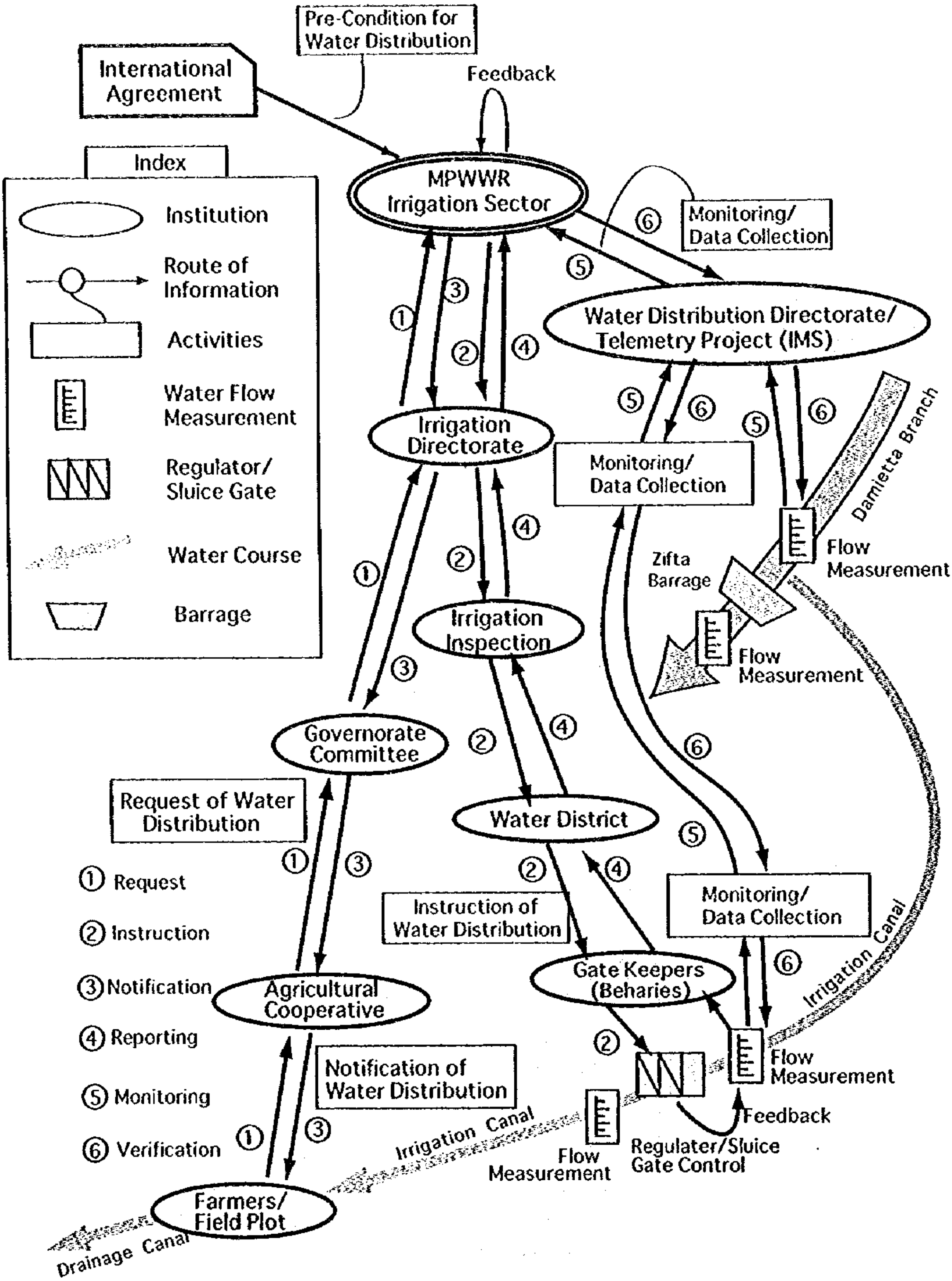
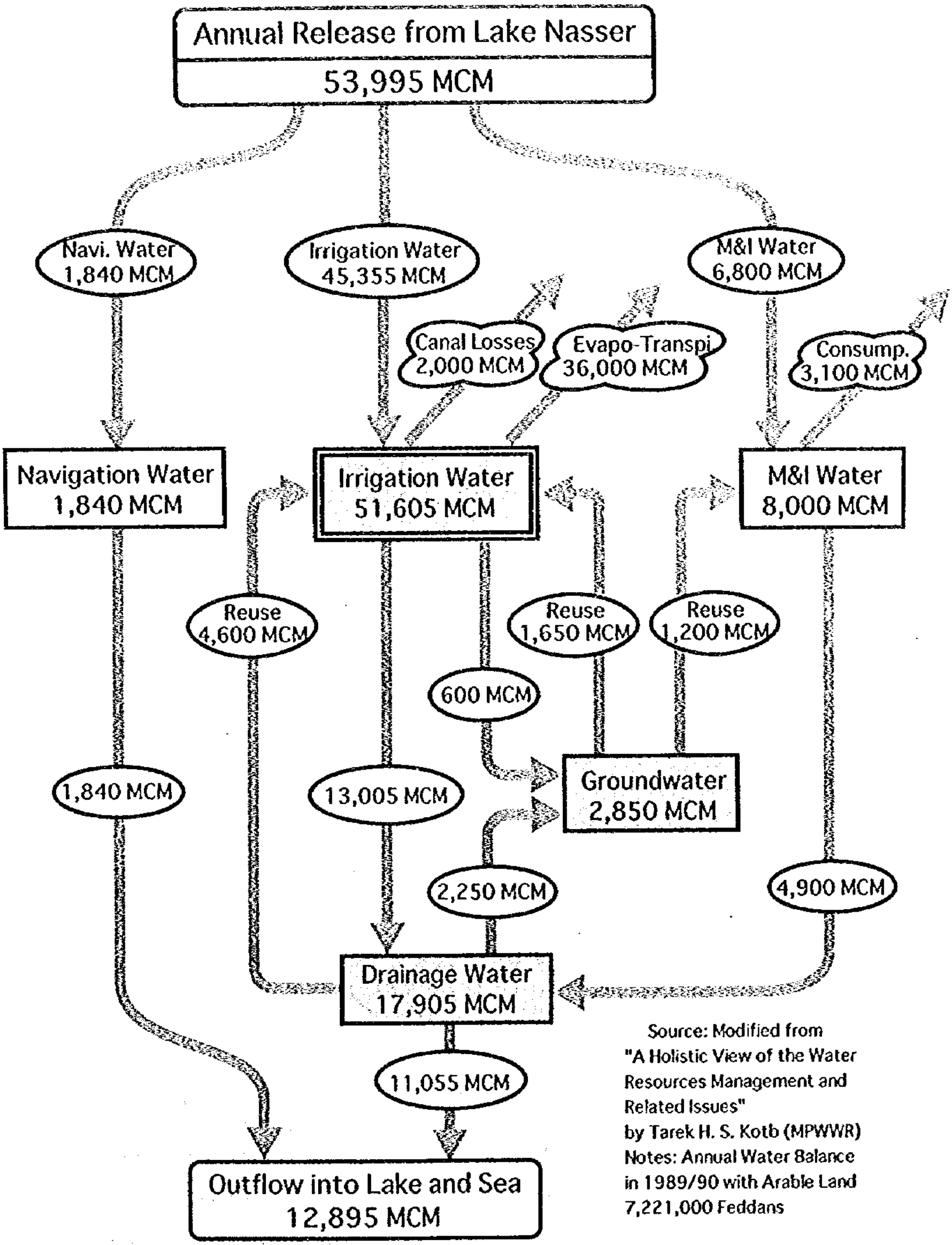


Figure 3.6.6 System Diagram in Water Management



Source: Modified from "A Holistic View of the Water Resources Management and Related Issues" by Tarek H. S. Kotb (MPWWR)
Notes: Annual Water Balance in 1989/90 with Arable Land 7,221,000 Feddans

Figure 3.6.7 Annual Water Balance in Egypt

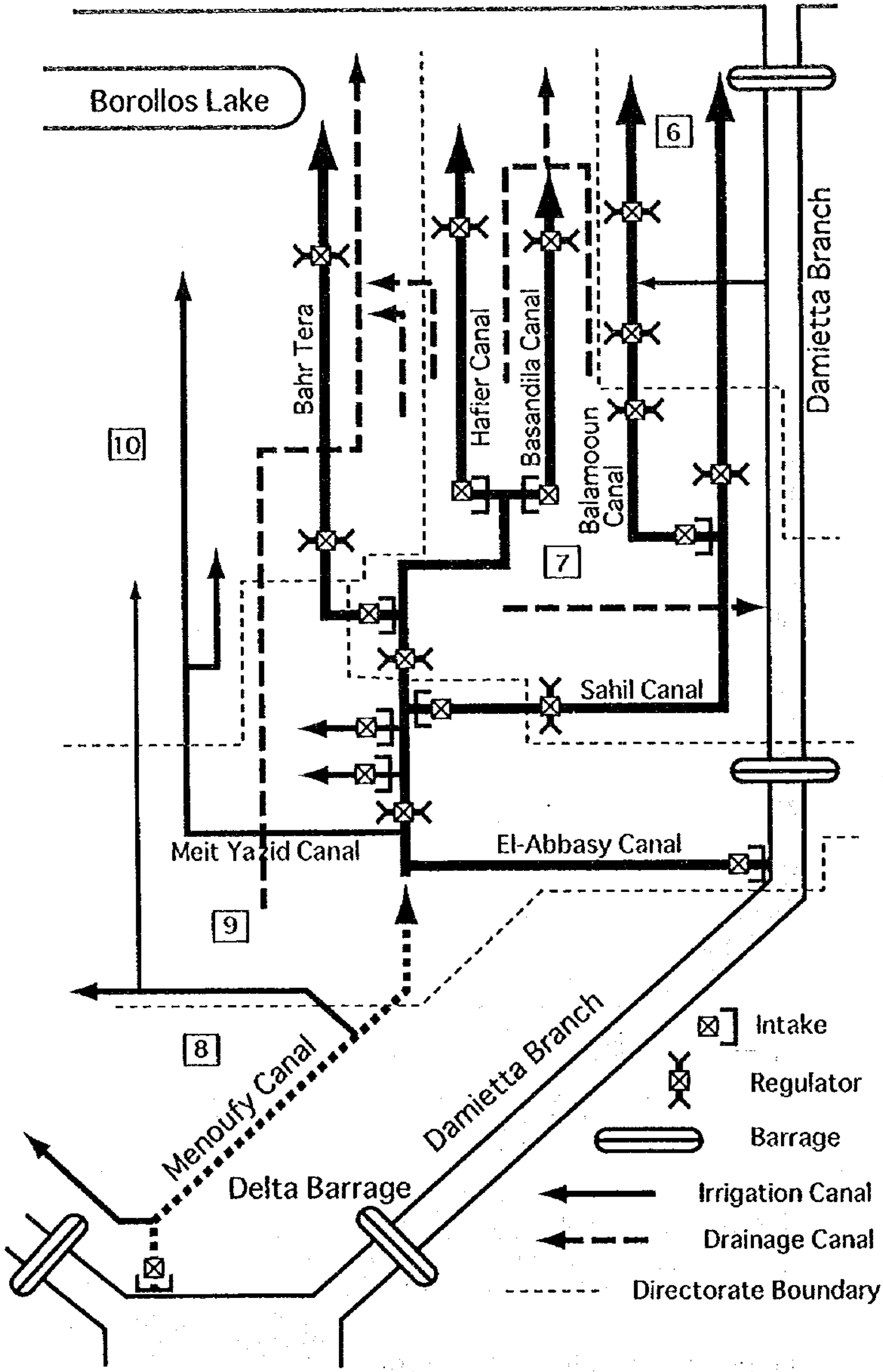


Figure 3.6.8 Main System Management

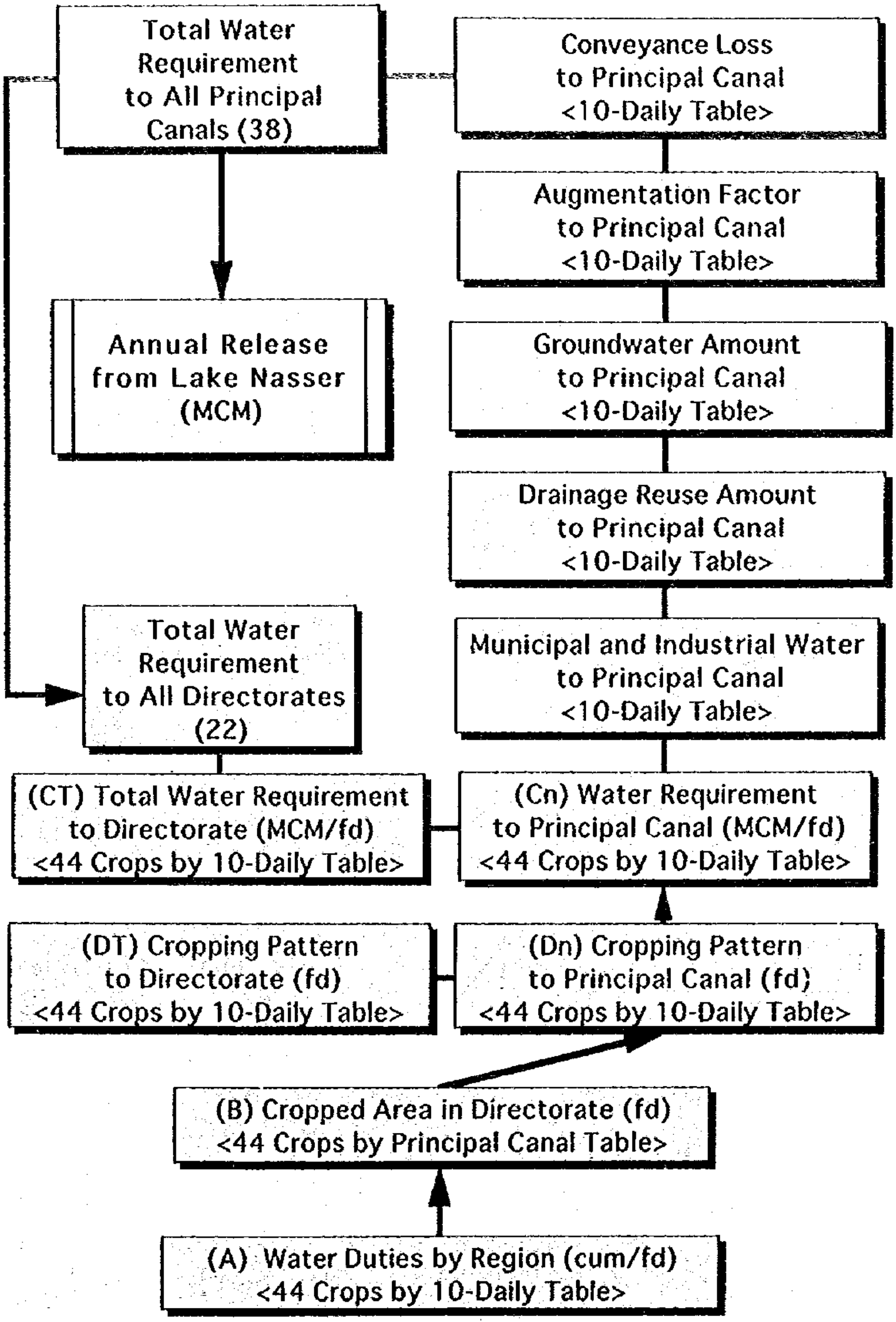


Figure 3.6.9 Estimation of Water Requirement

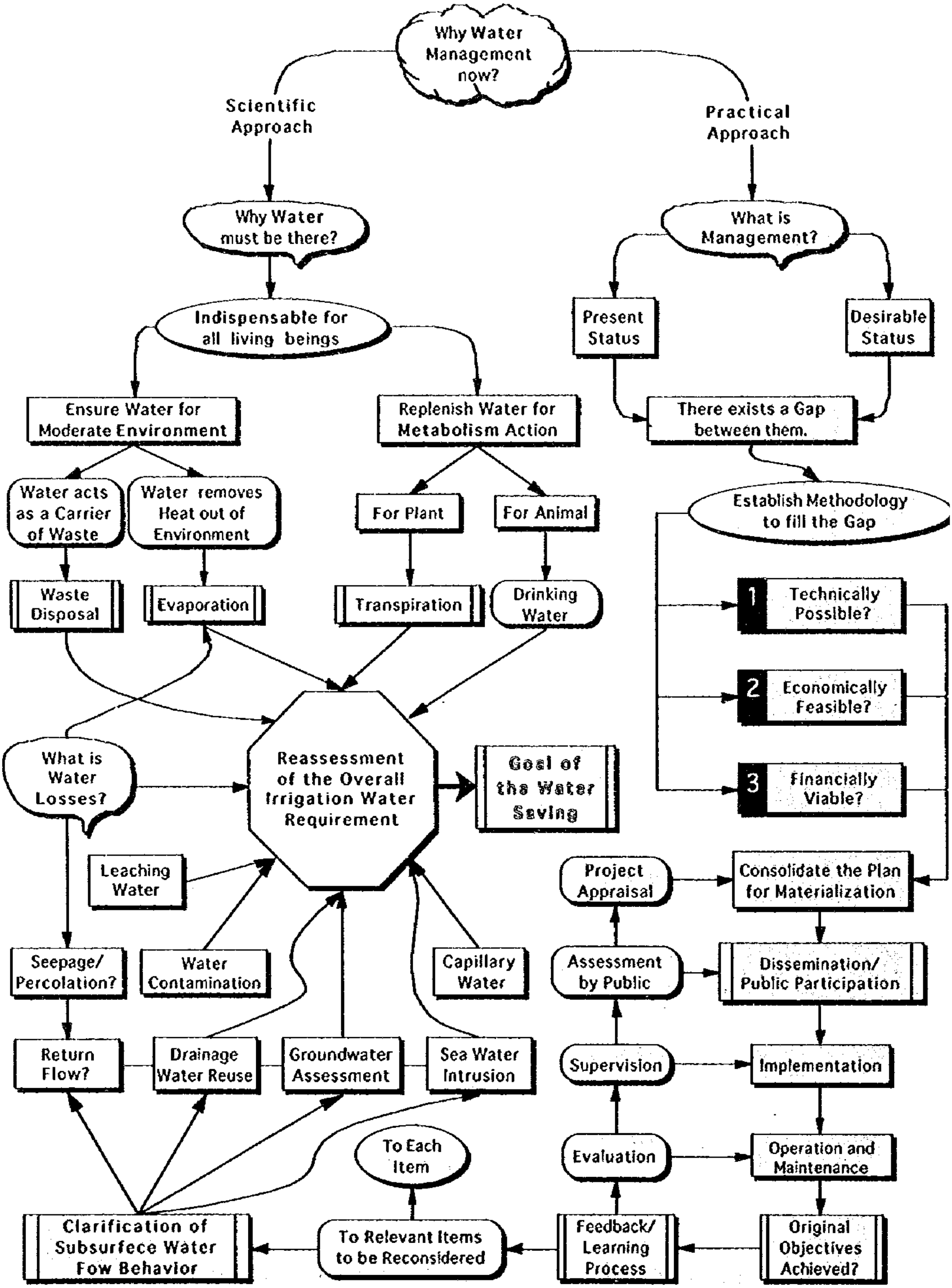


Figure 3.6.10 Overview of Water Management Issues

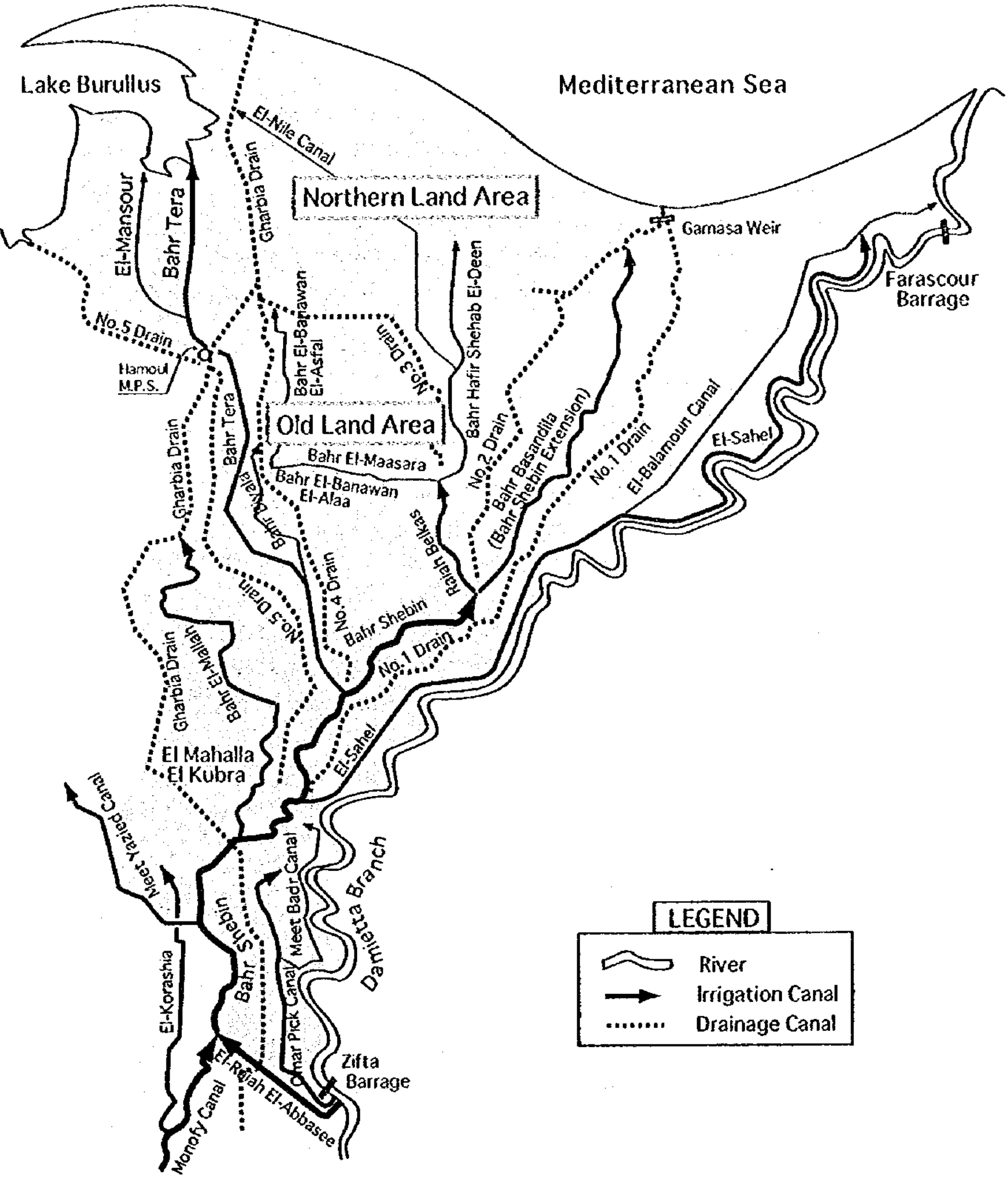


Figure 3.6.11 Canal Alignment in Study Area

3.7 Rural Community and Farmers' Organization

3.7.1 Rural Community

For the purpose of deepening understanding as per the relationship among rural society, farmers' willingness/incentives and IIP cum IAS, the Rural Sociology Survey has been done in which 11 delivery canals were selected and each 6 farmer was interviewed from the selected canals respectively, therefore 66 farmers replied on to the survey in total. Some focal points obtained from this survey are briefly shown in < >, in accordance with some other results obtained from the preceding economic survey in { }, respectively (In more detail, see Appendix J.2).

1) Average number of farmers: <96 per meska>
2) Each maska has around <17 marwas>
3) Accordingly <5 - 6 marwa intakes per meska>
4) Number of meska canals each farmer uses: {1.2 canals/farmer}
5) Irrigation pattern in each meska: individual use{75%}, grouping use{25%}
6) "Saqiya Ring" or other traditional incorporation: have<64%>, not have<36%>
7) Experiences of water shortage: yes{95%}, no{5%}
8) Magnitude of water shortage: annually{56%}, summer season only{44%}
9) Causes of water shortage: inadequacy of meska canal{32%}, insufficient water delivery from delivery canal{29%}, taking much water at upstream area{20%}, over irrigation under rotation{19%}
10) Own pumps by each farmer: horse power<8.6 HP>, irrigable area by own pumps<0.42F>
11) Ideal size of water users' unit: <less than 20 member farmers> <85%> of correspondents)
12) Monetary burdens for meska O/M: around <LE 40 per year>
13) How join meska O/M: money payment<81%>{86%}, use machine<14%>, own labor<5%>{6%}
14) How rules are decided: by discussion <62%>, by influential person such as Umuda<25%>, by regulations<13%>
15) Experiences of conflicts on water allocation: quite often{49%}, occasionally{28%}
16) Kind of water conflicts: inequity of water allocation between upstream/downstream<49%>, offense against decided agreement<30%>, damage/destruction of irrigation facilities<21%>
17) Penalty for offense: submission to police etc.<64%>, monetary fine<34%>
18) Who mediate conflicts: Umuda <35%>, police<32%>, other influential person<24%>
19) Whether farmers are aware of IIP and IAS: <73%> and <48%> affirmatively in each,

however if excluded Qahwagi and Bahr Saidi, where IIP has already been implemented, affirmative <67%> for IIP and <37%> for IAS.

20) Necessity of any kind of IIP: necessary{98%}, unnecessary{2%}
21) Anticipated improvement through IIP: participation to WUA and self-governing of water by farmers themselves{43%}, structural improvement{38%}, decrease in irrigation cost{19%}
22) Desirable component in IIP: continuous flow of water{48%}, raised lining meska{22%}, repair of existing meska{11%}, lining of existing meska, pipeline meska{9%}
23) How many percent of farm income payable for O/M after IIP: less than 4%{78%}, 4-6%{15%}, over 6%{1%}, not pay{5%}
24) Most indispensable supports to farmers through IIP and WUA: Stable water supply <21%>, lightening/elongation in IIP repayment<19%>, establishment of permanent field service offices for farmers<18%>, free and marketable agriculture<18%>
25) General constraints hampering agricultural activities and daily life of farmers:

* low prices of agricultural production and high costs of farm inputs <36%>, {34%}'
* chronicle scarcity and instability of water supply, unsuitable irrigation facilities and their poor operation <56%>, {40%}
* insufficient services by governmental organizations <6%>, {13%}, and
* others such as water pollution etc. <2%> {13%}

Incidentally, some evidences in analyzing differences, which can be seen in responses both from upstream and downstream farmers within a same meska, are shown below.

a) Regarding experiences of water shortage, there are no remarkable differences between the two.
b) Regarding the magnitude of water shortage, 53% of the upstream farmers suffer annually, and this percentage increases to 61% in the downstream farmers
c) Regarding the causes of water shortage, taking much water at upstream area is pointed out by 22% of the downstream farmers, by contrast, 18% of the upstream farmers agrees so
d) Regarding anticipated improvement through IIP, 11% of the upstream farmers indicates decreases in irrigation cost, and this percentage increases to 20% in the downstream farmers

Through these evidences, it is easily understood that if compare to the upstream farmers, downstream farmers in a same meska suffer from rather disadvantageous water situation and an attendant cost hike for irrigation, and these phenomena can also be seen in the relation between the upstream farmers and the downstream farmers in a same delivery canal.

However, they are not so extraordinary that remain in an expected range.

To the contrary, differences among each delivery are much remarkable ones, i.e. some delivery canals such as Abshan and Canal 4 where reported water shortage is not so serious have their own characteristics, and in the meantime, seriously water affected deliveries such as Taiba and Bashwat also have some different characteristics. For example, in the former group 51% of the farmers anticipates irrigation improvement through rather soft-type measures such as participation to WUA and self-governing of water by themselves than through a hard-type measures like structural improvement (which are anticipated by only 24% of farmers). In the latter group, by contrast, 61% of the farmers anticipate improvement through hard-type and remaining 33% through soft-type.

Prior to the decision of each IIP direction and its component, therefore, such differences encompassed in each delivery canal domain have to be carefully studied. In this connection, several group meetings will be organized in the phase II study period, aiming at collection of farmers' desires most suitable to improve socio-economic and technical situation in each delivery domain.

3.7.2 Present Situation of Farmers' Organization

Historically, several precedents can be seen as per farmers' irrigation systems in Egypt, such as "Sakia Rings" and "Ra'is El Munawaba" in the Fayoum Governorate, although they have been almost disappeared at present due to the rapid mechanization of lifting devices to the popular diesel power. In this context, the Egyptian government has been quite eager in developing new systems for farmers' water use. Such efforts have been inaugurated from 1977 onwards through the EWUP - Egypt Water Use and Management Project, and have been succeeded in the IIP where participatory irrigation management by farmers through establishment of WUAs is the most important component (As for the historical background of Egyptian irrigation and related Islamic water law, see Appendix J.3 in more detail).

Present situation of WUAs is categorized in 5 stages, i.e. from phase I to phase V, and so far 991 WUAs have reached to the phase V in national total, and 184 in Tanta Directorate.

	National Total	Tanta Directorate
Phase I: Entry activities	2,915^{nos}(176,890^{F})	890^{nos}(63,446^{F})
Phase II: Organizational activities	1,927^{nos}(120,752^{F})	602^{nos}(40,437^{F})
Phase III: Design stage	1,865^{nos}(113,692^{F})	574^{nos}(35,837^{F})
Phase IV: Construction stage	1,126^{nos}(67,595^{F})	269^{nos}(16,957^{F})
Phase V: Regular O/M	991^{nos}(59,666^{F})	184^{nos}(12,395^{F})

As far as Meska improvement concerned, so far 1,100 Meska have been improved in national total and 269 in Tanta Directorate. However, by some reasons operational Meska with pumps are 991(90%) at present in national total and 184(68%) in Tanta Directorate. From structural viewpoints, out of 991 operational Meska in the nation, 644(65%) are buried pipeline Meska and 325(33%) are raised Meska, and similarly 160(87%) and 12(7%) respectively in Tanta Directorate .

Meanwhile, the IAS, as the facilitating body for the irrigation management transfer to farmers, has organizations comprised of a general director, directors each concerning to field operations, training & records, water management, and an engineer in charge of communications in Cairo HQs. Meanwhile, at the local level, it has director offices in 5 Directorates (i.e. Tanta, Damanhour, Zagazig, Middle Egypt, and Esna) where engineers concerning to water delivery, water management, supporting WUAs, and assisting technicians (field agents) are allocated.

It is noted that a total number of IAS local staff in the nation is 278 against a total target area of 173,640 feddan (72,930 ha), and it means 625 feddan (260 ha)/person in national average and similarly 29,236 feddan (12,280 ha)/ 32person = 914 feddan (380 ha)/person for Kahwagi and Baha El Saidi Area. Should consider field agents only who offer direct services to the farmers, the mentioned values are decreased to more disadvantageous directions (i.e. less effective directions from the viewpoint of services for the farmers) to 793 feddan (330 ha)/person in national average and 1,124 feddan (470 ha)/person for Kahwagi and Baha El Saidi Area (In more detail, see Appendix J.3).

3.8 Women in Development (WID)

From 1956 onwards, Egyptian women have gained the right to vote and to stand for political office, however actual situation surrounding Egyptian them is not necessarily equal to men even in personal matters such as the right for divorce. Egyptian census data indicate that only 38.2 % of females were literate in 1986 when compared to 62.2% of males, and percentage showed only 24.2% especially for rural women. Also the census shows that women's participation in the wage labor force was 5.4% in 1986, as one of the lowest rates in the world. Under these circumstances, an ideal involvement of women in right way in the farm activities as well as farmers' organizations may not be easy.

In the meantime, gender issues have been increasing importance as one of the "key principles" of rural society, particularly of agricultural production, because "feminization of agriculture" is a general tendency in the world, i.e. women are increasingly the real farmers as men take "off-farm" jobs. In fact, some sectors like poultry raising, milking and the production, and vegetable production and selling are indeed "women's dominant sectors" through which they can get one third of cash income of average farm family. Nevertheless, women may be marginalized from decision making processes, and by contrast men generally control such processes more freely than women.

As for irrigation in particular, directions and decisions of irrigation activities have been kept as the men's domain due to the social structure and Moslem norms, thus water users organizations have almost invariably consisted of men only. By contrast, various farming activities other than irrigation such as sowing/transplanting of rice, manual weed control, thinning and secondary transplanting, grain storage and cleaning etc. have been undertaken mostly by women.

However, some examples from other developing countries show rather active involvement of women in PIM. For example, Orissa Water Resources Consolidation Project(OWRCP) in India, where targeted turnover of irrigation scheme is 150,000 ha and 50 WUAs covering 21,000 ha of command area have so far been organized at a level of minor canals(about 500ha command area), succeeded in involving about 23% of women farmers and electing 6% of women council for WUAs' board. Their roles in the board are to function as record keepers and information publishers. Such roles and their successful results can be also seen in other countries such as in Lao PDR.

Bearing all this (i.e. feminization of agriculture, rather marginalized situations of rural women from decision making processes etc.) in mind, some interventions may be needed in Egypt if women are to find a place in WUAs. INPIM suggests such interventions as legal rights to joint tenancy on land, and emphasizing women's role during the initial organizing of the association etc.

3.9 Farm Economy

3.9.1 Agricultural Income and Non-Farm Income

Based on the cropping pattern and unit yield for each region as determined in the Farm Economy Survey to 240 farm households, the average agricultural income per farm household according to average farm size in each region is estimated as follows;

Region	Farming Size	Gross Return	Net Income	Net Income per fed.
	(fed.)	(LE)	(LE)	(LE/fed.)
Upstream	2.0	6,742	3,668	1,834
Midstream	2.7	8,429	4,439	1,644
Downstream	4.2	12,457	5,531	1,317
IIP area	3.1	9,992	5,145	1,660

Although the upstream households get a lower income caused by the smaller farming size, the income per feddan is the highest because of the higher productivity for each crop. As the area goes downstream, the productivity per land is decreasing in contrast the farming size is increasing. Therefore the potential to increase agricultural income by unit yield increase will be higher in the downstream reaches. The agricultural income estimation in the preceding IIP areas stays in the middle compare to that of the Study Area. This is because the sample farm households include those who have not got benefit from the implementation of the projects (Refer to Appendix L, Table L.1.3).

Family members who worked on other owners' farm are 0.3 capita per household in upstream area, 0.1 in midstream and downstream area and 0.4 in IIP areas. About 60 % of sample farm households have members who have non-farm jobs. The sample farmers vary on their annual non-farm income from zero to 7,000 LE. The average annual non-farm income by region is 1,942 LE in the upstream area, 2,178 LE in the midstream area, 494 LE in the downstream area, and 1,488 LE in the preceding IIP areas. In the downstream area, the sample farm households who do not have non-farm income are 70 % and they are more dependent on their agricultural income.

3.9.2 Farm Household Income

The average annual household expenditure (including the estimation of their self-consumed food) for the sample farm households is 7,199 LE in the upstream area, 6,801 LE in the midstream area, 7,277 LE in the downstream area and 8,126 LE in the preceding IIP areas. To earn such amount of income, it is required for farmers to get another income source apart from farming, such as working on other farm, livestock breeding and non-farm jobs. In the upstream and midstream area, farmers fill their expenditure by non-farm jobs and working on other farms. (Refer to Appendix L, Table L.1.4)

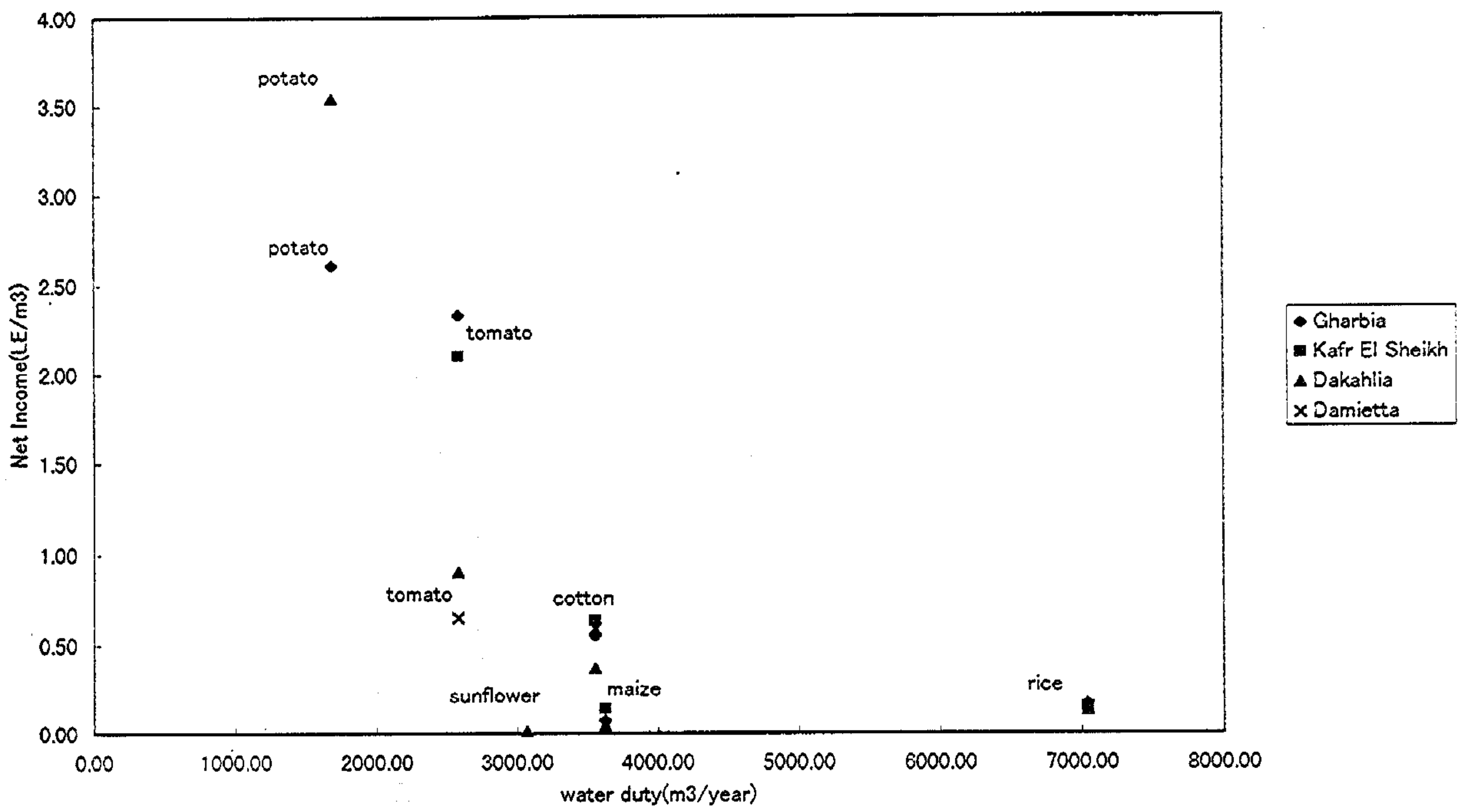
The Expenditure and Consumption Survey in 1995/96, shows that average annual expenditure of sample households are estimated at 6,600 LE in rural area in the four (4) governorates. Assuming that this amount is the average income of farm household and dividing the average annual expenditure by the agricultural income per feddan estimated above, the minimum farm size for earning a living is estimated. Accordingly it is required to manage about three (3) to four (4) feddan in the upstream and the midstream area and five (5) feddan in the downstream area.

Livestock breeding, fish culture and bee keeping are also considered as the other sources of farm household income. Farmers normally breed buffalo for milk (meat for child buffalo), cows, sheep, chicken and other livestock. In summer season, paddy fields are used as fish pond. Berssem flower provides good quality honey. These activities also add to the farm household income.

3.9.3 Water Duty by Crops and Income

To estimate the profitability of the crops in relation to their water duties, the net income per water duty can be an indicator, that is calculated by dividing the net income of crops by their water duties. Potato and tomato are the most profitable crops with less water duties. Summer potato requires 1,680 cu.m/feddan and the net income per water duty is calculated at 3.0 LE/cu.m.. Summer tomato requires about 2,580 cu.m/feddan and gets 1.5 LE/cu.m of net income. The net income per water duty for maize is about the same as rice. However rice consume twice of water to maize. Cotton and maize require about the same amount at 3,600 cu.m/feddan to grow, but cotton is more profitable with 0.6 LE/cu.m to 0.1 LE/cu.m of Maize. (Refer to Figure 3.9.1 and Appendix L, Table L.1.5)

Figure3.9.1
Net Income per water duty by summer crops in1995



3.10 Environment

3.10.1 Water Quality Environment

(1) Location of Water Quality Survey and Method

Water quality survey was carried out at 53 points in the Study Area and which has 18 irrigation canals, five (5) drainage canals, and six (6) pumping stations. Water samples have been collected from the surface by the local Bahary, gate keeper in Egyptian, under supervision of technical experts at the same date and the specific same clock time as 8 o'clock on 11th, and 23rd of May. The measurement was made after two or four hours from collection time at the IIP Tanta office by using Water Quality Checker (U10 type) brought by the Team. Moreover, measurement was directly determined at each investigation point at several times (refer to Figure 3.10.1 and Appendix K).

The following six (6) items were measured, water temperature, pH, turbidity, electric conductivity, dissolved oxygen, and salinity. Moreover, sodium, calcium, and magnesium were measured additionally by ion meter and pack test method in the second field investigation.

(2) Water Salinity of Irrigation and Drainage Canals in the Study Area

Water salinity have been evaluated by total dissolved solids (TDS), and calculated from electric conductivity by using 640 times, referred to Reuse Monitoring Programme report 39 by Drainage Research Institute, 1995. TDS problem of irrigation water was classified by guideline of water quality for irrigation referred to FAO, 1985. According to it, less than 450 mg/l is good TDS range. In this studied period, TDS is questionless about half longitudinal northern area from Zifta Barrage to the Mediterranean Sea coast, Bahr Hafir Shehab El Deen canal area, and beside the Damietta Branch of the Nile. On the other hand, downstream areas of Bahr Tera,

Bahr El Banawan and Bahr Basandila canals, and irrigation area of El Mansour canal were shown to have slight to moderate levels, between 450 to 2,000 mg/l TDS. And also, sodium adsorption ratio (SAR) which calculated from sodium, calcium and magnesium, was shown similar distribution relation to TDS, and recognized impact of sodium concentration to water quality(refer to Appendix K).

The electric conductivity in the drainage canals have been ranged from 1.19 to 2.05 dS/m, 1.25 to 2.32 dS/m, upstream end and midstream, respectively. This maximum electric conductivity was shown as 1,500 mg/l TDS level. The change of water quality of before and after at Hanoul MPS was decreased from 1,300 to 900 mg/l TDS and 5.9 to 4.3 SAR.

This is shown that re-use water of drainage improves water shortage in downstream agricultural area of Bahr Tera(refer to Appendix K).

In the middle part of the Central Delta, where the soil salinity is considered moderate, the drainage water salinity ranges from 1,000 to 2,000 ppm. And, in the most northern part of the Study Area, parallel to the sea coast, drainage water salinity is considered high and reaches to more than 3,000 ppm. Moreover, canals receive industrial effluent and domestic sewage from bank side habitation in villages or towns. Therefore, the drainage water in certain locations is highly polluted.

(3) Water Salinity of Irrigation and Drainage Canals around the Study Area

The TDS of main irrigation canals water in the preceding IIP three (3) project areas (Kahwagy, Bahr El Saidi, El Nazl) were not causing a problem less than 450 mg/l. And, TDS of drainage canals water were changed in a range from 480 to 2,400 mg/l(refer to Appendix K).

(4) Water Quality Situation of Canals which Passes the Village

Water quality situation of canals which pass the village areas, is special problem. Change in water quality with the passage of time as in the case of Bahr Basandila canal which show increasing amount of turbidity and TDS from 3 to 4, 10 times, respectively at before and after passing the village. Inflow of organic materials and soluble salts were also estimated(refer to Appendix K).

(5) Micro Elements and Nitrate around the Study Area

According to USAID project investigation, the content of Fe, Mn, Zn, Cu, B and nitrate in the canals, drainage and groundwater was very low and no toxicity problems due to any of them was expected to occur.

3.10.2 Soil Salinity

In the southern part of the Study Area near Zifta, the soils are generally non-saline. The salinity varies between 1.0 to 2.0 dS/m. The prevalent anion in the soil paste extract from some of these soils was bicarbonate while in the other parts the chloride ion becomes dominant. The soils lying between contour line 3.0 and 7.0 m from sea level have salinities ranging from 2.0 to 4.0 dS/m. In these soils, as irrigation water percolates through, there will be redistribution of cations between the solution and the exchange sites, and as the soil dries, the concentration of the soil solution increase, which alter exchange equilibrium between mono and divalent cations.

The major portion of the salt-affected soils more than 4.0 dS/m is found in the region which extends from east to west parallel to the sea coast and up to contour line 3.0 m from sea level. The salt accumulation in this soil is caused by saline water intrusion from the Mediterranean Sea, the lake of Burullus, and tidal marshes. This has been accelerated by its flat topography and low land level in that area bringing the water table close to the soil surface, in the absence of adequate drainage system (Refer to Appendix D).

The crop tolerance of main crops and fruit trees as influenced by irrigation water salinity, for normal growth are as follows in dS/m, Cotton 5.1, Sugar beet 5.1, Wheat 4.0, Rice 2.0, Maize 1.1, Broad bean 1.1, Squash 2.1, Tomato 1.7, Cucumber 1.7, Potato 1.1, Radish 0.8, Onion 0.8, Carrot 0.7, Berseem 1.0, Orange 1.1, Peach 1.1, Grape 1.0, Strawberry 0.7, respectively.

By increasing of sodium concentration and its proportion to calcium plus magnesium, and bicarbonate content in the irrigation water, the soils become alkaline and/or salt-affected. At the present, salt-affected soils are improved by applicable investment of gypsum in the Study Area(refer to Appendix K).

3.10.3 Other Environment related to the Area

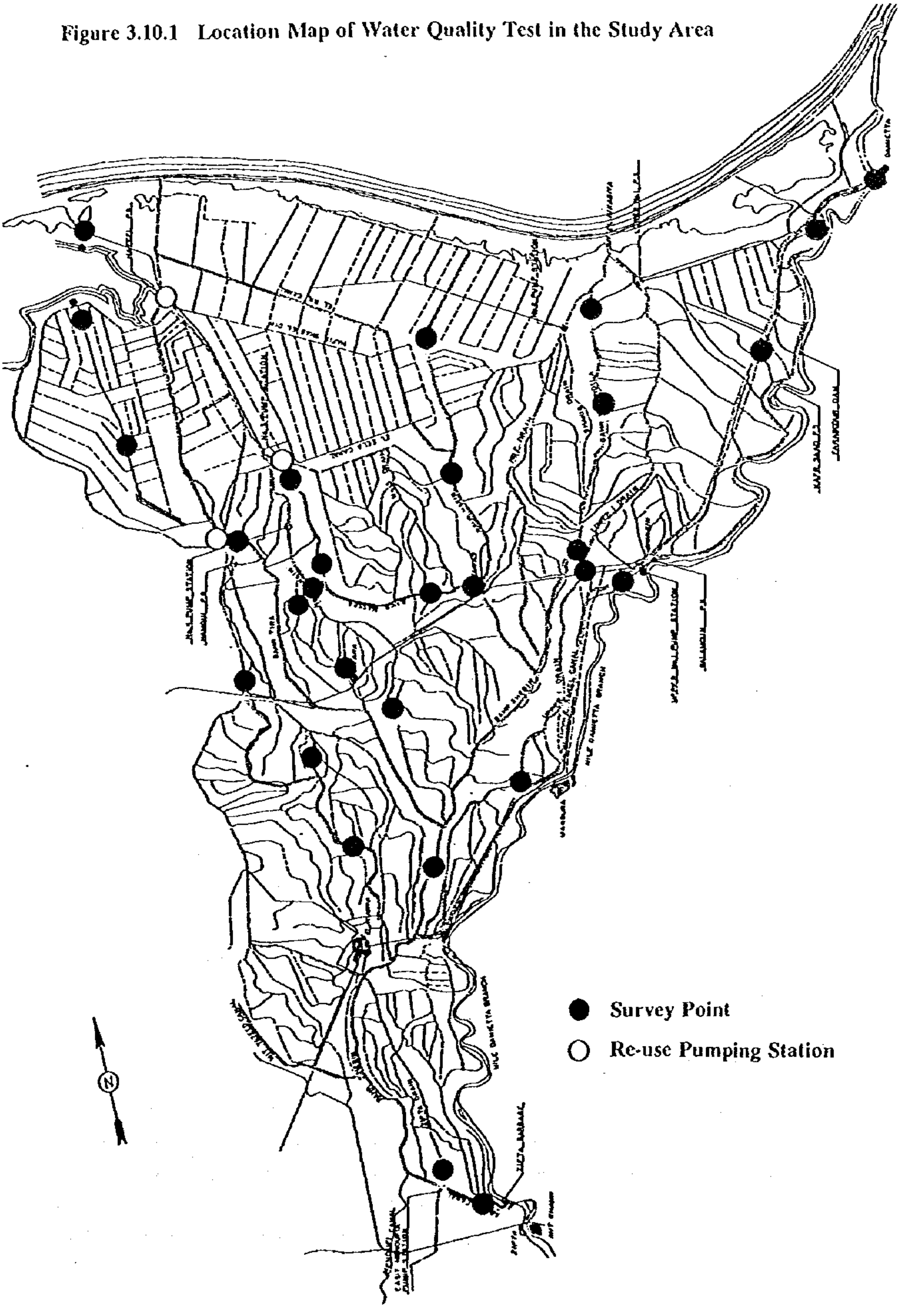
(1) Malaria

Malaria is transmitted by the bite of a mosquito of the genus Anopheles. The transmission cycle is only between man and mosquitoes. At the present, malaria is well under control with decreasing figures in Egypt of 4,900 cases in 1970, 91 cases in 1985, and 17 cases in 1993. Generation of maralia has almost reach to extinction situation in the Study Area.

(2) Schistosomiasis

There are two major types of schistosomiasis that affect man in Egypt, S. haematobium and S. mansoni. A generation percentage of schstosomiasis was suddenly decreased according to an investigation project supported by USAID. According to Institute of Research for Tropical Medicine, S. haematobium, and S. Mansoni which gives trouble to the bladder and liver, gut pipe, was generated 1.2 to 10.2 %, 42.2 to 50.0 % by population ratio in four(4) governorate, in 1981 respectively, but, these were decreased sharply to 0.01 to 2 %, 5.5 to 14 %, in 1997 respectively.

Figure 3.10.1 Location Map of Water Quality Test in the Study Area



3.11 Categorization of Delivery Canals

3.11.1 Methodology of Categorization

The 357 delivery canals in the Study Area were categorized to grasp the problems and constraints on the present irrigation and drainage system by collected data such as canal length, canal command area, degree of water shortage, water quality, facility condition, farming condition, etc. The method used for categorisation is multivariable, such as, the principal component analysis, discriminate analysis and cluster analysis. However, after examination and analysis, the cluster analysis with ranking data was adapted for categorization. The process of the analysis is presented subsequently. (Refer to Appendix G3)

(1) Principal component analysis

The principal component analysis searches for the linear combination (principal component) which would best represent the interrelations between indices. With the quantitative indices of delivery canals (command area, length of canal, percentage of area served by Meska, cropping intensity, and crop unit yield), several cases were tested by this analysis method. As a result, the first and the second principal component seem to indicate respectively the degree of agricultural affluence and the degree of water shortage by which the delivery canals could be categorised into four (4) or five (5) types. However the categorisation by this analysis was not adopted due to the following problems; (Refer to Appendix G3)

- The meaning of principal components were not very clear with regards to degree and coincidence of parameters
- The contribution of the first and second principal component were low (in each case tested, the contribution ratio were from 40 to 60%, which indicate the principal components do not represent the interrelation between the indices well)
- It appears that the agricultural data, which were applied to the delivery canals according to the district-wise data, were inadequate

(2) Discriminate analysis

Delivery canals were discriminated according to the degree of water shortage (rare, often, very often and always) and there appear certain characteristics in the delivery canals according to this degree. The validity of this category by water shortage degree was tested by the discriminate analysis. With the indices of delivery canals, the discriminate function was formed. However, the correct discrimination ratios by the discriminate function were low.

This analysis method is normally adopted when the category is a precondition and distinguishes which category the data belong, Therefore the categorisation by degree of water shortage was not adopted. (Refer to Appendix G3)

(3) Cluster analysis

The cluster analysis categorize data based on the similarity (distance) of indices of the data. While the former two methods include the testing indicators of the validity, such as, contribution ratio and correct discrimination ratio, the validity of cluster analysis is judged by the group cluster itself. Several cases were tested and the conclusions are as follows;

- On the analysis of several cases using quantitative indices, the delivery canals were not clustered (categorised) clearly.
- The analysis using ranking indices (category indices) of the delivery canals can clearly explain the meaning of each cluster (category).

3.11.2 Categorization

Among indices, three ranking data variable having difference among the delivery canals, such as, water shortage, water salinity and condition of canal improvement were adopted. The data variables which do not show the difference among the delivery canals, such as, ineffective water release or which can be represented by other data variable were eliminated.

Considering the unity of cluster on data distribution, six (6) clusters were identified by applying the cluster analysis with the furthest neighbour method. (Refer to Appendix G3)

(1) Process of analysis

a) Selection of variables

Selections of variables were based on the indices that are related to characterise the delivery canals. The five (5) variables were selected and with the combination of these variables, three (3) case studies were made as follows;

Case one (1): variables: Water shortage, Intake condition, Salinity
Case two (2): variables: those of Case1 +Agricultural income per feddan
Case three (3): variables: those of Case2 +Domestic waste

These variables were transformed to ranking data variables (category data variables).

b) Case study

On the three (3) cases above, cluster analysis was made. Considering the unity of cluster distribution and the average tendency of characteristics of the delivery canals indices in each cluster, the result of case three (3) was not clear in the meaning of the cluster made. With further analysis of the cluster distribution, case one (1) with six (6) clusters was finally adopted for the categorization. (Refer to Appendix G3)

(2) Result

The major feature by category are as follows;

Category A:

The delivery canals have no serious problem on water quality and quantity, and comparatively have better irrigation facilities and farming condition. The delivery canals in this category are located mainly at the upstream and midstream area. (183 delivery canals)

Category B:

The conditions of irrigation water and farming condition are the same as Category A. However, the canals facilities needs rehabilitation and/or repair. The delivery canals in this category are located mainly at the upstream and midstream area (50 delivery canals).

Category C:

There is serious problem on water quality, and the farming condition is also not so good. However, the canal facilities are not in serious condition. Most of canals are located at the downstream areas with poor water quality. (47 delivery canals)

Category D:

The canals in this category have serious problems on water quality and quantity. The lengths of the canals are relatively long. The present condition of canal facility is not so bad. Farming condition is classified as middle range. These canals are scattered over the Study Area. (31 delivery canals)

Category E:

Water shortage is the major problem. Water quality is also poor. The service area by Meska occupies a large share of the command area of the delivery canal. The conditions of canal facility and farm are not good. These canals are mostly located at the downstream area. (30 delivery canals)

Category F:

Water quality problem is in serious condition and facilities need rehabilitation and/or repair. The farming situation is also not in good condition. These canals are mostly located at the downstream area. (16 delivery canals)

The number of delivery canal by category are as follows; (Refer to Table 3.11.1, Figure 3.11.1)

Category	Upstream	Midstream	Downstream (East)	Downstream (West)	Total
A	66	71	29	17	183
B	12	29	5	4	50
C	0	11	15	21	47
D	7	9	5	10	31
E	1	6	5	18	30
E	0	5	4	7	16
Total	86	131	63	77	357

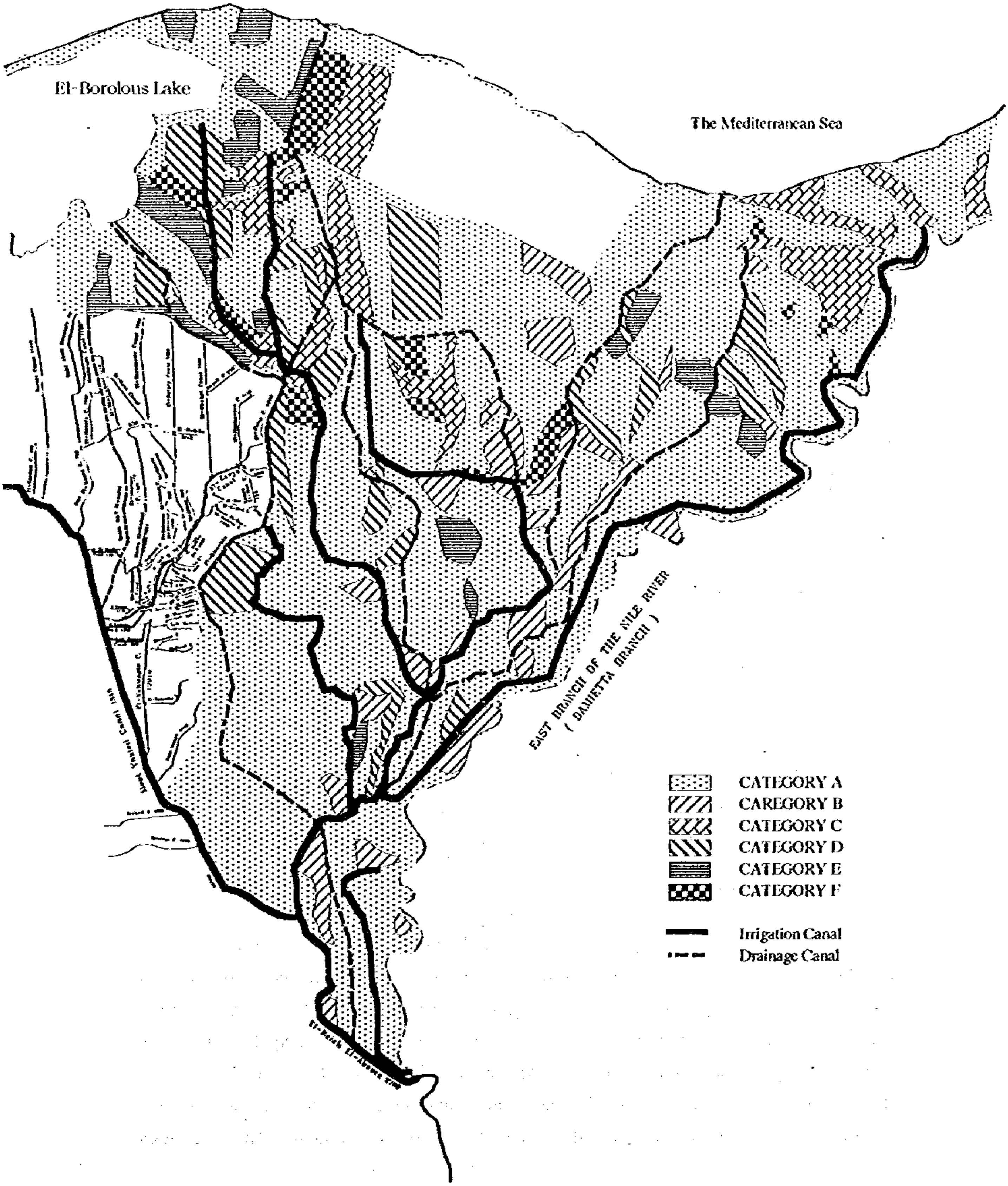
Table 3.11.1 Number and Average Data of Delivery Canals by Category

Category	No. of Delivery	Location: Upstream	Location: Midstream	Location: Downstream East	Location: Downstream West	Water Shortage: rare	Water Shortage: often	Water Shortage: very often	Water Shortage: always	Intake Condition: good	Intake Condition: repair	Intake Condition: replace
A	183	66	71	29	17	132	51	0	0	137	46	0
B	50	12	29	5	4	40	10	0	0	0	0	50
C	47	0	11	15	21	20	27	0	0	32	15	0
D	31	7	9	5	10	0	0	25	6	31	0	0
E	30	1	6	5	18	0	0	18	12	0	19	11
F	16	0	5	4	7	9	7	0	0	0	0	16
Total(average)	357	86	131	63	77	201	95	43	18	200	80	77

Category	Salinity: none	Salinity: slight	Salinity: moderate to strong	Official Drain Use	Domestic Waste: little	Domestic Waste: considerable	Domestic Waste: much	Agr. net income: high	Agr. net income: middle	Agr. net income: low
A	39	144	0	12	132	45	6	62	95	26
B	6	44	0	0	34	16	0	11	37	2
C	0	0	47	23	35	11	1	0	31	16
D	1	17	13	13	17	13	1	5	25	1
E	0	11	19	18	12	18	0	7	17	6
F	0	0	16	7	11	5	0	0	11	5
Total(average)	46	216	95	73	241	108	8	85	216	56

Category	Area Ser. feddan	Length km	% for Mesqa	Cropping Intensity (%) Major Summer Crops: Cotton	Maize	Rice	total	Crop Unit Yield (1993/94-1995/96): Cotton (ton)	Maize (ton)	Rice (ton)
A	1,941	4.60	28	23.9	20.2	46.6	90.7	0.75	2.45	3.05
B	1,323	3.87	21	26.1	20.0	47.5	93.7	0.73	2.37	3.09
C	2,047	4.97	23	26.7	11.7	43.2	81.6	0.65	1.97	2.72
D	4,235	8.42	28	26.9	14.8	46.3	88.0	0.74	2.26	2.97
E	1,628	4.07	44	24.8	15.9	41.0	81.7	0.71	2.02	2.85
F	1,985	3.38	17	27.4	12.0	41.4	80.9	0.70	1.96	2.73
Total(average)	2,193	4.89	27	26.0	15.8	44.3	86.1	0.71	2.17	2.90

Figure 3.11.1 Location Map of Delivery Canals by Category



3.12 Problems, Constraints and Potentials

3.12.1 Agriculture

1) Constrains and Problems

In the upstream areas, there are no severe water shortage due to location of the irrigation system. However, even in the upstream area, there are farmers who suffer from water shortage, specifically in the tail portion of the irrigation systems, where the farmers have lower crop yield. The subsurface drainage is installed in the whole upstream area and most of the midstream area, and the ground watertable is rather deeped than that in the downstream area. Throughout the Study Area, there is a limited opportunity to expand the area of such crops as onion, potato and other kinds of vegetables, because timely and adequately irrigation water is not available for these crops.

There are many farmers who have small size farms especially in the upstream and midstream areas. However, the suitable land to grow vegetables are limited due to the heavy soil texture in the area. On the other hand, in the downstream areas, there are large areas which are suitable to grow vegetables. Unfortunately, the following constraints and problems hamper the substantial development of horticulture in the area;

- Shortage of irrigation water
- Poor quality of water causing infestation of crop diseases and deterioration of products
- Aggregation of saline soils hazard

Furthermore, there are a large number of farmers that grows crops with re-used or drainage water. The water irrigation is not only in short supply but also poor in quality due to salt contents and pollution. Moreover, salinity problems is aggravated when the salts accumulate in the crop-root zone with low quality water.

2) Development Potential

In the successful project areas of the Bahr El Saidi IIP, the irrigation water is distributed efficiently and adequately even at the tail portion. An average of six hours is consumed to apply irrigation water before project has been implemented. However, this has decreased to two hours after project. The pumping cost is decreased by applying irrigation water by one point Sakia to concrete raised Meska. The timely and adequate irrigation water distribution made it possible to introduce non-traditional crops like winter onion and summer potato in wider area even in the tail portion of the irrigation system. Thus, irrigation improvement will bring about significant opportunity to improve the farming system with regards to the following:

- Increase crop unit yield by means of timely and adequately irrigation and right cropping time
- Wider selection of crops including high valued crops
- Intensification of farming through saving time and cost for pumping-up the water

Moreover, the irrigation improvement project is expected to play important role to solve water problems quantitatively and qualitatively. Supply of quality water will give a chance to improve the saline soils in the downstream area. With concerted irrigation drainage improvement in the downstream area, there is a great potential for agricultural development for production not only of traditional crops but also export oriented vegetables. This is because there are large areas with light textured soil which area suitable to grow these crops. Another advantage in the downstream area is that the farmers have rather large farm areas. The farmer can therefore afford to introduce such less intensive crop of sunflower without the limitation of farm size.

3.12.2 Irrigation and Drainage

The problems on the present irrigation and drainage systems are a) water shortage caused by inequitable water distribution between up and downstream reaches, b) flow obstruction by weeds in a canal and garbage dumped by rural inhabitants, c) illegal direct intake from a canal and illegal rice cultivation, d) Poor communication system between the office and sites, e) poor conditions of intake facilities, f) lower water level due to over dredging, and g) sea water intrusion from the Mediterranean sea.

The water shortages are serious in the summer season at the downstream area, even at the upstream area, partially are occurred. The most severe water shortages occur in Balteem, Mansour, and Hamoul, water district areas. The reasons are a) illegal rice cultivation b) no control of ground water level in a tile drainage system, c) long canal length, d) direct intake from a canal by farmers, e) occasionally stopping a pump operation of the Hamoul MPS, f) canal side slop sliding due to sandy soil located near the coast of the Mediterranean sea, etc..

3.12.3 Irrigation and Drainage Facilities

(1) Canal Section

The existing canals have formed with shallow depth. That is not suitable focmation as equivalent to water depth and canal bed bottom width. The normal water level in the canal is below the ground level and no paved on the canal. The major constraints and problems are evaporation loss, weeds etc..

(2) Physical Constraints and Problems

Many of the gates which used to operate the water discharge control are already very old and rusty with weathered part of steel grid and leafs that slow down gate operation. Accordingly, the gates have leaky conditions between the gate body and pier walls causing difficulty to keep design water level in some areas. The manual operation system is so heavy and without opening gauges. Under such condition, the gate could not be operated on its time schedule. Many water operation are undertaken with leaf gates installed with manual hoist system. These could not catch up with the existing telemeter information between the sites and monitoring operation rooms.

The center canal body becomes unstable when the rural inhabitants worked on the canal slope during periodic cleaning and weeding and when animals enter into the canals to drink and bathe. Along the existing canals located in the residental areas in towns and villages, the inhabitants have been dumping into the canal their domestic trash and garbages obstructing the gate operation works and flow of irrigation water.

(3) Preliminary Problems in the Improved Meska

The technical specifications for the implementation work and operation manual are not available. Extension services for guideline of new irrigation practices as well as counter measures for non working pump unit are not also existing.

(4) Potential of water loss saving

The Rahbeen regulator has taken about 70 cm water loss head when water is released with 150 cu.m/sec at peak water discharge. Accordingly the water level is lowered at the points of regulators located downstream reaches of Rahbeen regulator and taking design discharge becomes difficult.

3.12.4 Water Management and O&M

(1) Constraints on Irrigation Facilities

The irrigation facilities are classified into the principal and terminal facilities. The former consist of the delivery canal while the latter refers to down from the Meska according to the management bodies. Among the irrigation facilities, several regulators and intake gates equipped with movable parts are seriously deteriorated hindering proper water management in the Area. This is obvious in case of the Rahbeen and Demara regulators requiring immediate rehabilitation. It is difficult to operate properly the gates under the current manual operation system so that motorized operation system is recommended. Around the confluence of the Monofy Canal and Raiah Abbasee, adverse canal flows to Monofy Canal causing difficulty in insuring the original hydraulic conditions.

Further, at several places, canal banks collapsed broadening the canal width and accordingly lowering water level constraining diversion operation to down sections of canals. Similar situation happens in the terminal canals causing constraints for proper water management. Therefore, it is necessary to improve terminal canals inclusive of delivery canals to meet farmer's wishes along the line of water saving policy.

(2) Water Management in Terminal Field

According to USAID and ISAWIP studies, the irrigation efficiencies in field level are 70% without project and 75% with project in the vicinity of the Study area. These values are remarkably low in comparison with the irrigation efficiency of 85-95% in canal or Meska. In this context, there evidently exists sufficient room for improvement in field level water management. However 75% is the upper limit as far the conventional irrigation method is applied. Further, field surface is unevenly undulating in the Study Area. This hinders farming operations and also unfavorable for terminal water management. Accordingly, methods for field surface leveling and innovative terminal irrigation should be investigated with due attention.

(3) Reassessment of Water Requirement

In associating with the facilities improvement mentioned, the reassessment of water duties implies up-to-date subjects due to the following reasons. (See Figure 3.6.10.) For instance, despite the fact that canal conveyance loss is bigger in the downstream section than in the upstream section, the difference can not explicitly be identified as far as the same water duties are applied. Similar situations happen in cases of seepage and evaporation. Unless the regional and seasonal variations are not distinguished, it can not select the actual measures for the goal of water saving.

In addition the controversy on the water efficiency improvement focuses only on the surface water since it is not easy to quantify the subsurface flow in ordinary cases. Subsurface water behavior should be revealed in contexts of Figures 3.6.7 and 3.6.10 to achieve the goal of water saving. As is presented in Figure 3.6.7, 12% of irrigation water and M&I water requirements rely on the drainage water reuse and groundwater use. This value is obtained through empirical practices. However, to promote water saving for irrigation, it is necessary to examine the applicability of subsurface water whether total quantity itself is appropriate or where and when it is available. The review of water requirement would be an important issue to be tackled when considering goal of water saving inclusive of water quality control.

(4) Review of Navigation Water

The navigation water is not in use but seems to be excessive as compared with irrigation water requirement. In compliance with the water saving policy, the amount of navigation water and the necessity of navigation along the irrigation canals have to be reviewed taking into account the current transportation situations. In the meantime, there are comments that the preservation of navigation is based on security reason and should be distinguished from the matters of water saving or economic policy.

3.12.5 Environment

(1) Water Quality Environment

a) Evaluation of current state which is using irrigation canal for life water

Canal water are utilized for washing, tableware wash, and bathe of cattle. There is an increase in nutrient levels, especially nitrogen and phosphorous. Many canals are major sources of drinking water, so certain health aspects should be considered. At the present, the Ministry recommended that irrigation water after mixing with drainage water, should not contain total soluble salts(TSS) in excess of 750 ppm and the SAR should be less than 7.5.

b) Evaluation of dredged sludge and water plants, and it's usual procedure

There should be careful monitoring of the concentrations of heavy metals, pesticides, and complex organics in canal sediments for re-use. The Weed Control Institute of the Ministry has been studied under consideration the possible utilization of the weed biomass removed from waterways for compost or animal feeds.

(2) Soil Environment

The main soils found in the Study Area are alluvial Nile sediments classified in either the Vertisol Soil Order or Vertic Great Group of the Entisol Soil Order. These are heavy clay soils with a large potential for expansion and contraction upon wetting and drying, because of montmorillonites which are concentrated in the fine clay fraction of the clay size range. They are exceptionally difficult soils to undertake in physically root zone management.

By increasing the sodium concentration and its proportion to calcium plus magnesium, and bicarbonate content in the irrigation water, the soils become alkaline and/or salt-affected. At the present, salt-affected soils are improved by applicable investment of gypsum in the Study Area. Therefore, good quality water supply of irrigation is very important at the downstream areas in the Study Area.

(3) Infection of Schistosomiasis

The transmission of Schistosomiasis is based on a complex four-phase cycle which includes the presence of freshwater snails. The miracidia of the beginning larva have to find a specific aquatic or semi-aquatic freshwater snail as intermediate host within 24 hours. It is at this stage that they are infectious for man. Snails shed numerous cercariae into the water. These have to find human beings in contact with water in order to penetrate their skin.

Snail intermediate hosts of Schistosomiasis show great tolerance regarding pH values(5.3 to 9), mean water temperatures(18 to 30℃) and salinity. However, these aquatic snail species are sensitive to water velocity and water table fluctuations. Tolerable average current speed ranges between 0.0 to 0.3 m/s. Therefore, It is very important to remove water plant inside watercourse and maintain the design water flow and/or water quantity in order to eliminate those snails.

3.12.6 Rural Sociology and Farmers' Organization

The Study has been executed by adopting the means of a tripar ite combination of

(1)Comparative study of world-wide examples on PIM, including Japanese experiences
(2)Review of performance of the existing IIP in Egypt
(3) Study on farmers' opinion/ incentive

The reason of this approach is that the theme of PIM (Participatory Irrigation Management) is not necessarily only in Egypt but many countries have shared this theme. Therefore, enlightening and useful lessons which could be obtained through comparative study of world-wide samples should be scrutinized to grasp objective magnitude where Egyptian IIP is located now. Moreover, IIP implicates comprehensive key components not only from technical but financial and socio-economic viewpoints, and some common phenomena, which can be seen in world-wide samples as a major shortcoming hampering satisfactory performance of PIM, might be a lack of understanding for farmers' willingness/ incentive. In this context, a study on farmers' opinion/ incentive should be inevitably added. Some focal points obtained from such tripartite study are summarized below(In more detail, see Appendix J.4).

(1) Comparative study of world-wide examples on PIM, including Japanese experiences

Some useful and enlightening information scrutinized from worldwide experiences are summarized as shown below.

1)According to the estimation results by using indicators such as an agricultural output per unit command area(in $/ha), unit water consumed (in $/m3) and relative irrigation supply (in ratio), the performance of Egyptian irrigation is "good or excellent" for land economy , "moderate or low" for water economy and "moderate or good" for water efficiency. Based on this evaluation, irrigated agriculture in Egypt may have to introduce more profitable crops per unit water basis and to improve water efficiency.

2)Another enlightening information from worldwide experiences is an adoption of "the carrot & stick policy". Should combination between the carrot and stick be well-balanced, farmers may choose to implement IIP.

In the meantime, many examples of PIM seen in Asian countries may offer useful information to the Egyptian IIP, because land holdings are small and the subsistence agriculture is still predominant in Asia rather than market-oriented agriculture, thus such socio-economic background is quite similar to Egypt when comparing with that of western countries. The Land Improvement District (LID) in Japan is well known as a forerunner of successful PIM, however the facts cannot be ignored that this system has reached to an effective and clear-cut goal directed by promulgation of the Land Improvement Act in 1949 after long-years' bitter and painful conflicts pertaining to water allocation in accordance with narrow and fragmental land-holdings among the farmers (For reference, some Asian examples including Japanese LID system etc. are shown in Appendix J.4).

(2) Review of performance of the existing IIP in Egypt

Some satisfactory results can be found in the study reports prepared by Dr.Martin Hvidt etc. as well as by the IAS itself from 1992 to 1994. However, as is already recognized by the Egyptian government, such results are extremely successful examples, which can be seen in the Upper Nile areas in particular, and are not necessarily common to the whole nation. Thus the IAS has pointed out the importance of series of refinements, in which prompt realization of a Federation of WUAs in each branch canal bases is focussed. Also, the most difficult and formidable theme, of which many countries have been confronting with, will come soon. It is a theme pertaining to the cost recovery mainly anticipated through the repayment from beneficiary farmers.

(3) Study on farmers' opinion/ incentive

Through the results of the Rural Sociology Surveys, which were executed both in the phase I and II studies, it is understood that the farmers have several complaints against the currently implemented IIP. In other words, it is assumed that the following issues, which have been essential for the successful PIM throughout the historical experiences in other countries, are not satisfied at present in the Egyptian IIP(In more detail, see Appendix J.4).

1) A water unit to which farmers belong is to be small such as consisting of around 10 - 15 farmers, thus intimate and satisfying for them
2) There are land and belongings and intangible bonds such as shared experiences, traditions etc. in the unit, which have accumulated throughout the area's history which the member farmers wish to preserve
3) Intervention from outside community, which often clashes with the unit's own values, is the less the better
4) Actions taken by the member farmers for the general well-being of the unit and the maintenance of its property as well as its traditions/culture
5) Other actions taken by them should lead to tangible and quick profits other than abstract and long-term targets

As such, to achieve final targets of more active involvement of farmers, thus the greater and more successful performance of IIP, it is supposed that folowing 2 essential key conceptions should be taken into consideration much more.

*Key conception 1: "Ergonomics Consideration", in deciding ideal sizes of water users unit in terms of number of farmers

(Note: Ergonomics: Mechanism found out in human beings' activities no matter how they are derived from individual or in group)

*Key conception 2: "Hydrological De-centralization", for clear-cut separation of water divide and in enhancing farmers' incentives to effectuate water use

3.12.7 Farm Economy

The location for marketing in the Study Area is advantageous as there are big cities such as Cairo and Alexandria near the Study Area. Especially for fresh vegetables and fruits, the location near the big cities is crucial. Since Alexandria has a big international port and the Damietta port is going to be improved as an international port, the Study Area has the advantage to grow crops for export to Europe and Middle East. Furthermore, the International Mediterranean Sea Road has been under construction across the Nile delta from Rafah city in the east boundary of Egypt to El Salloum city in the west boundary. After the construction of the international road, the marketing condition in the Study Area will drastically be improved since this is the fastest direct way to Alexandria and Damietta port.

On the other hand, most of the farmers in the Study Area are small-scale farmers based on the traditional inheritance system. The liberalization of input and output agriculture prices is not beneficial yet because of the weakness of purchasing and marketing capabilities of most of the farm households. It is estimated that more than three(3) feddan is required for farm households to support their living from farming. With reference to the number of farm households by farm size (include tenant area in a farm), the share of farmers who manage less than three (3) feddan is about 80% of the total number of farm households in the upstream area and 70% in the midstream area. In the downstream area, more than four (4) feddan is required by the farm household to support their living from farming while more than 70% of the farmers hold less than the requirement. Especially, the small farming size in Gharbia is considered as a constraint for agricultural development.

Because of the rapid increase of population, high unemployment ratio, and the limited cultivable land, the improvement of the productivity per land area will be required. However, there are different conditions between the regions in the Study Area as to water supply and water quality. In the downstream area, the condition of water supply and quality is obviously worse than the upstream and the midstream area. This disadvantage in the downstream area leads to a disparity in agricultural income per area caused by the low productivity between the different areas.

As found in the Farm Economy Survey, the field position along the delivery canal brings the disparity of productivity. The fields which are positioned at the upper reaches of the delivery canal have higher productivity than the fields near the tail of the delivery canal due to the inequality of water distribution. This will also cause the inequality of agricultural income among farmers.

Table 3.12.1 Summary of Area Served by Meska based on Inquiry Survey durign Phase I Field Survey

Directorate	Water District	Canal	Delivery feddan	Meska feddan	Meska No	Meska Average	Meska Coverage, %	Remarks
Gharbia	Bahary Zifta	Bahr Shebin	9,970	5,753	32	180	58	
		Omar Pick	19,966	12,464	72	173	62	
		G. Dahtoura	2,000	2,000	21	95	100	
		Bahr Shershaba	7,100	2,680	19	141	38	
	Samanoud	Bahr Shebin	18,470	5,110	37	138	28	
		Bahr El Mallah	1,300	650	4	163	50	
		El Sahel	6,540	2,700	19	142	41	
	Bishbeesh	Bahr El Mallah	33,420	15,027	87	173	45	
	East El Mahallah	Bahr Shebin	7,755	2,100	26	81	27	
		Bahr El Mallah	22,070	15,415	105	147	70	
	West El Mahallah	Bahr Shebin	2,300	0	0		0	
		El Korashia	21,100	13,995	35	400	66	
Kafr El Sheikh	Balteem	Bahr Tera	26,805	19,950	128	156	74	
	Mansour	Mansour	45,700	19,450	97	201	43	
	Hamoul	Bahr Tera	38,755	5,800	24	242	16	**45 % from Inventry Survey in Phase II**
	Biyala	Bahr Tera	32,752	13,280	124	107	41	**49 % from Inventry Survey in Phase II**
West Dakahlia	Hafir	El Nile	11,621	1,000	8	125	9	
		El Eslah	18,981	1,600	12	133	8	
	Basandila	Bahr Shebin	3,025	800	5	160	26	
		Bahr Basandila	51,110	6,870	44	156	13	
	Bilqas	Bahr Shebin	3,240	1,000	5	200	31	
		Raiah Bilqas	11,748	3,150	17	185	27	
		Bahr Hafir Shehab El Deen	29,059	5,350	25	214	18	
	Maasara	Raiah Bilqas	2,500	400	2	200	16	
		Bahr El Maasara	31,066	1,350	10	135	4	
		Bahr El Banawan El Alaa	686	0	0		0	
	Zahraa	El Nile	23,980	3,800	19	200	16	
		El Eslah	11,420	4,350	17	256	38	
	Talkha	Bahr Shebin	36,284	12,290	52	236	34	
		El Sahel	3,140	200	1	200	6	
	Sherbin	El Sahel	10,504	1,880	13	145	18	
		Balamoun	19,300	1,020	10	102	5	
Damietta	Kafr Saad	Balamoun	42,702	7,008	9	779	16	
		El Sahel	5,300	400	1	400	8	
		Nile canal	5,400	1,350	3	450	25	
Sum & average of above			617,069	190,192	1,083	176	31	