CHAPTER 2 DEVELOPMENT PLAN

CHAPTER 2 DEVELOPMENT PLAN OF THE PRIORITY AREA

The development plan on irrigation improvement and water environmental conservation based on the establishment of farmers' organization in the Priority Area will be formulated to cope with the low agricultural productivity caused by the facts such as water shortage in the downstream area caused by over-irrigation in the upper part of canals and fall of on-farm irrigation efficiency, inequitable water distribution between up and down stream reaches seen in the whole area under the rotational irrigation system, old irrigation and drainage facilities, and aggravating water environment.

Based on the basic development concept in the Master Plan study of the Study Area, the development plan is formulated as following sections, aiming at saving water and rasing farm household income. The development goal with more than 7,900 LE of farm household income would be launched considering 6,900 LE of income without project situation and 45 % of the food expenditure ratio at the urban household. In order to achieve this goal, the agricultural development plan would be proposed under the condition of timely and adequate water supply considering the necessary cropping pattern with water saving crops limited water resources. Under this concept, the core of the development of the Priority Area is the participatory planning on organizing WUA, WUG, and Federation of WUAs who will undertake water management and O&M of proposed terminal facilities.

2.1 Plan of Farmers' Organization

IIP performance is not necessarily satisfactory at present. Besides, the government is aiming at prompt realization of Branch Canal Federations of WUAs in the future. For this target, several problems hampering effective implementation of IIP should be solved and innovative measures should be newly introduced. Following issues are some probable ideas focussing on "What kinds of situation should be consolidated for farmers' positive participation to a new IIP ? " (For reference, they are summarized in a table shown in Appendix J.8).

2.1.1 Methodology to Grasp Farmers' Opinions and to Establish Farmers' Organization

a)IIP inauguration and its implementation are to actually be based on the farmers' request. In other word, any IIP will not be implemented if farmers' willingness and mutual consent among them are still not matured.

b)At least 1.5-2 years is to be spent for the above maturity and/or preparation period.

c)For this purpose, PP (Participatory Planning)methodology is to be adopted.

2.1.2 Technical Supports to Farmers' Organization

a)The share of IAS staffs' job is to be drastically changed from the on-going IIP to the proposed IIP to grasping farmers' willingness and enhancing mutual understanding among them. This means a kind of "On-the-job Training" for the PP (Participatory Planning) methodology

b)Through it, some extra results are to be obtained such as transformation of the farmers from nominal participants to the training courses, to facilitators and/or social organizers to the future IIP implementation.

c)From the long term viewpoint, technical staffs are to be released from the field offices of the government to the Federation of WUAs to strengthen its technical caliber.

2.1.3 Financial Supports to Farmers' Organization

a)Current regulations regarding the repayment period etc. for IIP are to be lightened from current 20 years(including unredeemable 3 years) to 25 years(-do-) in the future(In more detail, refer to 2.1.1).

b)If more than 2/3 farmers of a delivery canal agrees upon IIP implementation with temporary submission of request within limited years (e.g. 5 years), they are to accept the government subsidy of e.g. 75% of O/M costs for the first year, 50% for the second year and 25% for the third year.

c)The government is to pay remuneration to Federations of WUAs as consignment allowance when it decides a turnover of O/M jobs to them in each delivery canal basis. To encourage farmers, allowances are to be discriminated from LE5/F to zero in accordance with the quality of O/M performance. Similarly, the government is to pay remuneration to Federations of WUAs when it entrusts a primitive survey necessary for M/E to them.

2.1.4 Government Commitment and Legal Framework

The government's basic commitment to the plan will be as follows;

1) Enhancing responsibility and authority of WUAs

The government is to expand farmers' authority/ responsibility for O/M in a manner of following to a good example of LWB(Local Water Board) in Fayoum, its reinforcement and application to the whole country. Also, the government is to promote establishment of a women's conference as an annex to a WUA. This conference is to contribute to a WUA not by direct participation in water policy decision, but by acting indirectly as a

catalyst to convey necessary information for the better rural life like environmental issues, rural welfare and daily learns among women etc. In the same way, a women conference is to be attached in a Federation of WUAs, too.

2) Implementation with cheapness and immediate effect

Since several unsuccessful examples can be seen in other countries where O/M works had been turned over to farmers' organizations without good physical condition of irrigation structures and as a result farmers had neither got their own water nor been willing to effort toward better O/M, a minimum structural works are to be undertaken prior to the turn-over to the farmers. They are, at least, reinforcement of a gate at the head of delivery canal and lock structures at the tail-end of each Meska and delivery canal.

3) Enhancing cooperation between specific sectors

Interaction among related organizations is to be strengthened through an arrangement of correlative sections of irrigation, drainage, mechanics and agronomy etc. in a Federation of WUAs, also through an active participation of officers/engineers to a Joint Committee. They are to be a District engineer, Area drainage engineer, Mechanical engineer and Agricultural manager etc. from each district-level office.

4) Presenting comprehensive government policy

"The carrot and stick policy" is to be introduced ,endorsed by strong and high level commitment by the government. As "carrot", several advantages aforementioned are to be presented precisely to concerning farmers. By contrast, "stick" is also to be shown to the farmers in justifiable ways explaining that the government cannot avoid re-allocation of water resources and relevant budget from the existing farmland to the newly reclaimed area and/or more potential area being supported by highly willing farmers.

2.1.5 Implementation Procedures of New IIPs

The following new implementation procedure is proposed for IIP by delivery canal unit.

a)Preparation period for farmers' willingness and mutual consent for new IIPs is to be provided at least 1.5-2 years.

b)Decision of interim leaders and temporary submission of IIP request are to be applied for new IIP in each delivery canal basis.

c)A Joint Committee is to be set up which is composed by representative members both from the government and farmers sides, and it promotes necessary planning, design,

bidding and supervision of construction jobs etc. under mutual collaboration between the both sides.

d)After one year's test running and defect correction period for the constructed facilities, the Federation of WUAs is to be officially established, registered to the I.D and be turned over authorities/ responsibilities for O/M execution in each delivery canal basis.

e)After the turn-over, a privilege period, probably limited within three years, is to be offered to support the Federation of WUAs till its full-scale independence.

These procedures for new IIP implementation are schematized in Fig. 2.1.5-1.

2.1.6 Monitoring and Evaluation (M/E)

M/E will be conducted according to the following two (2) categories.

a) Stage-waise M/E throughout IIP

This is to be carried out by farmers under a contract between IAS and the Federation with reasonable payment. Data submitted from the Federation is to be input to computerized data-base system by IAS.

b) Overall M/E to compare "before" and "after" of IIP

For this purpose, methodologies developed by international organizations are to be adopted. In such methodologies, quantitative indices such as an agricultural output per unit command area(in $/ha), unit water consumed (in $/m3) and relative irrigation supply (in ratio) are used, and they are to compare the Egyptian performance quantitatively with other countries.

2.1.7 Application of Proposed Ideas to the Priority Area

Based on the problems /constraints so far recognized and performance so far achieved, the Study will be continued more in detail to the end of the Draft final report. For reference, rough dimensions of the Priority Area are shown below to apply the proposed ideas to the area.

a)Area: 62,000 feddan (26,000 ha) (gross area), 56,900feddan (23,900 ha) (net area)
b)Administrative Local Unit (Oarya, ruled by Umda): around 20,000 feddan (8,400 ha)
c)Unit area of Aila: around 300 feddan (126 ha)
d)Unit area of agricultural cooperative: around 2,000 feddan (840 ha)
e)Command area of delivery canal: around 2,000 feddan (840ha)
f)Length of delivery canal: around 5 km

g)Number of cultivator farmers in a delivery canal: around 600

h)Number of meskas in a delivery canal: around 5, at present
around 18, if direct irrigation is mitigated by IIP

i) Number of cultivator farmers in a Federation of WUAs: around 600

j) Command area of a meska: around 100 feddan (42 ha)

k)Number of cultivator farmers in a WUA: around 30

l) Command area of a unified marwa: around 50 feddan (21 ha)

m)Number of cultivator farmers in a WUG(Water Users' Group): around 15

By applying these dimensions, estimated total farmers' organizations in the Priority area are shown below although such an estimation should be revised in more details by using characteristics and background of each delivery canal (Some examples of such detailed revision are shown in 3.3 for Bahr El Nour canal and Ganabia No.6 R. canal). For reference, in this estimation, 3 layers of organizations - starting from WUG(Water Users' Group)as a lowest-scale group where farmers can naturally incorporate each other through their daily life, WUA as a medium-scale group in unifying WUGs, then a Federation of WUAs as a highest-scale group in contacting and consulting with the government side - are adopted, because for the purpose of grasping people's incentive to incorporate among a group "Ergonomics consideration" is the most essential point.

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

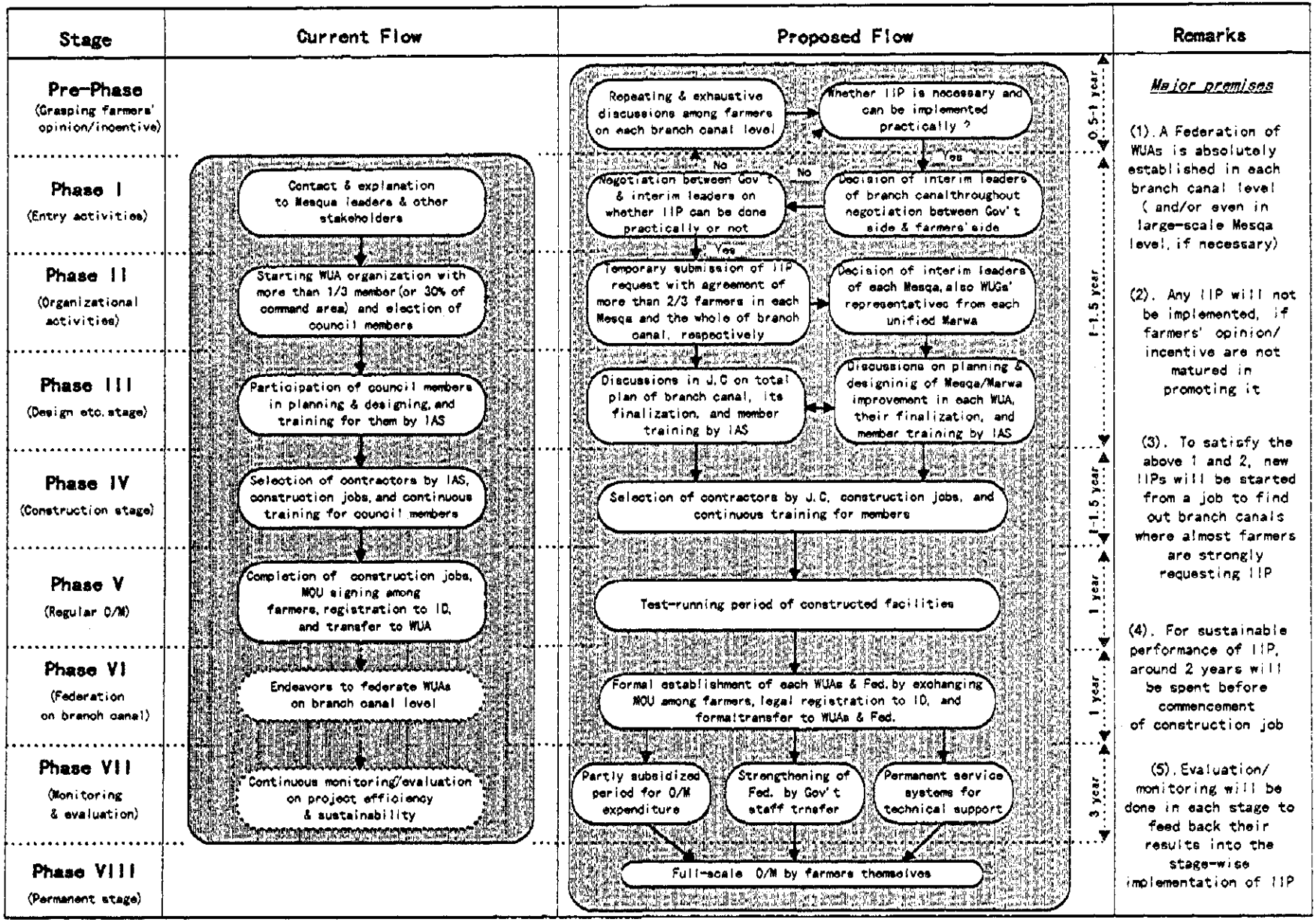
a)Number of the total WUG: around 1,150 (50 feddan (21 ha)/WUG)

b) -do- WUA: around 500 (90-150 feddan (38-63 ha)/WUA)

c) -do- Federation: around 30 (1,000-5,000 feddan (420-2,100 ha)/Federation)

A schematic image of 3 layers of farmers' organization is shown in Fig. 2.1.2., and a standardized organization chart of Federation is shown in Fig. 2.1.3 to 2.1.5, respectively.

Figure 2.1.1 Comparative Flow Chart of IIP Implementation



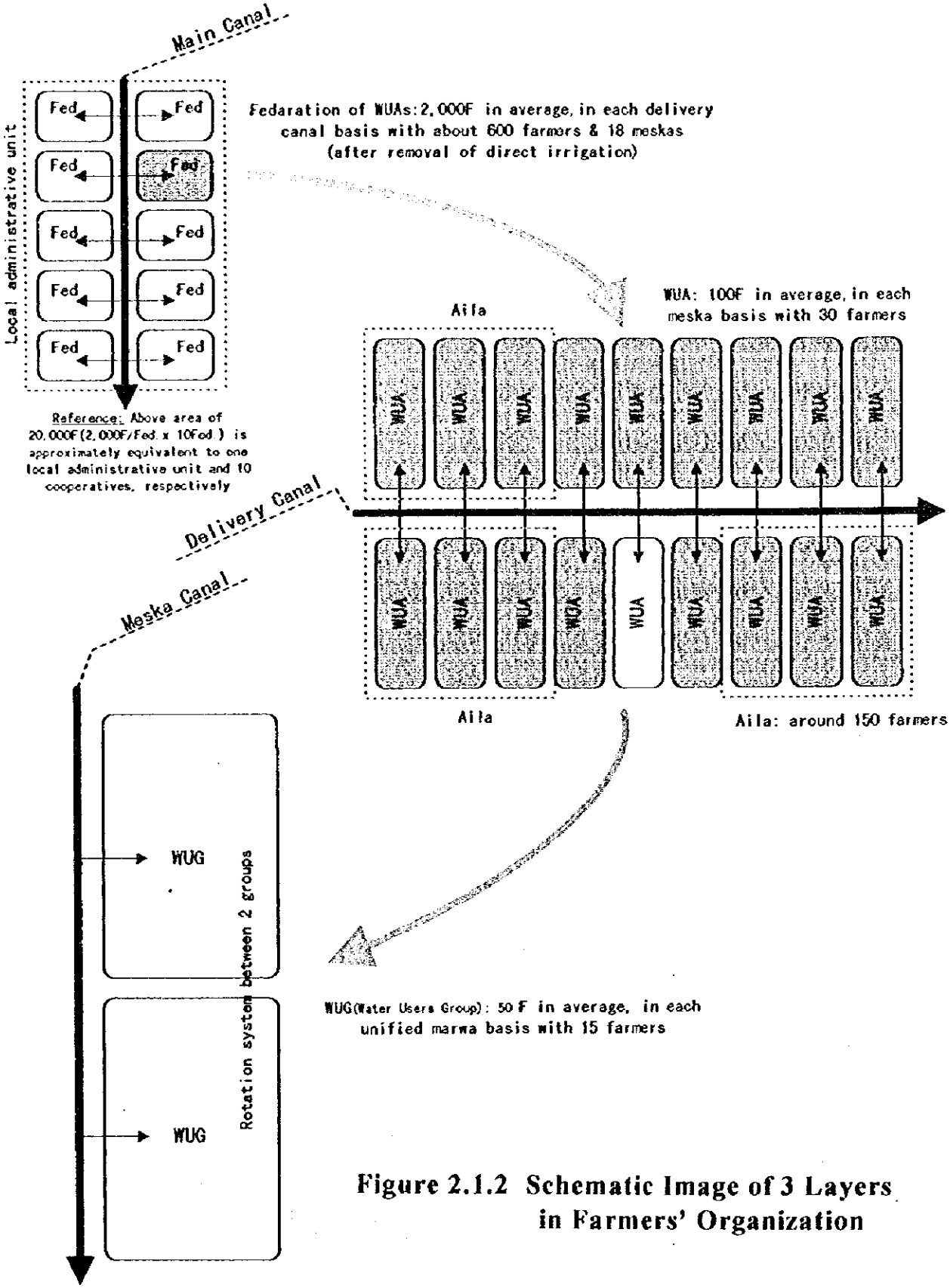
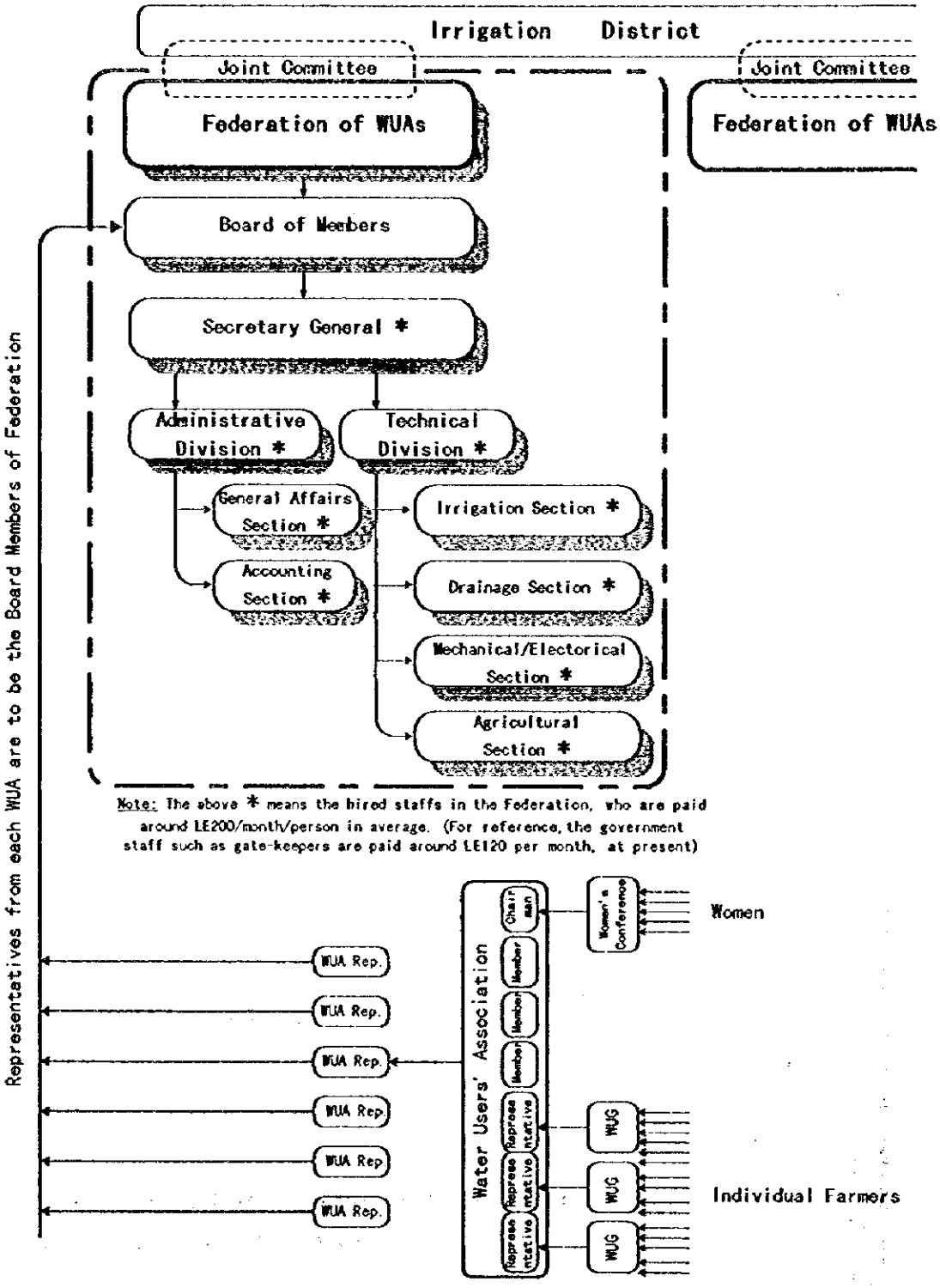


Figure 2.1.2 Schematic Image of 3 Layers in Farmers' Organization

Figure 2.1.3 Standardized Organization Chart of Federation



Note: The above * means the hired staffs in the Federation, who are paid around LE200/month/person in average. (For reference, the government staff such as gate-keepers are paid around LE120 per month, at present)

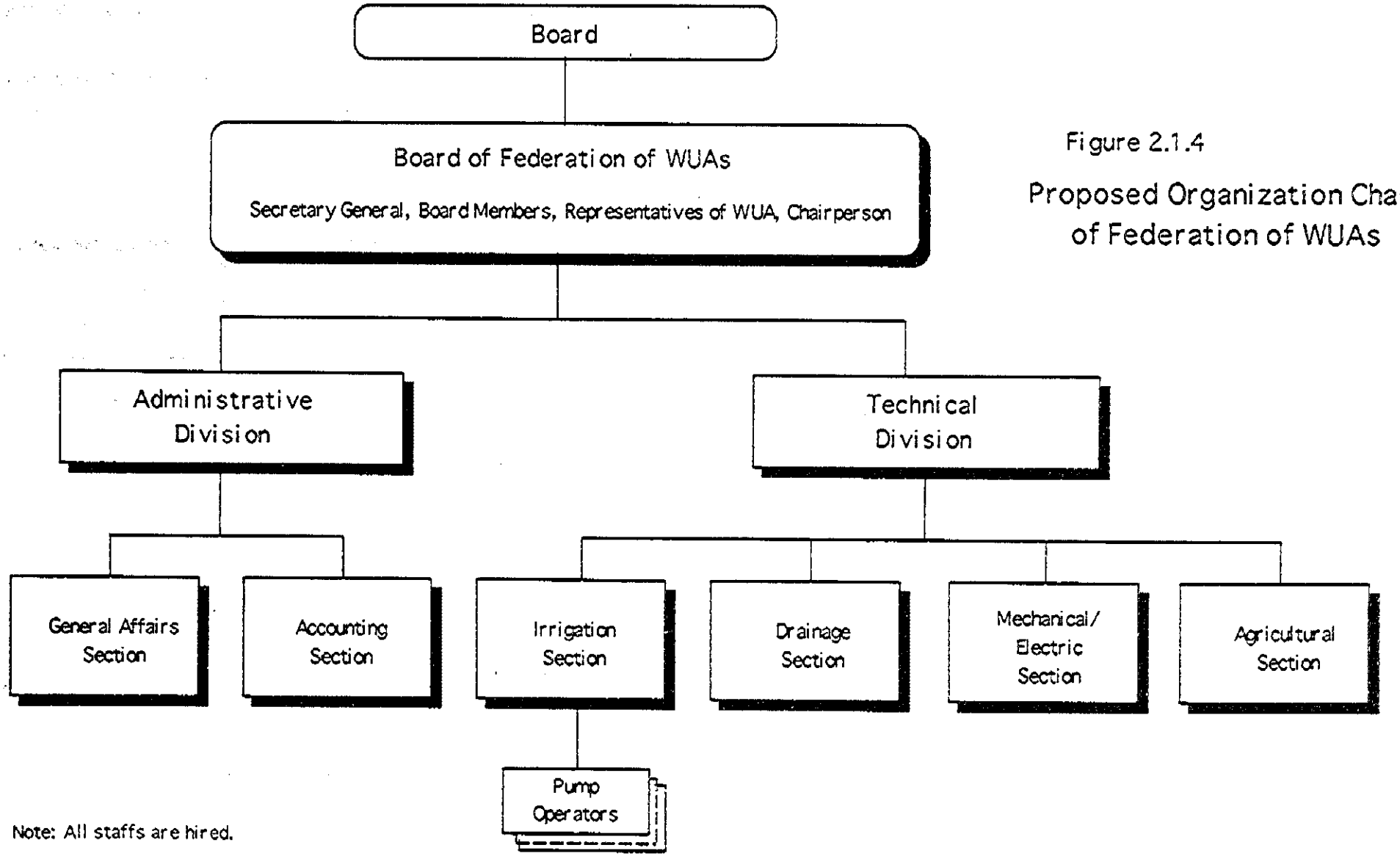


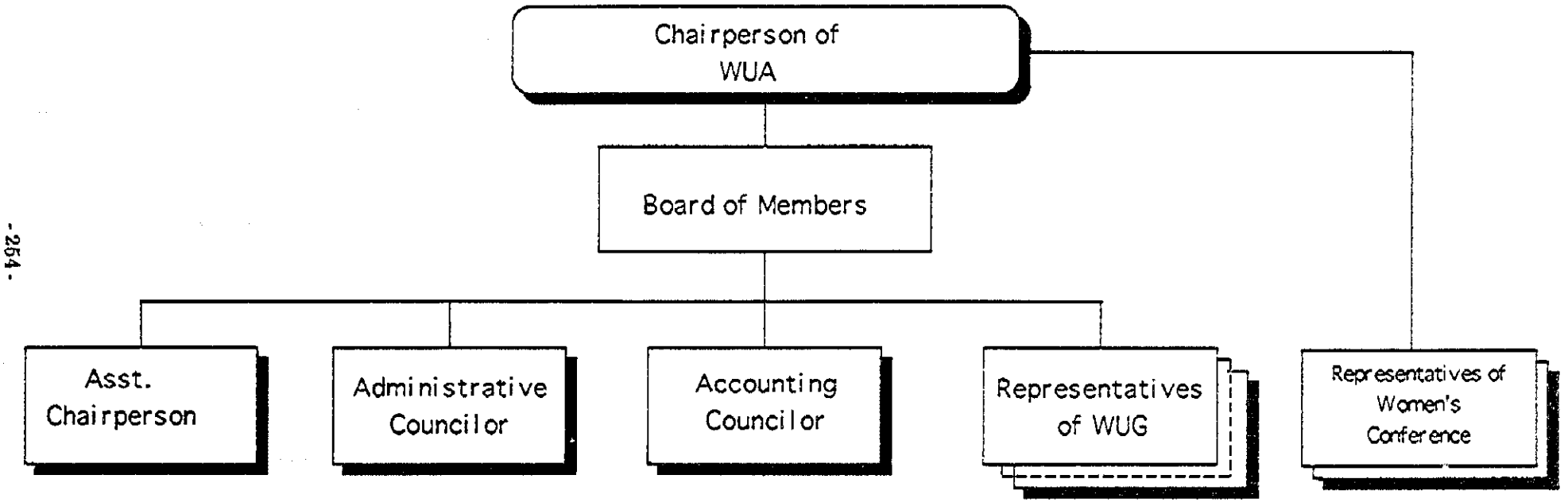
Figure 2.1.4

Proposed Organization Chart of Federation of WUAs

Note: All staffs are hired.

Source: JICA Study Team, 1999

Figure 2.1.5 Proposed Organization Chart of WUA



Note: Pump operators belong to the proposed federation of WUAs.

Source: JICA Study Team

2.2 Agricultural Development Plan with IIP

2.2.1 Basic Strategy on Agricultural Development with IIP

Timely and adequately irrigation is important not only to increase crop production in the downstream area but also to intensify agricultural production with the introduction of high valued diversified crops for raising farm income. About 99 % of the total sample farmers in Farm Economy Survey have the intention to increase income through raising the farm income. The intensification of farming through diversified crops and high yield has to be emphasized strongly to raise farm income of the small scale farmers.

There are a considerable number of farmers in the upstream, who succeeded in raising farm income by intensified farming by growing carrot in the fields and cucumber in plastic tunnel house. These intensive farming shall be expanded in the downstream area. Not only improvement of water management for timely and adequately irrigation and but also soil improvement of saline soils have to be promoted to intensify the farming with introduction of vegetables in more wide areas.

2.2.2 Proposed Land Use

Generally the same land use is proposed because the IIP will not have any significant change in the Priority Area. However, it is expected that the buried Meska will generate one or two percent of the existing right-of-way with the installation of the raised open and/or the pipe-line Meska. Since, there is a very low intensity of farm roads in Priority Area, it is proposed to develop farm roads with the generated land through Meska improvement.

2.2.3 Proposed Crop and Cropping Pattern

(1) Proposed Cropping Pattern

Rice area will be reduced by 57 %of the existing rice area, following the master plan. In the proposed cropping pattern, summer vegetable areas will be increased by one third of the original rice reduction area (36 % of the existing rice area), which means 12 % of the existing rice area. Maize and other summer crops will be cropped for the remaining two third of the original rice reduction area. The introduction of continuous flow irrigation under IIP, will make possible the introduction of vegetables throughout the Priority Area. Not only IIP but also the agricultural supporting services will be provided to promote intensive farming with crop diversification.

(2) Crop Selection

It is proposed to introduce short and medium duration rice varieties with the reduction of rice area for water saving. These varieties have growth period of about 120 to 140 days, which make it possible to harvest berseem one or two times more or to plant and harvest sugarbeet earlier for the winter cropping. Since the cropping intensity is as high as 200 %, at present, it is not easy to have a more timely cropping schedule than existing ones without improvement of water management. The introduction of the continuous flow of irrigation to the short and medium duration rice varieties will bring about more efficient cropping schedule, that will increase crop yield.

The crops of high net income per water duty shall be selected to utilize water more efficiently. With the introduction of continuos flow irrigation under IIP, vegetables will be introduced aside from the existing major crops. Considering the prevailing soils which have heavy texture in the Priority Area, the following vegetables are selected in the proposed cropping pattern;

Summer crops: tomato, egg plant, squash and potato

Winter crop : onion, carrot, cabbage, potato, pea and cucumber/ bell pepper and tomato, some flower in the plastic tunnel

2.2.4 Proposed Farming Practices

The IIP will improve farm management substantially from the following aspects;

- Timely and adequate irrigation throughout the area even in the tail portions
- Right cropping time for high valued crop
- Decrease of irrigation cost with efficient irrigation

Saline soils will be improved by applying about 100, 000 ton of gypsum according to soil improvement plan. Also, sub-soiling as well as land leveling by laser will be applied to improve the land. The land leveling by laser beam will be operated to increase crop production and also to save irrigation water. As the existing land leveling by laser beam is operated efficiently only in the land of more than 20 feddan (8 ha), there is a need to improve land leveling for small scale farmers. Recently, the mounted type of leveler is developed in Japan, which can be operated more efficiently in smaller plots. Based on the opinion of Egyptian Authority of Land Improvement Projects (EALIP) it is proposed to introduce land leveling technology in the Priority Area on a pilot scheme basis.

The other crop production practices have to be improved by applying continuous flow of irrigation. In the proposed farming practices, the chemical fertilizer of nitrogen requirement of about 10 kg to 80 kg per feddan (24 kg to 190 kg/ ha) for wheat, sugar beet, cotton, maize and rice, are considered reasonable amount to attain the target yields. (refer to Appendix E Table E.2.16)

2.2.5 Proposed Crop Yield and Crop Production

The increase rates of unit yield based on the yield difference between the upstream and the downstream in the master plan is applied to estimate the target yield with IIP. As in the master plan, the increase yield rates are applied for the yield with subsurface drainage in the area where the subsurface drainage project is not yet executed. The average unit yield per feddan for the major crops of wheat, sugarbeet, berseem, cotton and rice are estimated at 18.00 ardab (6.43 ton/ha), 20.09ton (47.83 ton/ha), 18.36ton (43.71ton/ha), 8.00 kantar (3.00ton/ha) and 4.07ton(9.69 ton/ha), respectively. The total crop production in Priority Area are estimated at 55,600 ton of wheat (increased by 15 % of the present production, 104,600 ton of sugarbeet (19%), 394,300ton of berseem (decreased by 5% of the present production), 14,300 ton of cotton (49%) and 53,200 ton of rice (paddy, decreased by 43% of the present production), respectively. Some crops have by product aside from the main products. Including the by products the target yield with IIP area projected yearly, where the full target yield will be attained within four years after project implementation (refer to Table 1.4.1 and Appendix E Tables E.2.8 E.2.9, E.3.5)

2.2.6 Agricultural Supporting Plan

The federation of WUA shall have an organization to collect and renew the basic data on water management and also to prepare cropping plan for the command area. WUA will have the Farm Management Section to take charge of data collection and preparation of cropping plan. The Farm management section will have three staff for the average scale of the federation. With assistance of the Joint Committee which will be composed of the governmental supporting organizations including the Agricultural Extension Center, this section will have activities to improve water management for the members of WUA.

The Farm Management Section will be provided support services on the preparation of cropping pattern with crop diversification, arrangement of seeds and seedling supply and introduction of production technology for crop diversification. Based on data on the cropping pattern for the coming season as well as those on maintenance and operation, problems on water management shall be checked before the actual water distribution. Once problems are

discovered like the capacity of the irrigation and drainage facilities as well as the shortage of allocated water, the federation will have to be assisted by MPWWR in the solution of the problems through a Joint Committee. (refer to Figure 3.2.1)

2.2.7 Marketing and Agro-processing Improvement Plan

(1) Marketing improvement

Under the free economy policy, Marketing improvement for vegetables will be focused since the vegetables are relatively profitable but fluctuate with the prices decided by the free market.

It is estimated with project situation in the Priority Area that the total annual supply of vegetables from the Priority Area will be 124,000 tons (summer vegetables with 78,000 tons and winter vegetables with 46,000 tons). The Priority Area has advantage for marketing with the location and the products will be supplied constantly to local markets such as Tanta, and central markets in Cairo or Alexandria and also exported through the International Mediterranean Sea Road, Alexandria port and Damietta port which will be promoted as an international port.

The annual growth rate of the population in Egypt is 2.1 % and the vegetable consumption per capita (except potatoes) is 144.0 kg in 1993/94, 160.9 kg in 1994/95, and 175.7 kg in 1996/97. As for potatoes, its consumption per capita is also increasing as 16.2 kg in 1993/94, 28.6 kg in 1994/95, 29.0 kg in 1996/97. Hence the increase of the vegetable consumption will be expected in the future in Egypt. The total population of Egypt in 2007 after the implementation of the project in the Priority Area will be 74,496,000, so the total consumption of vegetables will be 15,249,000 tons of which only 0.8 % will be supplied from the Priority Area. Also with regarding the increase of vegetable export, the supply of vegetables from the Priority Area will not affect the market prices.

The expansion of capability of farmers facing the fluctuating market price, the traditional custom between middlemen, acquiring market information to sell their products will be required. It is also required for farmers to organize themselves for vegetable marketing with assistance of agricultural loan and agricultural extension and fortify a system of sharing the transportation inventory, market information and farming technology, and standardizing products, sustainable supply with adequate amount and fund for the risk.

Approximately 20 to 40 feddan (8 to 16 ha) for a crop will be required to get the

recognition as the vegetable-growing area from markets. The number of farmers will be 10 to 20. There are 15 green house farming farmers who are organizing themselves for marketing with the leadership of a large-scale farmer who initiated the green house farming in the Priority Area. The marketing plan in this Study, will be to utilize the benefit of Meska improvement plan and organization plan for WUA to accelerate the farmers independent marketing activities including their own organization. The benefit of the plans mentioned above will be 1) improvement of product quality and access to main roads by improving feeder road as the component of Meska improvement, 2) increase and stable supply of vegetable products by introducing the continuous flow on delivery canals, 3) equalizing the gap of water supply and location between upstream and downstream reaches of canals by the methods above1) and 2), and 4) upsurge of co-operation among farmers through WUA organization program and activating conventional customs such as Mosharaka.

(2) Agro-processing improvement

Regarding the present condition with control of supply of products and pricing by the government for most large-scale agro-processing factories, farmers may have less incentives to select the factories to bring their products. But for the point of securing the destination of products, the improvement of agro-processing will be required. As the sugar factory, which has been mentioned at chapter two (2), in Kafr El Sheikh still has room to process another 600,000 tons of sugar beets, the improvement of operation ratio is required to keep the supply of products. The increase of agricultural products by the irrigation improvement including Meska improvement will contribute raising operation ratio of the factories.

Table 2.2.1 Crop Unit Yield with Project (F/S Area)

Crop	Unit	kg per unit	Upstream		Midstream		Downstream		Rate of Yield Increase			
			Per feddan	Ton per ha	Per feddan	Ton per ha	Per feddan	Ton per ha	Upstream (%)	Midstream (%)	Downstream (%)	Subsurface Drainage (%)
Winter Crops												
- Wheat	Ardab	150.0	18.51	6.61	18.51	6.61	17.24	6.16	12	12	12	15
- Broadbean	Ardab	155.0	9.58	8.47	9.58	3.54	9.67	3.57	13	13	13	20
- Sugarbeet	ton	1,000.0	21.09	50.21	21.09	50.21	19.54	46.52	12	12	12	20
- Berseem(Long Term)	ton	1,000.0	24.93	59.36	24.93	59.36	22.78	54.24	13	13	13	20
- Berseem(Short Term)	ton	1,000.0	15.87	37.79	15.87	37.79	14.50	34.52	8	8	8	20
- Vegetables(Onion)	ton	1,000.0	9.83	23.40	9.83	23.40	8.68	20.67	12	12	12	20
Summer crops												
-Cotton	Kantar	157.5	8.13	3.05	8.13	3.05	8.13	3.05	32	32	32	25
- Maize	Ardab	140.0	23.74	7.91	23.74	7.91	22.93	7.64	33	33	33	15
- Rice	ton	1,000.0	4.10	9.76	4.10	9.76	4.01	9.55	28	28	28	5
- Water Melon Seeds	ton	1,000.0	0.42	1.00	0.42	1.00	0.42	1.00	20	20	20	20
- Vegetables(Tomato)	ton	1,000.0	14.23	33.88	14.23	33.88	14.16	33.71	35	35	35	25
Fruit trees(Orange)	ton	1,000.0	11.43	27.21					28			25

Note:
The increase rate of unit yield in the mid and downstream areas is estimated from the yield without IIP and the yield difference between the top and tail in Farm Economy Survey for the downstream area, while the rate of 67 % are applied for the upstream area because of the favorable irrigation conditions in the area.
The unit yield without IIP is estimated for the mid and downstream areas, referring the feasibility study report on Farmland Environmental Improvement Project in omoum Area.

Source: MALR,DOS

Figure 2.2.1 Proposed Cropping Patter (F/S Area)

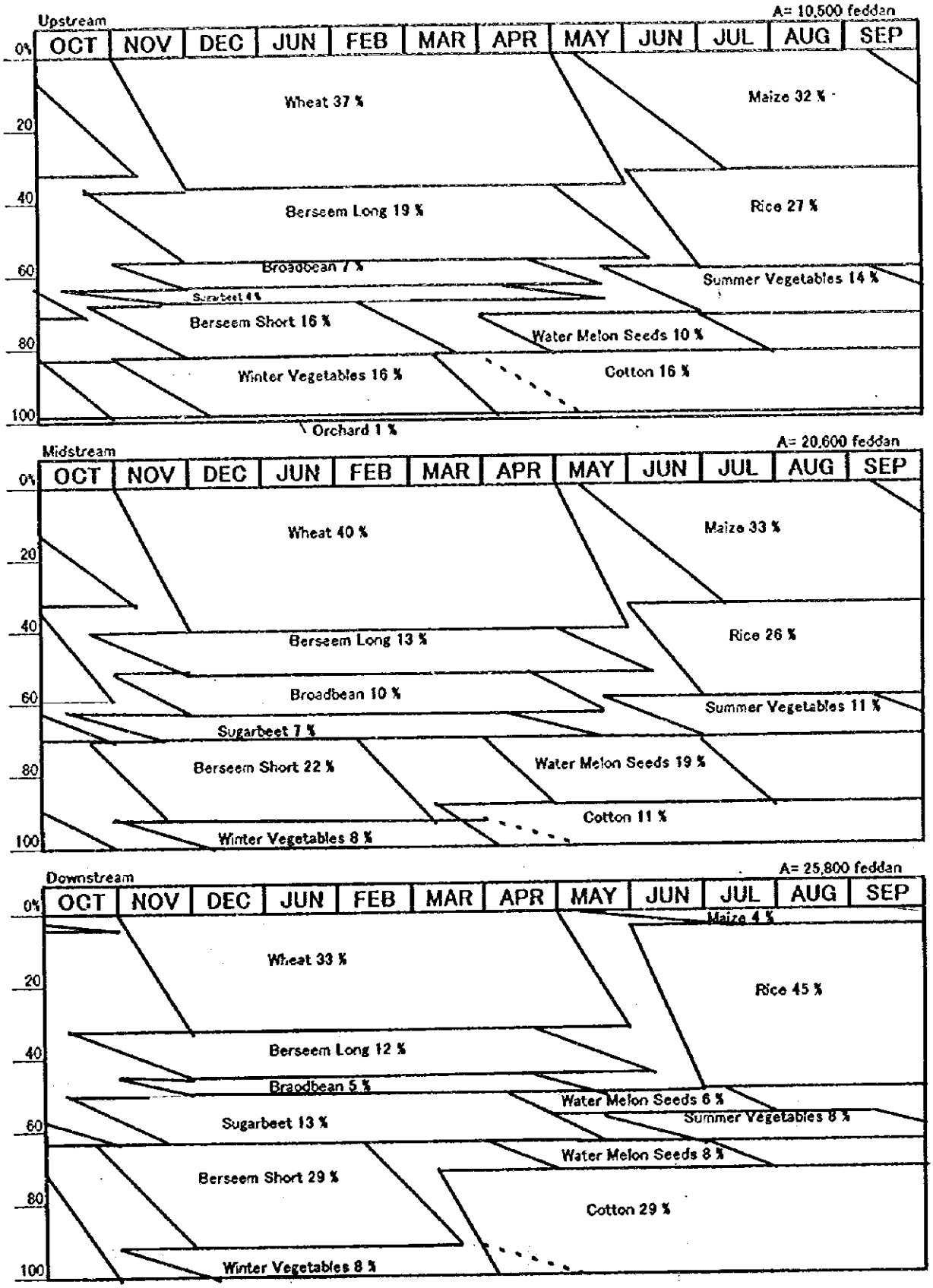


Figure 2.2.2 Farmer' Organization and Agricultural Supporting Organization

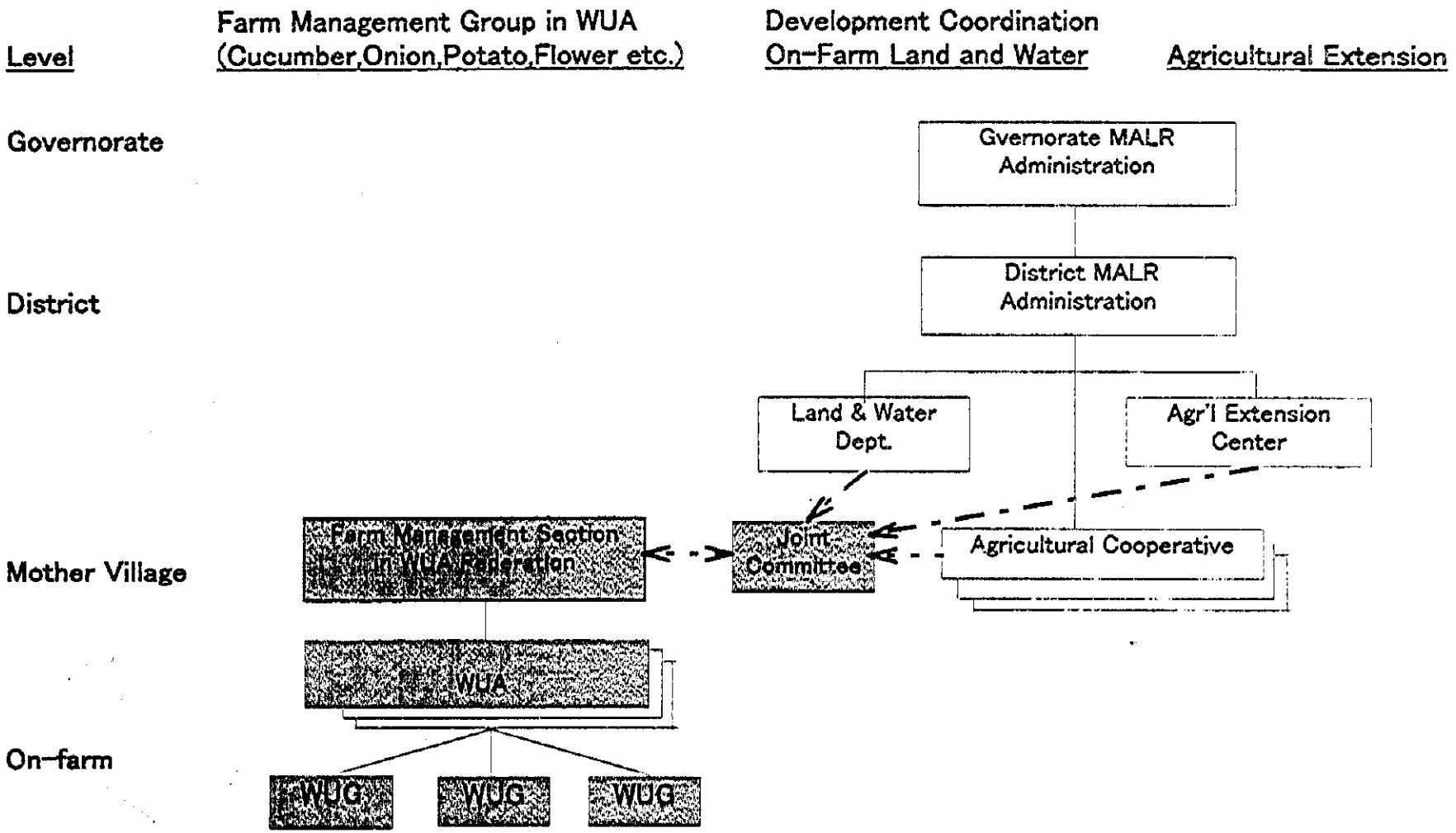
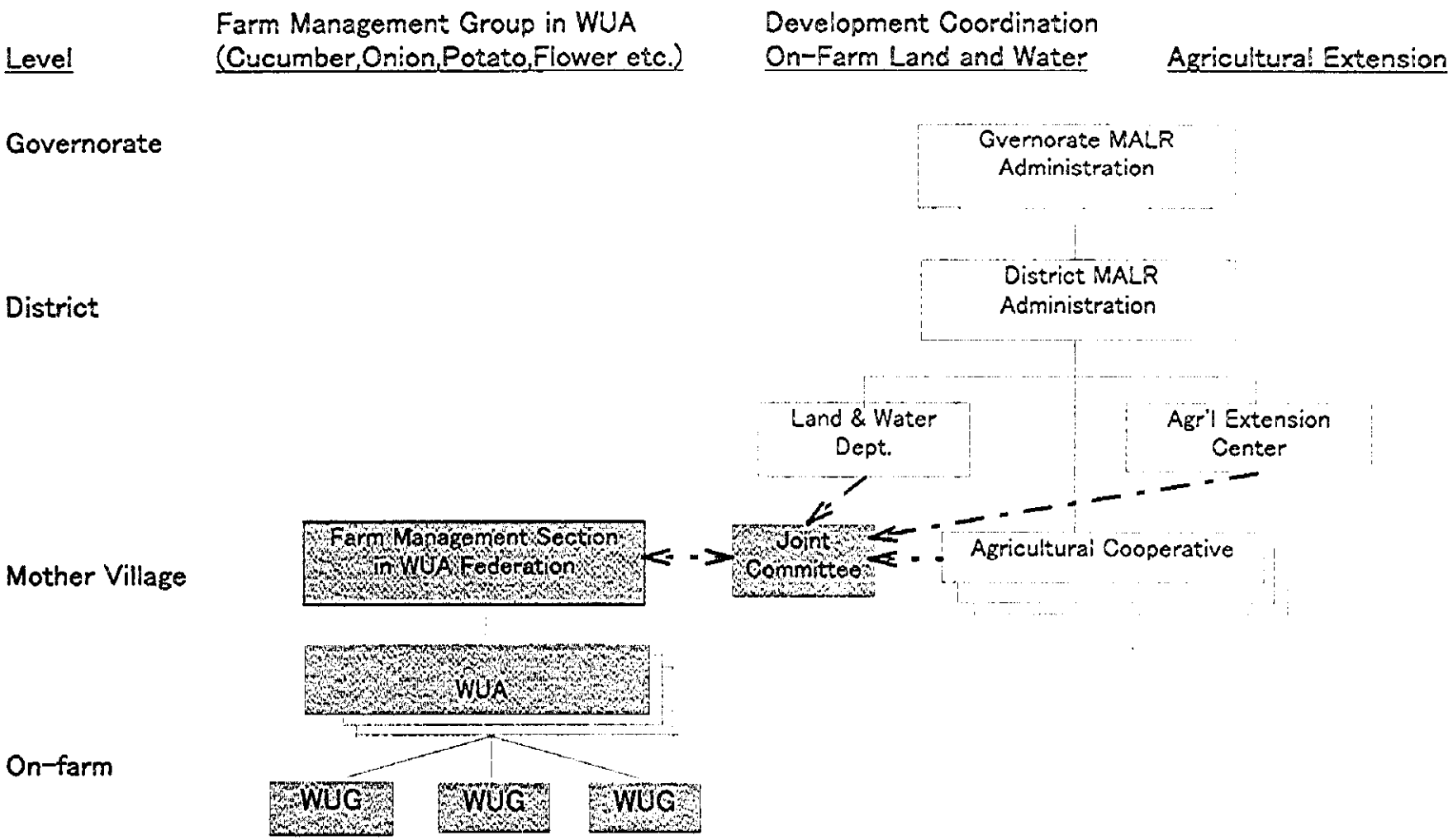


Figure 2.2.2 Farmer' Organization and Agricultural Supporting Organization



2.3 Irrigation and Drainage Development Plan

2.3.1 Irrigation Efficiencies

To estimate conveyance efficiency of Bahr Tera, the canal within the Priority Area was divided into 4 reachs, and those conveyance efficiencies were surveyed during Phase II study by carrying out current measurement at the beginning and the end points of each reach simultaneously. The measurement had been done 4 times each and the average conveyance efficiency is summarized below;

Section	Conveyance Efficiency (%)	Length (km)
Reach A-A'	97.1	10.6 (fr. Tera intake)
Reach B-B'	98.6	6.5
Reach C-C'	92.5	7.7
Reach D-D'	98.6	5.7 (to the end of P.A.)

The conveyance efficiencies shown above are very high. The efficiency of reach C-C' is relatively low of 92.5 %, and it is probably because of submerged weeds which had been observed at the measurement section and direct irrigation along Bahr Tera. During current measurement, all deliveries' intakes were closed but there were some leakages flowing through the gates. Also, direct irrigation had been sometimes observed.

Taking into the situation above, the conveyance efficiency of Bahr Tera can be concluded to be very high. This is most probably due to the high groundwater table that reduces seepage loss. Also, return-flows replenished by groundwater might contribute to the high efficiency. In Section "3.4.5 Overall Inflow & Outflow Balance on Bahr Shebin Command Area" in Part I, at least 462 MCM groundwater was estimated as the return flow into drains, which is equivalent to 11 % of the total inflow into the whole study area. Although the bed level of Bahr Tera canal is obviously higher than those of any open drains, there might be a possibility that there is a return-flow into Bahr Tera.

Taking into consideration the measurement results above and the fact that little waste spillage has been observed from the tails of delivery canals and even from Meska, this study suggests high efficiencies of conveyance, distribution, and even Meska related. This somewhat contrasts to what has been considered in previous studies. However, on-farm related efficiency could be concluded to still remain low with reference to the irrigation over-dosages, a part of which go to drain or return to Meska and canal.

Therefore, following efficiencies are considered; same efficiencies as those employed

in Part I for the base case, and also a case study for which return flow from paddy field will be considered for without-project. The case study will consider that a part of irrigation water for paddy applied to farm, at maximum 50 % of the on-farm loss, is to be reused.

Item	Without(Base)	Without(case study)	With-Project
On-farm Application, Eo	0.65	50% paddy loss	0.73
Meska Conveyance, Em	0.90	returns to	0.95
Main, Sec. Del. Conveyance, Ec	0.95	canal/Meska	0.95
Overall Efficiency, Ep	0.56	0.51(for summer only)	0.66

2.3.2 Water Requirement and Water Balance Study

Crop evapotranspiration is estimated on basis of modified Penman method as the Mater Plan in Part I did. Also, crop coefficients (Kc) are same as those employed in the Master Plan. Reference crop evapotranspiration (ETo) for the Priority Area is calculated on basis of the meteorological data at Mansoura station and the ETo for the downstream of Bahr Tera (out of the Priority Area) on basis of the meteorological data at Damietta station.

For paddy cultivation, land preparation and percolation should be considered in addition to the crop evapotranspiration. As Master Plan did, a total of 80 mm composed of 30 mm for supplement into the soil and 50 mm for ponding is undertaken, and 2.0 mm/day is considered as the percolation. These requirements are net and the gross is calculated taking into consideration the Meska conveyance and main/secondary/delivery canal conveyance only and excluding on-farm application.

With the cropping patterns proposed and irrigation efficiencies applied, water requirements are estimated. For the cropping pattern, 2 cases are undertaken; namely, first one's cropping pattern has 170% intensity for the downstream of Bahr Tera and 200% for the Priority Area, and second one has all 200% cropping intensity. Therefore, both cases has same cropping pattern and intensity for the Priority Area but different in the downstream of Bahr Tera (out of the Priority Area).

Also, each case is examined with two conditions for areas, 14,550 feddan (6,111 ha) in total, currently irrigated by gravity-fed drainage that are located at the downstream of Bahr Tera (out of the Priority Area). One is that no supplemental fresh water feeds the areas, thus to be irrigated by drainage only as it is (referred to as "Drainage not Supplemented"), and the other is that a half of the required irrigation water is supplemented by fresh water (referred to as "Drainage Supplemented"). Therefore total number of study cases becomes 8.

Cropping Pattern	Without Project Ep=0.56 (0.51)	With Project Ep=0.66	Remarks
Present	O	O	Crop intensity; DS 148%
Pattern 1		O	Crop intensity; DS 170%
Pattern 2		O	Crop intensity; all 200%

Note; Ep=0.56 is the base case for without-project, and 0.51 is a reference in case of considering return flow from paddy cultivation, 50% of the on-farm loss.

The studies reveal the following (refer to Appendix F.18, Tables 2.3.1 & 2.3.2 and Figures 2.3.1 to 2.3.6);

- Present cropping pattern under without-project requires an annual amount of 1,071 MCM ("drainage not supplemented") that is 5.5% less than the annual available water of 1,133 MCM. However, the monthly peak requirement is 202 MCM in July ("drainage not supplemented"), which is 23% more than the actually available of 165 MCM, suggesting water shortage during summer season (refer to Table 2.3.1, Figures 2.3.3 and 2.3.4).
- Present cropping pattern with project (Ep=0.66 applied to whole Bahr Tera area) requires an annual amount of 914 MCM in case of "drainage not supplemented" and 958 MCM in case of "drainage supplemented". The balances are 19% less and 16% less than the annual available water. However, the monthly peak still requires an amount more than the actually available of 165 MCM in July; namely, 173 MCM (4.5% over) in case of "drainage not supplemented" and 180 MCM (8.9% over) in case of "drainage supplemented" (refer to Table 2.3.1, Figures 2.3.3 and 2.3.4).
- With the introduction of irrigation improvement into the Priority Area (Ep=0.66 for the Priority Area and 0.56 for the downstream of Bahr Tera), an annual amount of 72 MCM (6.4% of total 1,133 MCM) would be created under the same cropping pattern as the present, and 118 MCM (10.4%) under the planned cropping pattern (Table 2.3.2, Figures 2.3.1 & 2.3.2).
- With the saved water of 118 MCM, increases of 7.8% cropping intensity for winter crop and 11% for summer crop would be realized in the downstream of Bahr Tera. These increments corespondent to 8,400 feddan and 12,000 feddans respectively. Or, 76 % and 100% of the areas currently irrigated by drainage only, 14,550 feddan located at downstream of Bahr Tera, could be irrigated with the saved water (See Table 2.3.2, Figures 2.3.1 & 2.3.2).
- Cropping pattern 1 (downstream cropping intensity 170 %) with project (Ep=0.66 over whole Bahr Tera) and under "drainage supplemented" requires 943 MCM that is 191 MCM (16.8%) less than the annual available of 1,133 MCM. Also, the annual requirement of cropping pattern 2 (all cropping intensity 200%) is 1,064 MCM, which

is 70 MCM (6.1%) less than the annual available (refer to Table 2.3.1, Figures 2.3.3 and 2.3.4).

- Though both cropping patterns' annual requirements are, as above-mentioned, within the annual available, the monthly peak requirement of cropping pattern 2 requires more than the actually available. Cropping pattern 2 requires 186 MCM in July even in case of "drainage not supplemented" that is 12.5 % more than the actually available of 165 MCM. While, cropping pattern 1's peak requirement is 164 MCM in July that is within the available (refer to Table 2.3.1, Figures 2.3.3 and 2.3.4).
- With reference to the design discharge of 50 cu.m/s at Bahr Tera intake, the peak requirement of the cropping pattern 2 cannot be in-taken. The peak requirement at Bahr Tera intake is 55 cu.m/s in case of "drainage not supplemented" and 59 cu.m/s in case of "drainage supplemented". This suggests that cropping pattern all 200% cannot be realized without renovation of Bahr Tera intake even if water reallocation among months was arranged (refer to Table 2.3.1 and Figure 2.3.5).
- Cropping pattern 1 requires 47 cu.m/s in case of "drainage supplemented" at the Bahr Tera intake that is less than the designed of 50 cu.m/s. Thus, cropping pattern 1 can be realized without renovation of the intake and within the presently available water. Cropping pattern 1 would create 191 MCM annually (or 196 MCM after water reallocation among months done). This is equivalent to about 17% of the annual available (refer to Table 2.3.1, Figures 2.3.5 & 2.3.6).

2.3.3 Hydraulic Simulation for Bahr Biyala Command Area

An unsteady flow simulation is carried out for Bahr Biyala command area. The objectives are; 1) to simulate the present conditions under rotational irrigation and to identify the problem incurred, and 2) to simulate the continuous flow to be introduced in future in line with one point lifting pump instead of current individual liftings and to verify the merit or otherwise identify the demerit accompanied if any.

(1) Simulation Modeling

Simulation study is carried out for the cases of; 1) present condition, 2) planned condition without automatic check gate (downstream water level constant gate), and 3) planned condition with the automatic check gate. The simulation period is to be 10 days in June that requires the maximum irrigation water of 8.69 cu.m/s for without-project (2 x 8.69 is inputed for the first 5 days) and 6.16 cu.m/s for with-project. Also, minimum requirement is checked with the irrigation water of 1.02 cu.m/s in October.

Outflow from the model is the pumping from Meskas and canals onto the fields by the farmers, and the pumping is modeled on basis of sine curve;

Without Project;

First 5 days; $Q = (1.0 + SIN((T-t)\pi/12)) \times 1.7 \times 8.69 \times a / A$

Last 5 days; $Q = (1.0 + SIN((T-t)\pi/12)) \times 0.5 \times 8.69 \times a / A$

Where;

t; 6 for upstream and 10 for downstream (4 hrs difference)

1.7 / 0.5; adjustment factor

8.69; design outflow, cu.m/s

a; command area by the node concerned, feddan

A; total irrigation area of Bahr Biyala; 14,380 feddan

With Project;

In July; $Q = (1.0 + \alpha \times SIN((T-6)\pi/12)) \times 6.16 \times a / A$

In Oct; $Q = (1.0 + \alpha \times SIN((T-6)\pi/12)) \times 1.02 \times a / A$

Where;

6; the peak is to show up at noon with this 6

α; maximum sine factor, 0.5 applied

6.16; design outflow in July, cu.m/s

1.02; design outflow in October, cu.m/s

(2) Simulation Results of Present Rotational Condition

Simulating present condition reveals that;

- It takes about 6 hours that the water discharged fills canals at upstream area of Bahr Biyala, while takes 24 hours or more to have the canals at downstream area of Bahr Biyala filled (see Figure 2.3.7).
- Water levels at downstream of Bahr Biyala fluctuates widely since discharge coming from upstream area cannot keep pace with the pumping done by farmers due to the time lag to reach. The low water level shown at the downstream area of Bahr Biyala makes it difficult to supply water into Meskas and canals branching from Bahr Biyala (refer to Figure 2.3.7).
- Water levels at tails of representative Meskas fluctuate more widely than those above. Meska Rab El Fashool often dries up since enough water cannot be delivered into the Meska because of the fluctuation in Bahr Biyala canal.
- Water at around tail of Meskas and canals is flowing very unstable running forward

and backward. Water management under this situation is very difficult, and the farmers would face difficulty to lift enough and stable water from the Meska.

- Water in Bahr El Nour canal starts reverse-flowing after the discharge from Bahr Biyala intake stopped. This is because that the Nour's capacity is relatively large comparing to other canals, therefore the reserved volume is easily withdrawn by Bahr Biyala.
- Present condition's hydraulic profile along Bahr Biyala fluctuates widely, giving difficulty to water management and making it difficult to supply enough water to Meska and canals downward. While, Bahr Nour's hydraulic profile does not fluctuate so much because of the large capacity of the canal. After the discharge is stopped, the water level in Bahr Nour goes down quickly, and this can be explained by backward-flow from Bahr El Nour into Bahr Biyala (Figures 2.3.8).

(3) Simulation Results of Continuous Flow

Simulating continuous flow reveals that;

- With the continuous flow of maximum of 6.16 cu.m/s without check gate, the water level fluctuates with a range of 0.4 m only, and this does not seem to create any noticeable problem. However, when looking into the water level at the tail of Bahr Biyala, the water level is gradually raising up. This is because that some Meskas from Bahr Biyala cannot take enough water, maybe because of the high bed level elevation, so that excess water goes to the downstream of Bahr Biyala (see Figure 2.3.9).
- With the continuous flow of minimum 0f 1.02 cu.m/s without check gate, the water level at the downstream of Bahr Biyala was raising up as observed before but very sharply. This was caused by the fact that Meskas and canals from Bahr Biyala could not take enough water since the water level in the Bahr Biyala remained low. This suggests that check gates be required.
- There are 7 existing gates and those behave as a gate keeping upstream water level constantly. Therefore, the water level downstream of the gate often goes down quickly, making it difficult that the farmers around take enough water. Also, since those gates are manually operated, it is difficult to control the water level precisely. This suggests that an automatic downstream water level constant gate be required (Figure 2.3.10).
- With the introduction of the gate keeping downstream water level constantly, the effect of pumping (outflow from the model) move to upstream area of the Bahr Biyala

irrigation system. The water levels in the upstream of Bahr Biyala fluctuate within a range of 1.85 to 2.45 m (See Figure 2.3.11).

- The hydrogaphs fluctuate periodically, and the flow at the intake of Bahr El Nour often goes backward. This would make it difficult to measure the inflow volume into Bahr El Nour.
- The water level profile along Bahr Biyala does not give any problem, having enough water levels thanks to the downstream water level constant gate. The water level along Bahr El Nour does not give any problem either (See Figures 2.3.12).

2.3.4 Irrigation and Drainage Development

Considering the above discussions, following are proposed in irrigation and drainage development;

- As a first step, an annual amount of 118 MCM (10.4% of 1,133 MCM) would be created with the introduction of irrigation improvement into the Priority Area, thereby mitigate the water shortage in the downstream area, Mansour and Balteem Districts, of Bahr Tera. The 118 MCM would raise the cropping intensity of the area by 8 % for winter crop and 11 % for summer crop, or otherwise supplement the area of 14,550 feddan currently irrigated by drainage only with the fresh water.
- Then, cropping pattern 1 (downstream cropping intensity of 170 %) should be realized in the mid term's irrigation development with the introduction of irrigation improvement to the downstream of Bahr Tera.
- After that, the intensity should be increased to 200 % towards long term irrigation development in line with the renovation of the Bahr Tera intake and water reallocation among months.
- For areas of 14,550 feddan (6,111 ha) currently irrigated by drainage water only, supplemental irrigation water will be provided which is commensurate to about half the irrigation requirement, giving improvement of water quality.
- Water reallocation among months shall be considered, according to the water requirement discussed before, in order to save and create new water. In considering the reallocation, same condition mentioned in Master Plan should be applied as 1) minimum should not be less than the present December's available in order to keep water level that can feed succeeding canal, and 2) water presently available for January and February should not be changed considering the canal closure period though the actual requirements are more than the presently available (refer to Table

2.3.1).

- After the reallocation, there could be 196 MCM (about 17 % the annual available of 1,133 MCM) saving in case of cropping pattern 1 (downstream cropping intensity 170 %) and "drainage supplemented", and 81 MCM (7 % the annual available of 1,133 MCM) in case of cropping pattern 2 (cropping intensity all 200%) with the same condition (refer to Table 2.3.1).

- Hamoul MPS feeds about 84,755 feddan (35,597 ha) with the annual mixing amount of 321 MCM. The Gharbia drain, from which Hamoul MPS lifts the drainage into Bahr Tera, is already almost fully developed. Therefore a decrease of the drainage volume would occur in line with irrigation improvement, and this must be supplemented. With irrigation efficiency improved from Ep=0.56 to 0.66, the drainage would decrease by as much as about 20 % ((0.66-0.56)/0.56), and this amount of 64 MCM (321MCM x 0.2) could be managed within the amount to be newly created. As to the discharge to be additionally required at Bahr Tera intake, the amount is to be 2.9 cu.m/s (39.33 MCM in July / 31 / 86,400 x 0.2). Therefore, the total discharge at Bahr Tera intake will be 50 cu.m/sec (47 for C.I.170% + 2.9) that is not more than the designed.

- Continuous flow with an automatic downstream water level constant gate shall be introduced in line with the Meska improvement as this provides the stable water especially to the farmers at around terminal places of the irrigation system. Farmers think that off-period caused by rotation system is too long, and that the off-period is the most recognized reason of water shortage. Continuous flow relieves farmers' view in this regard, and could be the most incentive that invites farmers to irrigation improvement project.

- With the introduction of continuous flow, there will be a possibility of taking more water than the current rotational irrigation even under the improved Meska system. To cope with this, H-Q relationship (gate formula) at the intake of each delivery canal shall be established, and the discharge shall be monitored.

2.3.5 Monitoring and Measuring Water

Monitoring and measuring the water, allocated to a federation or an association, are essential for this irrigation improvement project in view of; 1) farmers feel the water as their own property thereby getting the farmers motivated in doing improved irrigation, and 2) in order not to let the farmers take more water than the allocated.

With reference to the present condition, most simple and practical way is to establish a

gate formula at the existing gates such as Bahr Biyala intake, Bahr El Nour intake, and Hazek regulator, so on. One example is given below that was established for Bahr Biyala intake during Phase II field survey;

$$Q=1.165 \times (d - 0.095) \times H^{0.5}$$

Where; Q; discharge, (MCM/day)
d; Gate Opening, (m)
H; Head difference between upstream and downstream, (m)

With the formula above, Bahr Biyala command area took an amount of 4.23 MCM during November 1998, while the actual requirement is estimated at 3.42 MCM on basis of the cropping pattern and Penman method. About 24% (0.81 MCM) was excessively taken. This kind of arrangement could be practiced at all delivery canals, each of which corresponds to a Federation of WUGs.

However, a difficulty lies to keep the accuracy of the measuring as the simulation revealed. With a downstream water level constant gate, the effect of the pumping by the farmers will go to upstream and be concentrated there, by which water level moves with a certain range. This makes it difficult to know an amount in-taken for a certain period like one day or one week without doing successive measuring, conversion into flow and the summation. Also, if the canal concerned was secondary or tertiary delivery branching from upstream of a first delivery, the difficulty would increase as shown on Bahr El Nour (Nour's discharge at intake periodically reverse-flowed).

A discharge at a time can be know with the arrangement shown above, however it would not be easy to know an amount taken for a certain time. Therefore, to know the amount, successive measurement associated with automatic water level recorder would be required and also pump operation records must be supplemented.

In connection with the above, a large size federation commanding whole Bahr Biyala area would be viewed since it is easier to know the amount at Bahr Biyala intake rather than to know the amount at secondary or tertiary delivery intakes.

Though similar IIP installed an automatic downstream water level constant gate at just downstream of the existing intake gate (probably the existing one was supposed to be removed), this practice is not recommended in view of;

1) The existing intake gate shall be left in order to measure the discharge as mentioned

above and to control the inflow manually to prevent excessive irrigation usage by the farmers. Thus the gate will be the hydraulic boundary between main canal, like Bahr Tera, and deliveries.

2) With the existing gate left, automatic downstream water constant gate installed at just downstream of the existing one does not function at all with the purpose. To have a certain reserve back-watered by the automatic gate, the gate location shall have certain distance from the existing gate.

Table 2.3.1 Summary of Water Requirements for Whole Bahr Tera, Surpluss or Deficit and Modified Water Allocation, '000 CUM

Cropping	Ep	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	% to Original
Avairable for Bahr Tera		32,127	41,973	78,222	86,432	104,322	151,922	165,290	153,839	120,257	71,373	74,712	52,990	1,133,458	
Water Requirement															
Crop Intensity 170% (Drainage not supplemented)	0.66	55,693	68,896	69,149	40,075	37,385	126,840	157,272	147,005	93,737	25,760	29,930	43,798	895,540	
Surplass or Deficit, %		-73.4	-64.1	11.6	53.6	64.2	16.5	4.8	4.4	22.1	63.9	59.9	17.3	21.0	
Modified		32,127	41,973	69,149	40,075	37,385	126,840	157,272	147,005	93,737	52,990	52,990	52,990	904,534	20.20
Surplass or Deficit, %		-73.4	-64.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.4	43.5	17.3	1.0	
Crop Intensity 170% (Drainage supplemented)	0.66	59,428	73,476	73,822	42,447	38,952	132,372	164,425	153,912	98,210	26,978	31,972	46,816	942,809	
Surplass or Deficit, %		-85.0	-75.1	5.6	50.9	62.7	12.9	0.5	-0.0	18.3	62.2	57.2	11.7	16.8	
Modified		32,127	41,973	73,822	42,447	38,952	132,372	164,425	153,912	98,210	52,990	52,990	52,990	937,211	17.31
Surplass or Deficit, %		-85.0	-75.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49.1	39.7	11.7	-0.6	
Crop Intensity 200% (Drainage not supplemented)	0.66	56,413	69,948	70,822	43,698	47,259	146,146	185,977	176,018	107,596	28,816	30,277	44,280	1,007,251	
Surplass or Deficit, %		-75.6	-66.6	9.5	49.4	54.7	3.8	-12.5	-14.4	10.5	59.6	59.5	16.4	11.1	
Modified		32,127	41,973	70,822	43,698	47,259	146,146	185,977	176,018	107,596	52,990	52,990	52,990	1,010,588	10.84
Surplass or Deficit, %		-75.6	-66.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.6	42.9	16.4	0.3	
Crop Intensity 200% (Drainage supplemented)	0.66	60,228	74,644	75,680	46,470	49,917	153,203	195,395	185,214	113,162	30,276	32,357	47,352	1,063,898	
Surplass or Deficit, %		-87.5	-77.8	3.2	46.2	52.2	-0.8	-18.2	-20.4	5.9	57.6	56.7	10.6	6.1	
Modified		32,127	41,973	75,680	46,470	49,917	153,203	195,395	185,214	113,162	52,990	52,990	52,990	1,052,113	7.18
Surplass or Deficit, %		-87.5	-77.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.9	38.9	10.6	-1.1	
Present Cropping (Drainage not supplemented)	0.56	57,251	69,668	68,716	45,322	49,941	172,175	202,474	180,592	117,414	30,937	31,505	45,307	1,071,301	
Surplass or Deficit, %		-78.2	-66.0	12.2	47.6	52.1	-13.3	-22.5	-17.4	2.4	56.7	57.8	14.5	5.5	
Modified		32,127	41,973	68,716	45,322	49,941	172,175	202,474	180,592	117,414	52,990	52,990	52,990	1,069,705	5.62
Surplass or Deficit, %		-78.2	-66.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.6	40.5	14.5	-0.1	
Present Cropping (Drainage supplemented)	0.56	60,694	73,797	72,848	47,885	52,548	179,006	211,116	188,702	122,527	32,295	33,455	48,120	1,122,992	
Surplass or Deficit, %		-88.9	-75.8	6.9	44.6	49.6	-17.8	-27.7	-22.7	-1.9	54.8	55.2	9.2	0.9	
Modified		32,127	41,973	72,848	47,885	52,548	179,006	211,116	188,702	122,527	52,990	52,990	52,990	1,107,703	2.27
Surplass or Deficit, %		-88.9	-75.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.1	36.9	9.2	-1.4	
Present Cropping (Drainage not supplemented)	0.66	48,294	58,768	57,965	38,231	42,128	148,928	172,703	154,244	100,890	26,733	26,576	38,219	913,677	
Surplass or Deficit, %		-50.3	-40.0	25.9	55.8	59.6	2.0	-4.5	-0.3	16.1	62.5	64.4	27.9	19.4	
Modified		32,127	41,973	57,965	38,231	42,128	148,928	172,703	154,244	100,890	52,990	52,990	52,990	948,160	16.35
Surplass or Deficit, %		-50.3	-40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49.6	49.8	27.9	3.6	
Present Cropping (Drainage supplemented)	0.66	51,198	62,251	61,451	40,393	44,327	154,837	180,069	161,162	105,276	27,904	28,221	40,591	957,679	
Surplass or Deficit, %		-59.4	-48.3	21.4	53.3	57.5	-1.9	-8.9	-4.8	12.5	60.9	62.2	23.4	15.5	
Modified		32,127	41,973	61,451	40,393	44,327	154,837	180,069	161,162	105,276	52,990	52,990	52,990	980,586	13.49
Surplass or Deficit, %		-59.4	-48.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.3	46.7	23.4	2.3	

Table 2.3.2 Summary of Water Requirement to be saved by Irrigation Improvement Project in the Priority Area and Supplement to the Downstream of Bahr Tera

Cropping	Ep	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Remarks
Present (Priority Area Only)	0.56	26,087	32,296	31,311	22,126	26,349	85,614	92,961	77,820	52,629	13,728	13,857	19,850	494,629	
Present DS Req. per feddan (148%)	0.56	338	405	406	252	256	939	1,188	1,115	703	187	191	276	6,256	
Monthly Base Cropping Intenaity	%	76	76	76	76	76	72	72	72	72	72	76	76	148	
Requirement to raise 1% of C.I./feddan	CUM	4.4	5.3	5.3	3.3	3.4	13.0	16.5	15.5	9.8	2.6	2.5	3.6	85.3	
Present C.P. + IIP (Priority Area Only)	0.66	22,005	27,243	26,413	18,665	22,226	74,048	79,362	66,589	45,309	11,895	11,689	16,745	422,190	
To be created	'000CUM	4,081	5,053	4,899	3,462	4,122	11,566	13,599	11,230	7,320	1,833	2,168	3,106	72,439	
Available per feddan (DS total 106,735 feddan)	CUM	38	47	46	32	39	108	127	105	69	17	20	29	679	
Cropping Intensity to be raised	%	8.6	8.9	8.6	9.8	11.5	8.3	7.7	6.8	7.0	6.6	8.1	8.0	8.0	
Area to be newly planted	feddan	9,175	9,472	9,176	10,456	12,242	8,869	8,242	7,253	7,499	7,069	8,607	8,547	8,489	
Seasonal Lowest, Percent	%			8.0					6.6			8.0			
Seasonal Lowest, feddan	feddan			8,547					7,069			8,547			
Planned C.P. + IIP (Priority Area Only)	0.66	21,888	27,442	26,852	18,611	23,201	56,729	66,633	59,491	37,059	10,326	11,455	16,480	376,167	
To be created	'000CUM	4,199	4,854	4,459	3,516	3,147	28,885	26,328	18,329	15,570	3,402	2,402	3,370	118,462	
Available per feddan (DS total 106,735 feddan)	CUM	39	45	42	33	29	271	247	172	146	32	23	32	1,110	
Cropping Intensity to be raised	%	8.8	8.5	7.8	9.9	8.8	20.8	15.0	11.1	14.9	12.3	8.9	8.7	13.0	
Area to be newly planted	feddan	9,439	9,100	8,352	10,619	9,346	22,148	15,957	11,838	15,952	13,123	9,536	9,275	13,883	
Seasonal Lowest, Percent	%			7.8					11.1			7.8			
Seasonal Lowest, feddan	feddan			8,352					11,838			8,352			
Req. for Dr'ge Irr. Area (14,550 fed)	'000CUM	4,919	5,899	5,904	3,661	3,724	13,662	17,285	16,221	10,225	2,716	2,785	4,018	91,019	
Present; Percent that can be supplemented		83	86	83	95	111	85	79	69	72	67	78	77	80	
Seasonal Lowest, Percent				77					67			77			
Planned; Percent that can be supplemented		85	82	76	96	85	211	152	113	152	125	86	84	130	
Seasonal Lowest, Percent				76					113			76			

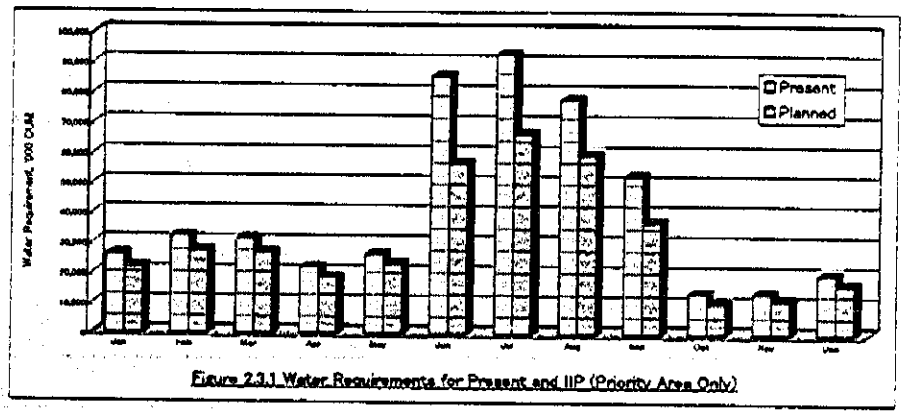


Figure 2.3.1 Water Requirements for Present and IIP (Priority Area Only)

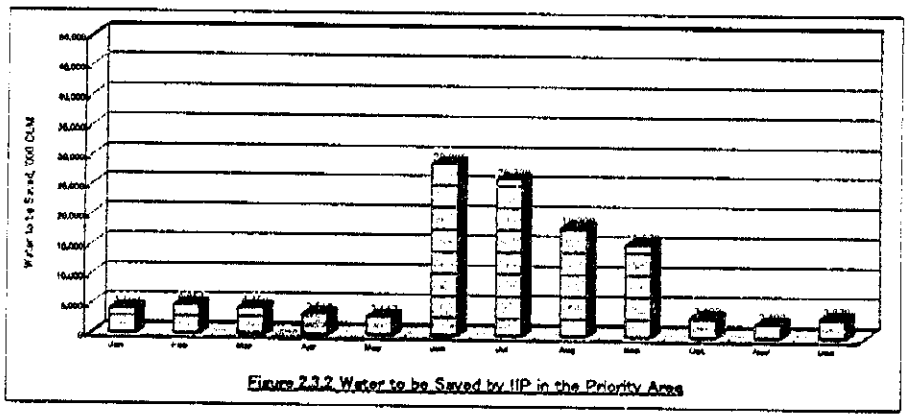


Figure 2.3.2 Water to be Saved by IIP in the Priority Area

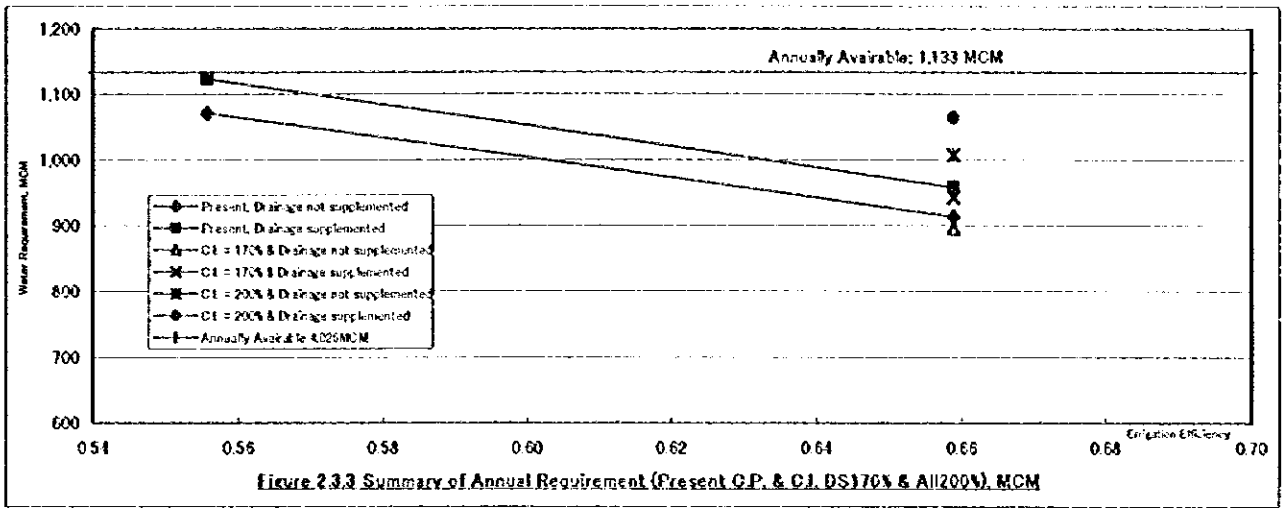


Figure 2.3.3 Summary of Annual Requirement (Present C.P. & C.I. DS170% & All200%), MCM

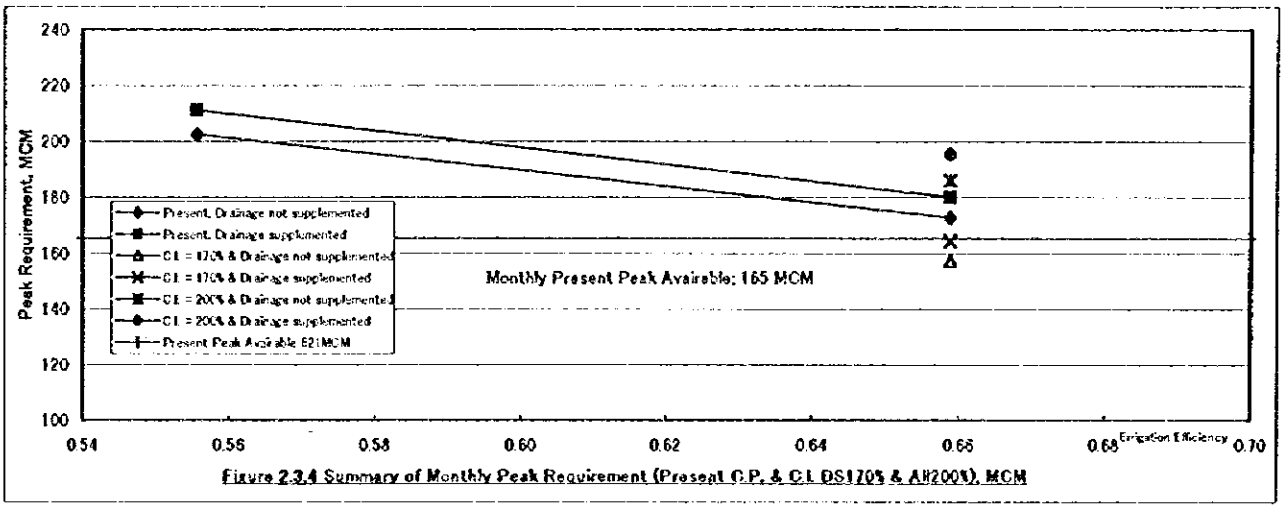


Figure 2.3.4 Summary of Monthly Peak Requirement (Present C.P. & C.I. DS170% & All200%), MCM

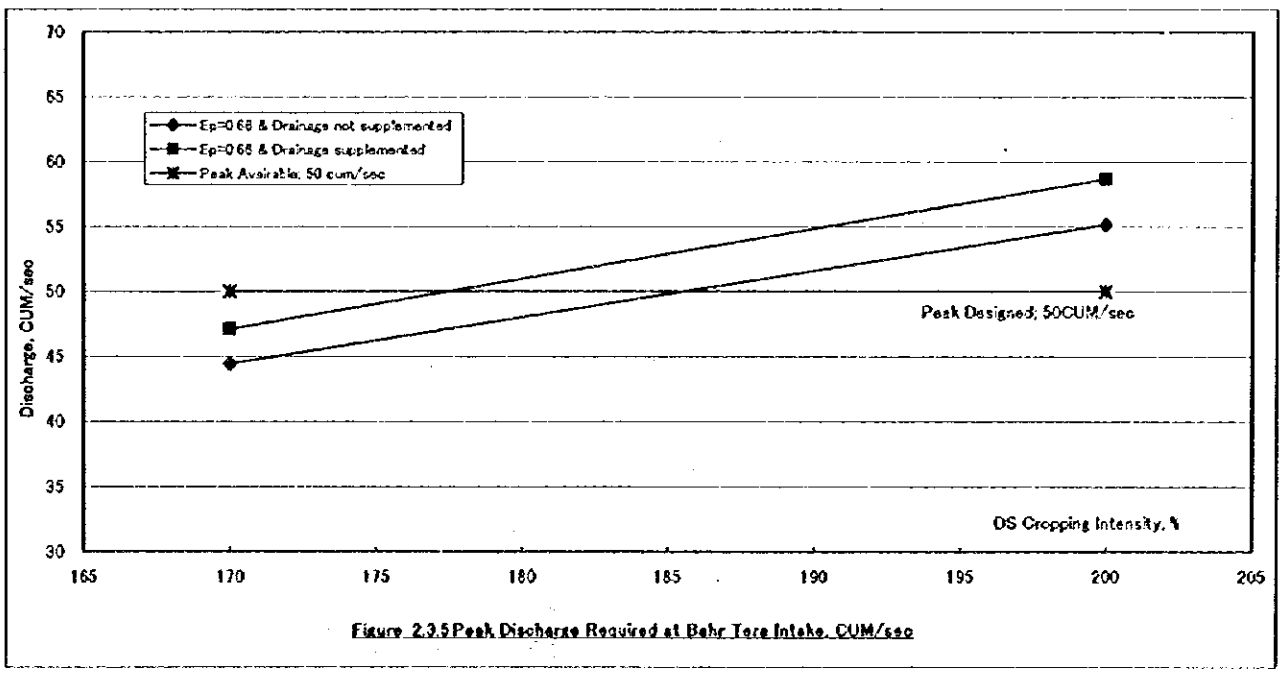
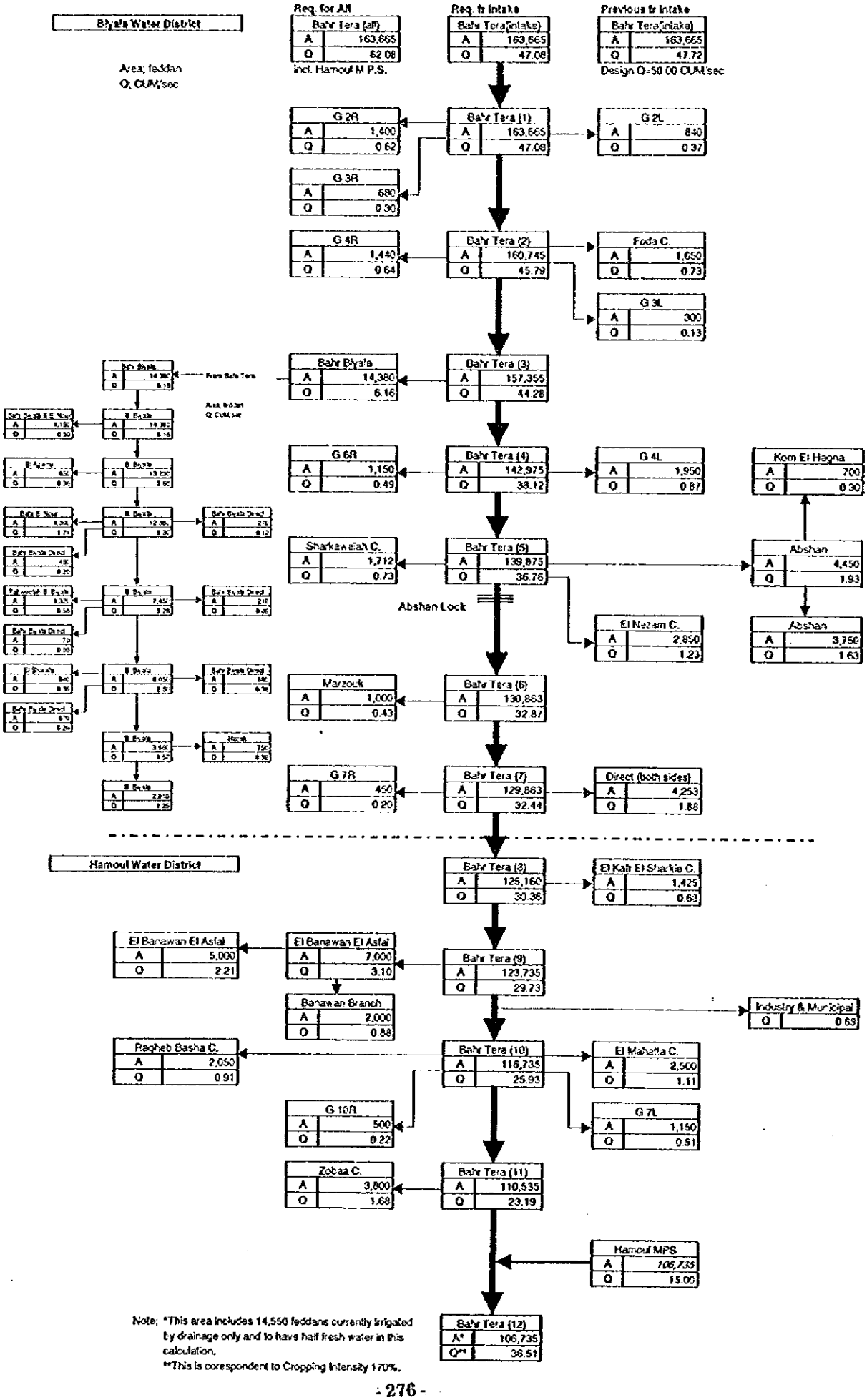


Figure 2.3.5 Peak Discharge Required at Behr Tore Intake, CUM/sec

Figure 2.3.6 Skeleton Map of Irrigation System of Upper Bahr Tera Canal, Downstream Cropping Intensity 170%



Note; *This area includes 14,550 feddans currently irrigated by drainage only and to have half fresh water in this calculation.
**This is correspondent to Cropping Intensity 170%.

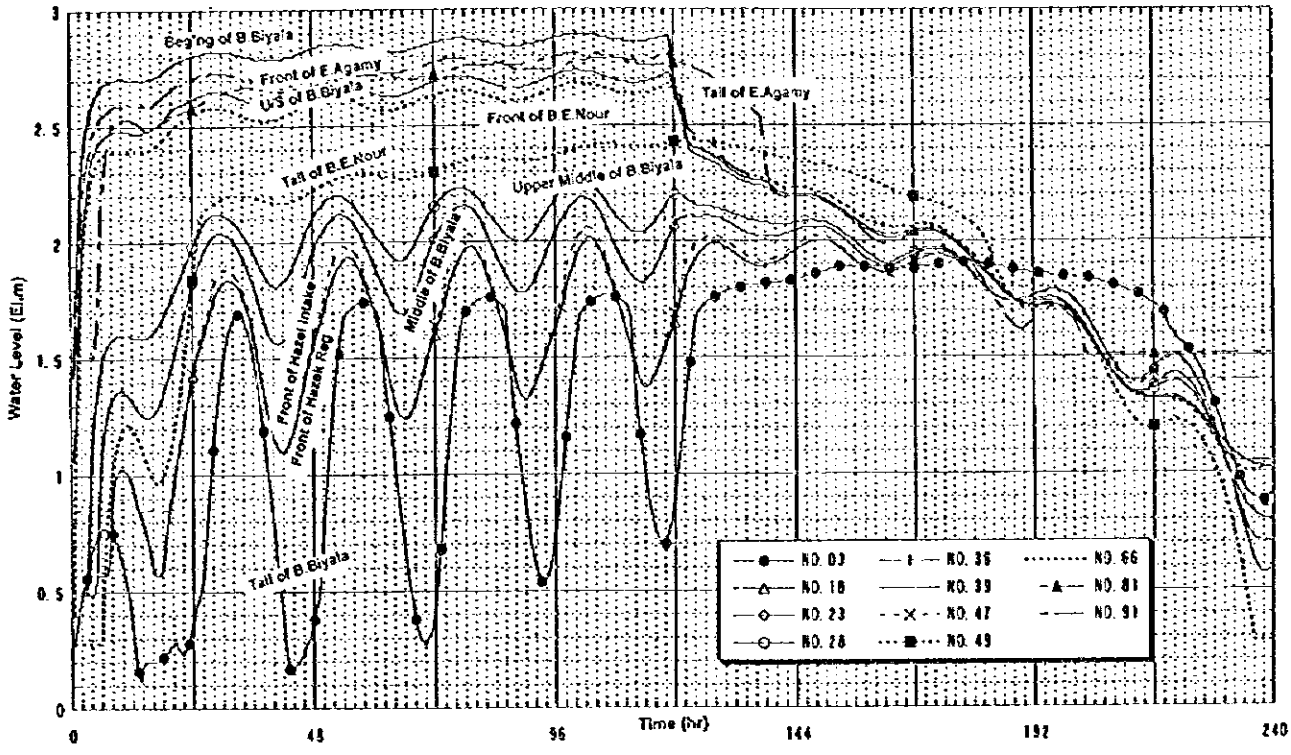


Figure 2.3.7 Water Levels at Major Points (Case 1, Present Condition, Q=8.69cu.m/s, Rotation)

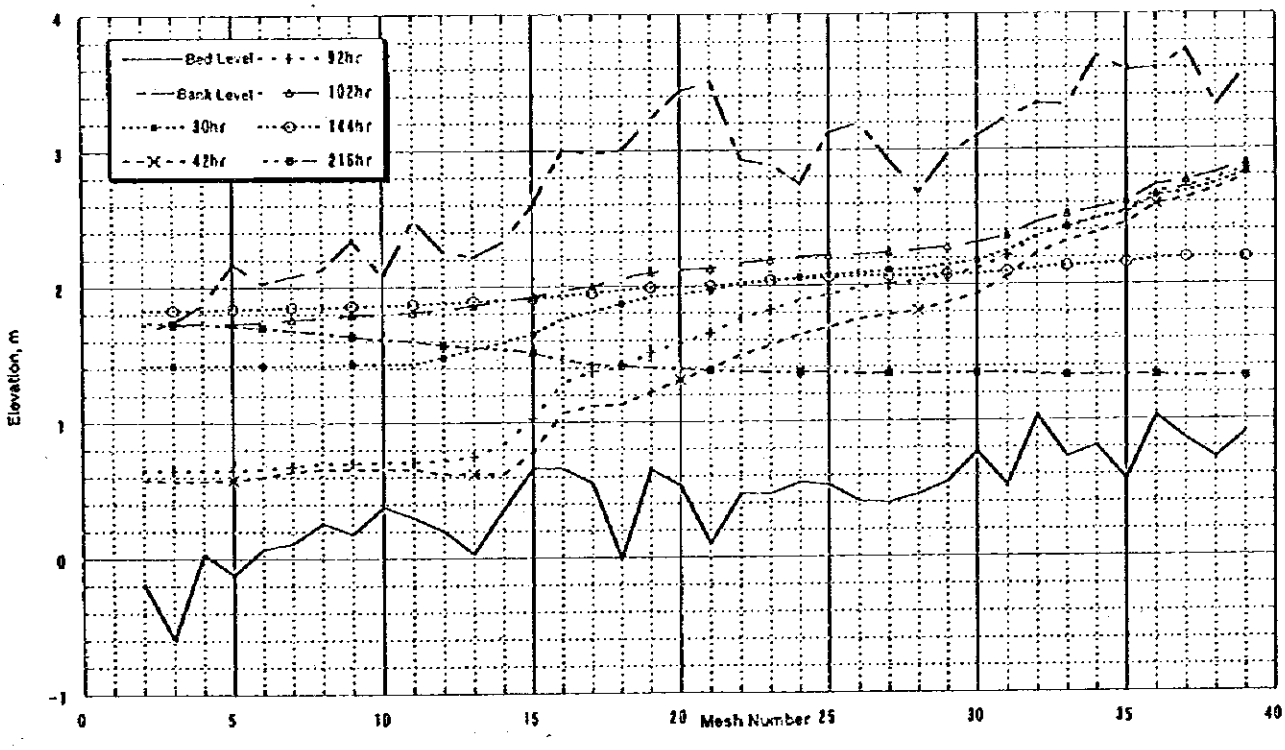


Figure 2.3.8 Hydraulic Profile along Bahr Biyala (Case 1, Present Condition, Q=8.69cu.m/s, Rotation)

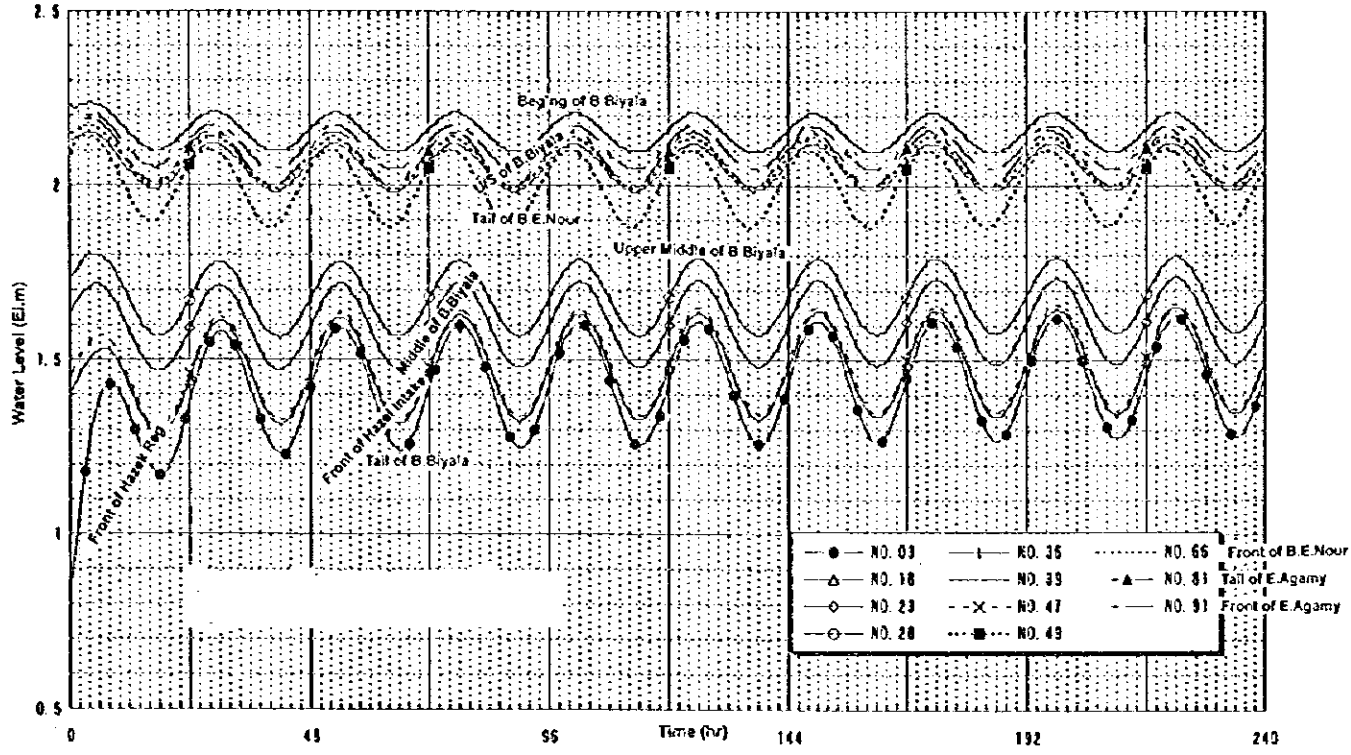


Figure 2.3.9 Water Levels at Major Points (Case 2, Continuous, Q=6.16cu.m/s, Existing Gates Fully Opened)

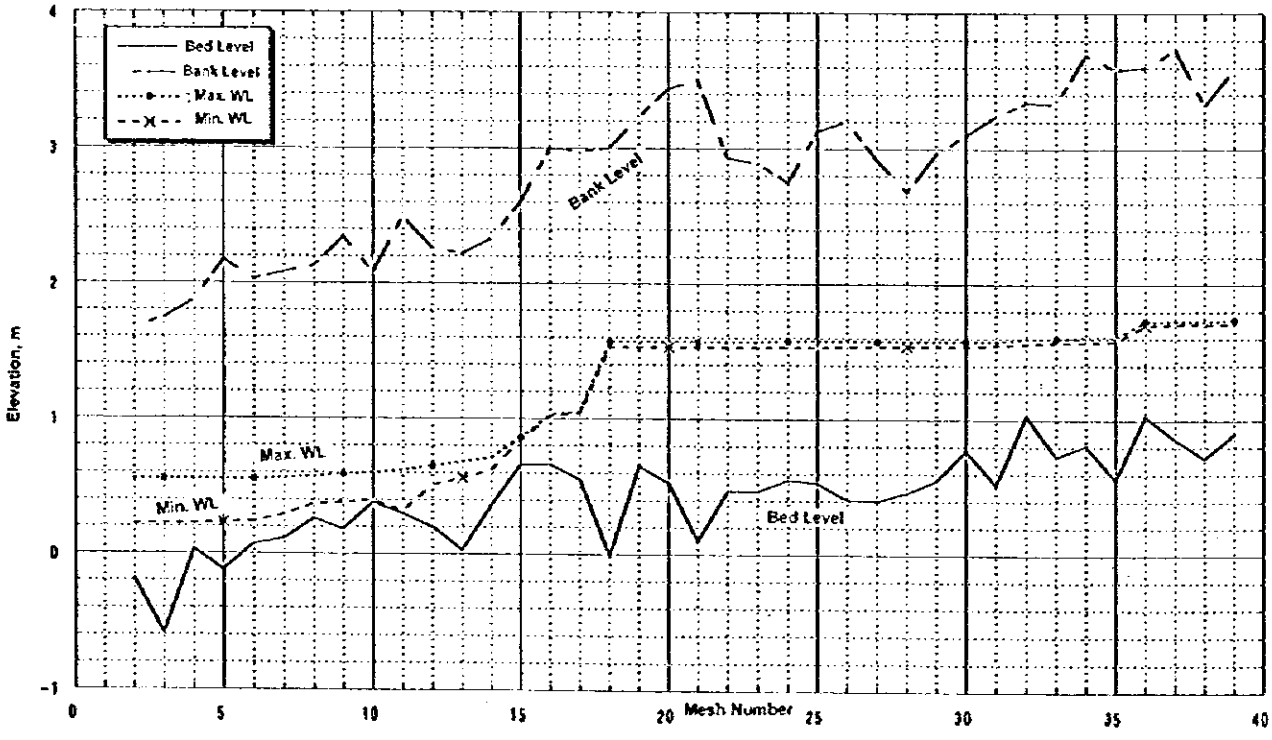


Figure 2.3.10 Hydraulic Profile along Bahr Biyala (Case 2', Continuous, Q=1.02cu.m/s, Existing Gates Operated)

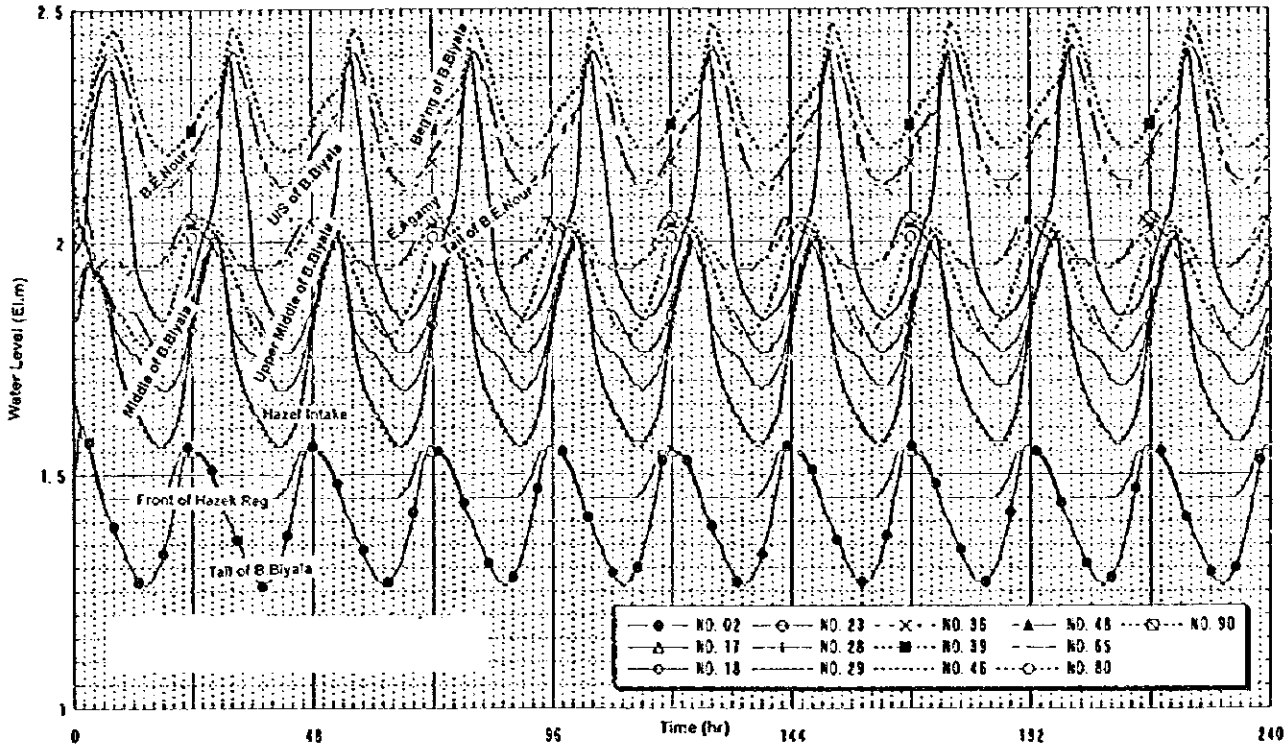


Figure 2.3.11 Water Levels at Major Points (Case 2A, Continuous, Q=6.16cu.m/s, Automatic Gate Installed)

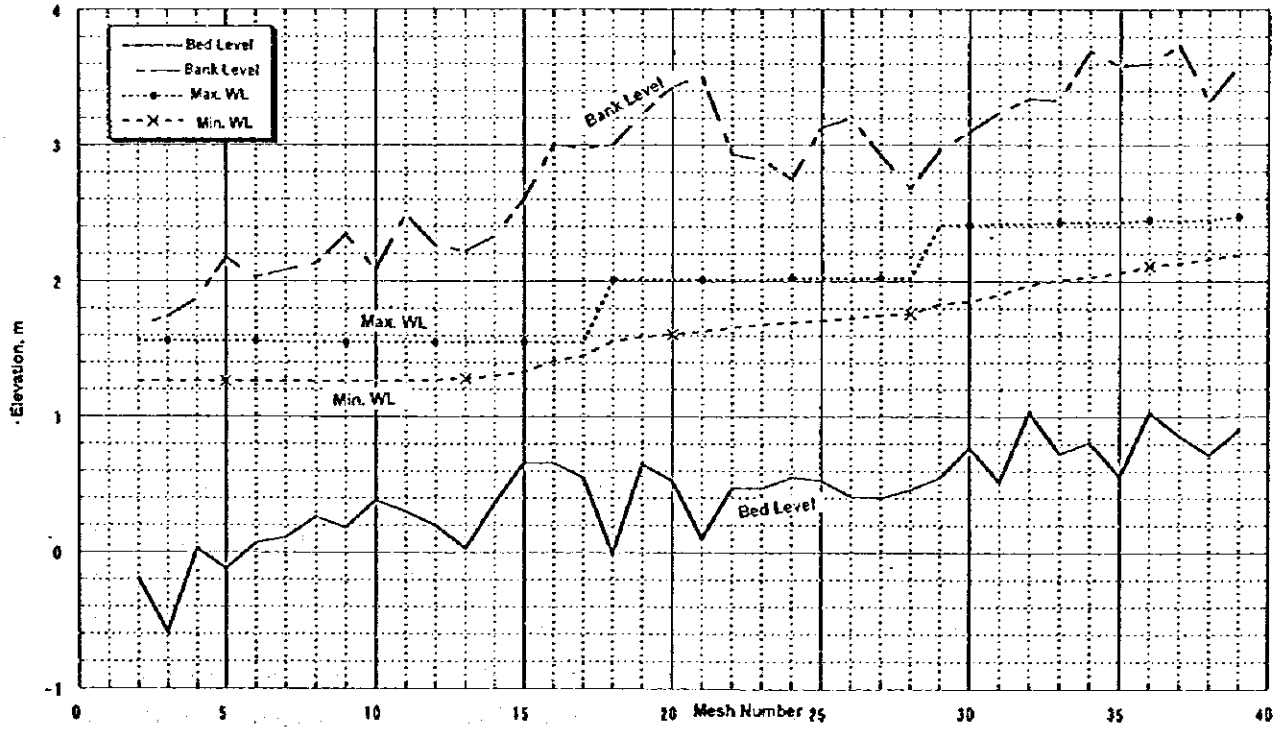


Figure 2.3.12 Hydrographs at Major Points (Case 2A, Continuous, Q=6.16cu.m/s, Automatic Gate Installed)

2.4 Water Management Plan

2.4.1 Basic Line

(1) Scope of Plan

The Water Management comprises Institution Management, Facilities Management, Water Distribution Management and Information Management. The Water Management refers to Water Distribution Management and reviewed in the Study emphasizing more the institutional aspect of the Water Distribution Management in chapter 4.5 of the Master Plan Study.

The Institution Management in terms of water users association is discussed in detail in Section 3.1. The Facilities Management related to water management system is also dealt with in Section 3.5 within the framework of facility improvement plan. Under the context, the Water Management Plan is broadly formulated as a PC (Personal Computer) Network Plan in line with the basic policy proposed in the Master Plan Study. The Water Distribution Management Plan itself is considered as a component of the PC Network Plan.

(2) Objective of Plan

The plan aims to materialize an Open Collaboration Environment establishing the integrated information system to support water administration through the introduction of PC Network Plan.

(3) Background of Plan

The water management issues in the MPWWR can not be resolved by improving only the institution or facilities. It also requires a perceptive breakthrough of concerned persons. To perform the goal, it is necessary to upgrade the overall administration operations by establishing the Open Collaboration Environment.

There is a remarkable progress in computer technology in recent years associated with downsizing, decentralizing, low costing and development of easy-to-use software. The telecommunication technology linked with computers is also fast advancing removing the space barrier. The PC Network Plan is proposed under the circumstances to build up the integrated information system to support water administration. This proposal is identical with the CALS (Continuous Acquisition of Life-Cycle Support) concept, which attracts worldwide attention in providing "Global Standard" in the engineering field.

2.4.2 Organizational Setup

(1) Steering Committee

The Steering Committee, the top decision-making body in the PC Network Plan, consists of the Chairman and the Committee Member. The Committee Members are selected from the head of organizations in which the PC Network Plan will be implemented. The Chairman is elected from among the Committee Members and appointed by the Minister. The Steering Committee conducts together with the Working Group such undertakings as promotion, instruction, supervision, coordination, training, procurement and evaluation. The Steering Committee can invite external experts under the title of Panel of Experts to provide technical advice.

(2) Working Group

The Working Group consists of Group Leader and Members set up in accordance with the decision of the Steering Committee. The Group Leader is responsible for the Group operation and appointed by the Chairman. The Group Members are recommended by the Group Leader and appointed by the Chairman for specific subject. The Working Group conducts the subjects stated in the preceding 2.4.2 (1).

(3) Executing Organization

There are six groups in the executing organizations such as MPWWR Headquarters, the Irrigation Directorate/the Irrigation Improvement Projects, the Water Distribution Directorate of Lower Egypt, the Inspection Office, the Water District Office and the Federation of Water Users Associations. The Federation of Water Users Associations is not a government organization and is considered only in the Biyala Water District area. The total number of executing organizations are 37 among which 12 are grouped as first priority organizations indicated by **mark, 13 as second priority by *mark and the remaining 12 as third priority according to the extent of popularity by computer applications. (Refer to Table 2.4.2)

2.4.3 PC Network Plan

(1) Selection of Subject

The constraints, problems and improvement potentials in water management issues are discussed in Part 1, 3.12.4 and Part 2, 1.9.4which can be summarize under the context of the PC Network Plan as follows.

(a) Improved Water Distribution
(b) Standardization of Drawing and Document
(c) Monitoring and Evaluation of Improved IIP
(d) Building up of Water Management Database, and
(e) System Administration relevant to the Above Items

The most urgent item in the above would be, (c) Monitoring and Evaluation of Improved IIP that is closely associated with (b) Standardization of Drawing and Document. The Standardization of Drawing and Document is significant in terms of project cycle management under CALS concept, which involves such elementary technologies as GIS, CAD and SGML (Standard Generalized Markup Language) as illustrated in Figure 2.4.1.

The database structure the Monitoring and Evaluation of Improved IIP system is suggested to build in the form of several modules as shown in Table 2.4.1. Due to the significance of data structuring, it is recommended to deliberate on the structure under the framework of the following organizational setup. The Improved Water Distribution and the Building up of Water Management Database are proposed to commence when the Monitoring and Evaluation of Improved IIP System are in place.

(2) Equipment Configuration

To attain the above-mentioned targets, the equipment configuration plan consisting of hardware and software is proposed as shown in Table 2.4.2. The total number of 48 sets is identical to one Round, which will be implemented during three consecutive years. The equipment number will be 21 sets, 15 sets and 12 sets during the first, second and the third years respectively. (Refer to Tables 2.4.2 and 2.4.4)

(3) Cost Estimate

The cost of the equipment is estimated at about 1.52 million LE per round or about 4.56 million LE in total. This cost covers only the direct expense of the equipment excluding such overhead expenses as the Steering Committee, the Working Group, Seminars and Training Programs. (Refer to Table 2.4.3)

(4) Implementation Schedule

The annual implementation schedule of the PC Network Plan by round and by executing organization is presented in Table 2.4.4. The round unit is introduced with underlying reasons: first, the need for familiarization in computer application. Second, to cope

with frequent model change and version upgrading. (Refer to Table 2.4.4)

(5) In House Training Program

The computer application technology should be able to attain its original objective by integrating hardware, software and manpower. In this case, the manpower is the cause of bottleneck the above three factors. Under this context the MPWWR is currently undertaking Training Program for computer application. The aforementioned equipment allotment plan is prepared in conformity with the Training Program so that the proposed PC Network Plan can provide the suitable training courses that can be applied to their daily works. It is practical that the lecturers in the Training Courses are concurrently appointed as members of the Working Group. (Refer to Table 2.4.5)

(6) External Training Program

Due to the rapid advancement of computer technology, it is difficult to rely on the House Training Program. It is therefore necessary to incorporate the updated application technology from the computer manufacturers, software houses, vendors, research institutes and universities/colleges. Since it is difficult to take into account such technology at present, the external training program have to be considered within the monitoring/evaluation activities of the Steering Committee and the Working Groups to foster the next generation.

(7) Training Program for Improved Irrigation Management

The MPWWR Training Program in 6 October also provides subject-related courses in addition to computer applications. Development possibility of subject-related courses to application programs is expected to the scrutinized by the Steering Committee and the Working Group during the course of implementation. (Refer to Table 2.4.6)

2.4.4 Implication in Continuous Flow

(1) Background of Continuous Flow

Water management issues relevant to transition from Rotational Flow to Continuous Flow were preliminarily reviewed. The Continuous Flow is generally practiced up to the Main Canal, while the Rotational Flow is practiced down from the Branch Canal or Delivery Canal in the study area. Meantime, the Government manages the Delivery Canal inclusive of the Meska Intake while the local farmers manage down from the Meska. It is therefore needless to operate Meska Intake in case of the Rotational Flow. Meska Intake is let open state all the time or

sometimes concrete pipe is laid down without any control structure. Under the context farmers can irrigate his field by pumping up from Meska to Marwa during the state of the Rotational Flow.

The Rotational Flow thus far described has been practiced in the terminal canals for a long time, however several attempts to shift to the Continuous Flow have been initiated under the preceding projects such as Qawahgy Area, Bahr El Said Area and Balaqtar Area in recent years. Under the circumstances, water management issues relevant to transition to the Continuous Flow are summarized based typical case conceived from the preceding projects as shown in Figures 2.4.2, 2.4.3 and 2.4.4.

(2) Institutional Framework

As is mentioned in the previous subsections, the local farmers manage the terminal facilities down from Meska. Meantime, the improved irrigation management proposed as organization of the Water Users Organizations illustrated in Figure 2.4.2. The shaded portion in Figure 2.4.2 corresponds to the facilities to be taken over from the Government by the Federation of Water Users Associations. The water management issues incidental to the takeover process comprises the Institution Management, Facilities Management, Water Distribution Management and Information Management.

An effective approach for the takeover process would be a complete correspondence of computer system to be introduced to the Water District Office and the Federation of WUAs Office. For the success of this approach, computer system should be established prior to setting up of the Federation. It means that the same system should be worked out throughout all relevant organizations such as MPWWR headquarters, Irrigation Sector/IIS, Irrigation Directorate/IIP, Inspection Office, Water District Office and Federation of WUAs. This approach calls for a combined operation of CALS (Continuous Acquisition and Life-cycle Support) and WAN (Wide Area Network).

(3) Plan Map of Facilities

To visualize the improved irrigation management there should be a plan map of facilities alignment that indicates all components required to the continuous flow. It is a common practice to implement the works from downstream side in the preceding projects. It is desirable to complete the works as soon as possible to eliminate the extra gate operation in the remaining rotational flow section. It is necessary to get farmers' consensus prior to commencement of the construction works through sufficient presentation to the local farmers.

(Refer to Figure 2.4.3)

(4) Profile of Delivery Canal

The Delivery Canal receives water from the main canal where the continuous flow is practiced and the required irrigation water is diverted through the intake gate. In this case it should be noted that the flow condition in the main canal affects remarkably to the flow stability in the delivery canal. The gate calibration at the intake gate and the flow monitoring at the tail end are also prerequisite for the continuous flow. (Refer to Figure 2.4.4)

The automatic control gate to downstream water level is drawn, but the type of gate structure should be carefully examined employing simulation. The night storage and storage capacity in the delivery canal should be analyzed associating with variation of water requirement due to variation of cropping pattern. A comparison between the rotational flow and the continuous flow is summarized in Table 2.4.7.

Table 2.4.1 Modules for Monitoring/Evaluation of Improved IIP (Provisional)

Module1: Project Database
(1) Project Description
(2) Chronologic Records
(3) Preceding IIP Projects
(4) Reports/References
(5) Agricultural Information
(6) Environmental Information
(7) Photography/Microfilm

Module2: Institutional Frameworks
(1) MPWWR
(2) WUAs
(3) Joint Committee
(4) Technology Transfer
(5) Training Programs
(6) PC Network Plan

Module3: Project Cycle Management under CALS
(1) Investigation
(2) Planning
(3) Design
(4) Cost Estimate
(5) Construction
(6) Inspection
(7) Operation & Maintenance

Module4: Water Users Association
(1) Geography
(2) Legal Procedures
(3) Organization
(4) Personnel Affairs
(5) Financial Status
(6) Operational Records
(7) Project Monitoring/Evaluation

Table 2.4.2 Equipment Configuration for PC Network Plan (per Round)

HQ/Directorate	Inspection/WD	PC	Monitor17	Monitor15	CD-RomR	CD-RomD	Printer	Scanner	Modem/LAN	MSOffice97	AutoCAD14	Sap90	PageMaker6.5	MapInfo4.5
MPWWR	IS**	2	2	-	2	-	2	2	2	2	2	-	2	1
	IIS**	2	2	-	2	-	2	2	2	2	2	2	2	1
	IAS**	2	2	-	2	-	2	2	2	2	2	-	2	1
	NWRC**	2	2	-	2	-	2	2	2	2	2	-	2	1
	Sub-Total	8	8	0	8	0	8	8	8	8	8	2	8	4
GharbiaDirect	ID**	2	2	-	2	-	2	2	2	2	1	-	1	1
	IIP**	2	2	-	2	-	2	2	2	2	1	1	1	1
	WDDLE**	2	2	-	2	-	2	2	2	2	-	-	1	
	MahallahInspection*	1	-	1	-	1	1	-	1	1	-	-	1	-
	BaharyZiftaWD*	1	-	1	-	1	1	-	1	1	-	-	1	-
	SamanoudWD*	1	-	1	-	1	1	-	1	1	-	-	1	-
	BishbeeshWD*	1	-	1	-	1	1	-	1	1	-	-	1	-
	EastMahallahWD*	1	-	1	-	1	1	-	1	1	-	-	1	-
	WestMahallahWD*	1	-	1	-	1	1	-	1	1	-	-	1	-
	Sub-Total	12	6	6	6	6	12	6	12	12	2	1	9	2
KafrElSheikhD	ID**	2	2	-	2	-	2	2	2	2	1	-	1	1
	IIP**	2	2	-	2	-	2	2	2	2	1	-	1	1
	BiyalaInspection**	1	-	1	-	1	1	-	1	1	-	-	1	-
	BalteemWD*	1	-	1	-	1	1	-	1	1	-	-	1	-
	MansourWD*	1	-	1	-	1	1	-	1	1	-	-	1	-
	HamoulWD*	1	-	1	-	1	1	-	1	1	-	-	1	-
	BiyalaWD**	1	-	1	-	1	1	-	1	1	-	-	1	-
	Federation**	1	-	1	-	1	1	-	1	1	-	-	1	-
	Sub-Total	10	4	6	4	6	10	4	10	10	2	0	8	2
WestDakahliaD	ID*	2	2	-	2	-	2	2	2	2	1	-	1	1
	IIP*	2	2	-	2	-	2	2	2	2	1	-	1	1
	BilqasInspection	1	-	1	-	1	1	-	1	1	-	-	1	-
	HafirWD	1	-	1	-	1	1	-	1	1	-	-	1	-
	BasandilaWD	1	-	1	-	1	1	-	1	1	-	-	1	-
	BilqasWD	1	-	1	-	1	1	-	1	1	-	-	1	-
	MassaraWD	1	-	1	-	1	1	-	1	1	-	-	1	-
	ZahraaWD	1	-	1	-	1	1	-	1	1	-	-	1	-
	TalkhaInspection	1	-	1	-	1	1	-	1	1	-	-	1	-
	TalkhaWD	1	-	1	-	1	1	-	1	1	-	-	1	-
	SherbinWD	1	-	1	-	1	1	-	1	1	-	-	1	-
	NewReclaArea	1	-	1	-	1	1	-	1	1	-	-	1	-
	Sub-Total	14	4	10	4	10	14	4	14	14	2	0	12	2
DamiettaD	ID*	1	1	-	1	-	1	1	1	1	1	-	1	1
	IIP*	1	1	-	1	-	1	1	1	1	1	-	1	1
	DamiettaInspection	1	-	1	-	1	1	-	1	1	-	-	1	-
	KafrSaadWD	1	-	1	-	1	1	-	1	1	-	-	1	-
	Sub-Total	4	2	2	2	2	4	2	4	4	2	0	4	2
Total		48	24	24	24	24	48	24	48	48	16	3	41	12

Notes:(1)Total 48 sets (identical to 1 Round) will be implemented during 3 consecutive years. (See Table 2.4.4)

(2)** denotes First Year, * Second Year and No Mark Third Year corresponding to 21 sets, 15 sets and 12 sets respectively.(See Table 2.4.4)

(3)IS:Irrigation Sector, NWRC:National Water Research Center, WDDLE:Water Distribution Directorate of Lower Egypt, WD:Water District

Table 2.4.3 Cost Estimate of PC Network Plan

(Unit: LE)

ID	Item	Rate	Quantity	Amount	Specification
10	PC	7,500	48	360,000	IBM Compatible, CPU PentiumII 400 MHz or LatestModel, Memory 64MB, HD 6.2 GB, Window 98 Preinstalled
20	Monitor17	1,400	24	33,600	Color 17 inches
25	Monitor15	800	24	19,200	Color 15 inches
30	CD-RomR	2,000	24	48,000	CD-Rom Rewritable
35	CD-RomD	800	24	19,200	CD-Rom Drive
40	Printer	4,000	48	192,000	HP Lazer 4000
50	Scanner	5,000	24	120,000	HP A3 Size-Page
60	Modem/LAN	1,500	48	72,000	US Rotics56K/ Hub, LAN Board and Cable
90	MSOffice97	2,000	48	96,000	Word; Excel; PowerPoint; Access; Internet Explorer, Arabic Version
100	AutoCAD14	2,500	16	40,000	Drawing Software for Engineering Design
110	Sap90	10,000	3	30,000	Structural Analysis Software for Engineering Design
120	PageMaker6.5	2,500	41	102,500	Desk Top Publishing Software for Report Writing/Publishing
130	MapInfo4.5	15,000	12	180,000	GIS Software for Computer Mapping including 4 Days Training
140	Supply&Misc.	2,500	48	120,000	CD-Rom, Floppy Disk, Ink etc.: Qt'y equal to PC column
150	TCP/IP Charge	1,800	48	86,400	Provider 1,200 LE/yr: Qt'y equal to Modem column
	Total		48	1,518,900	Approximate Cost per Set 31,643.750
	Grand Total	1,518,900	3	4,556,700	

Table 2.4.4 Implementation Schedule of PC Network Plan

(unit: set, LE)

Office	1st year	2nd year	3rd year	4th year	5th year
First Round					
**Mark Offices (set)	21				
*Mark Offices (set)		15			
No Mark Offices (set)			12		
Second Round					
**Mark Offices (set)		21			
*Mark Offices (set)			15		
No Mark Offices (set)				12	
Third Round					
**Mark Offices (set)			21		
*Mark Offices (set)				15	
No Mark Offices (set)					12
Total (set)	21	36	48	27	12
Cumulative (set)	21	57	105	132	144
Approximate Cost (LE)	664,519	1,139,175	1,518,900	854,381	379,725
Cumulative Cost (LE)	664,519	1,803,694	3,322,594	4,176,975	4,556,700

Table 2.4.5 MPWWR Training Program for Computer Application

No.	Course	Duration	Trainees
4	Auto Cad 14	04/07/1998-16/07/1998	Engineer; Technician
8	3D Studio	25/07/1998-06/08/1998	Engineer; University Graduate
13	Windows 98	15/08/1998-20/08/1998	Engineer; University Graduate; Diplomat
20	Access 2 levels	22/08/1998-03/09/1998	University Graduate
22	Power House	29/08/1998-03/09/1998	Electrical and Civil Engineer
26	Introduction+DOS	05/09/1998-10/09/1998	Engineer; University Graduate; Diplomat
29	Primavera	12/09/1998-24/09/1998	Civil Engineer
34	Arc Info	26/09/1998-08/10/1998	Engineer
-	Map Info	-	Engineer
35	Windows 98	10/10/1998-15/10/1998	Engineer; University Graduate; Diplomat
41	Introduction+DOS	17/10/1998-22/10/1998	University Graduate; Diplomat
43	Sap90	17/10/1998-29/10/1998	Civil Engineer
48	Auto Cad 14	31/10/1998-12/11/1998	Engineer; Technician
55	Visual Basic	14/11/1998-26/11/1998	University Graduate
59	MSWord	28/11/1998-31/12/1998	University Graduate; Diplomat
62	Windows 98	05/12/1998-10/12/1998	University Graduate; Diplomat
70	Auto Cad 14	06/02/1999-18/02/1999	Engineer; Technician
74	Visual Basic 5.0	20/02/1999-04/03/1999	Engineer; University Graduate
79	Introduction+DOS	27/02/1999-04/03/1999	Engineer; University Graduate; Diplomat
85	Introduction+DOS	03/04/1999-08/04/1999	Engineer; University Graduate; Diplomat
92	Excel	10/04/1999-15/04/1999	University Graduate
94	Windows 98	08/05/1999-13/05/1999	University Graduate; Diplomat
100	Auto Cad 14	15/05/1999-27/05/1999	Engineer; Technician
103	MSWord	29/05/1999-03/06/1999	Engineer; University Graduate; Diplomat

Table 2.4.6 MPWWR Training Program Related with Improved Irrigation Management

No.	Course	Duration	Trainees
6	Project Management	04/07/1998-16/07/1998	Degree Engineer
10	Following up Implementation of Drainage and Irrigation Projects	25/07/1998-06/08/1998	Technician
15	Controlling Quality and Repairing Establishment	15/08/1998-27/08/1998	Civil Engineer
17	Flow in Open Channel and Measuring Behaviour	27/08/1998-27/08/1998	Technician
18	Hydraulics	22/08/1998-27/08/1998	Civil Engineer
19	On-Farm Irrigation Management and Decreasing Water Consumption	22/08/1998-03/09/1998	Technician
24	Irrigation Advisory	29/08/1998-10/09/1998	Civil Engineer
28	Construction Tests and Controlling Quality	28/09/1998-17/09/1998	Technician
30	On-Farm Irrigation Management and Decreasing Water Consumption	12/09/1998-24/09/1998	Technician
32	Technical Report Writing	19/09/1998-24/09/1998	Engineer
33	Controlling Quality and Repairing Establishment	19/09/1998-01/10/1998	Civil Engineer
38	Controlling Quality and Repairing Establishment	10/10/1998-22/10/1998	Civil Engineer
40	Management Basis	10/10/1998-22/10/1998	Engineer; University Graduate First/Second Degree
42	Following up Implementation of Drainage and Irrigation Projects	17/10/1998-29/10/1998	Technician
45	Construction Tests and Controlling Quality	24/10/1998-29/10/1998	Technician
53	Project Management	07/11/1998-19/11/1998	Engineer
57	Codes and Concrete Standards Description	21/11/1998-26/11/1998	Civil Engineer
71	Following up Implementation of Drainage and Irrigation Projects	06/02/1999-18/02/1999	Technician
73	Risk Management	13/02/1999-25/02/1999	Engineer; University Graduate First/Second Degree
76	Flow in Open Channel and Measuring Behaviour	20/02/1999-04/03/1999	Civil Engineer
89	Night Storage of Water	03/04/1999-15/04/1999	Agriculture/Civil Engineer
93	On-Farm Irrigation Management and Decreasing Water Consumption	02/05/1999-17/06/1999	Agriculture/Civil Engineer
97	Flow in Open Channel and Measuring Behaviour	08/05/1999-13/05/1999	Technician

Table 2.4.7 A Comparison Table on Flow Method

Description	Rotational Flow	Continuous Flow
1.General Items (1) Merit (2)Demerit (3)Remarks	(1)1.Easy to manage. 2.Meska intakes are not alway needed. (2)1.Tough water management in supply side that hardly responds to farming practices. 2.Constrained water use to farmers in amount and in timing of water supply. 3.Repetitive on-off gate operations enlarge canal capacity resulting in bank esosion. (3)Water supply under Supply Side Initiative.	(1)1.Enable to materialize stable water supply and water saving as well. 2.Farmers trust supply side with feeling of psychological stability. (2)1.Unwilling to pay extra cost for new project. 2.Difficulty to convert farmers' conscience. 3.Weak accountability for farmers burden due to new project. (3)Water supply in future under Demand Side Initiative.
2.Technical Items (1) Engineering in General (2) Structural Viewpoints (3) Hydraulic Viewpoints (4) Operational Viewpoints (5) Constructional Viewpoints (6) Cost Aspects (7) Local Farmers Aspect	1.Scrutiny of current situations for benchmark survey is needed to eliminate incidental troubles in future. 2.Due arrangement of basic data such as maps and statistics is prerequisite to achieve the goal of improved IIP. High technology represented by GIS, CALS etc. may be duly effective to conduct the project successfully. 3.For integrated managements in institution. facilities and water distribution. consensus among relevant authorities will be required. 4.Learnings from the preceding projects should be considered in future projects. 5.Financial arrangement or fund source should be carefully worked out in advance.	1.Innovative approaches such as standardized design, bidding with loan etc. are required to reduce farmers' burden . A possibility of BOT (Build-Operate-Transfer) or PFI (Private Finance Initiative) may provide a resolution of the matter. 2.Water saving under improved irrigation management is expected after the project. 3Terminal water management under farmers' initiatives will be materialized after the project. 4 .Conceivable requirements for success in continuous flow are: (1)Farmers' incentive endorsed by group leaders' initiative and devotion for the project and local farmers. (2)Response of government in terms of availability of eligible IAS staff to support the farmer's incentive. (3)Contractor's ability/understanding to implement the farmer-based specific construction works.

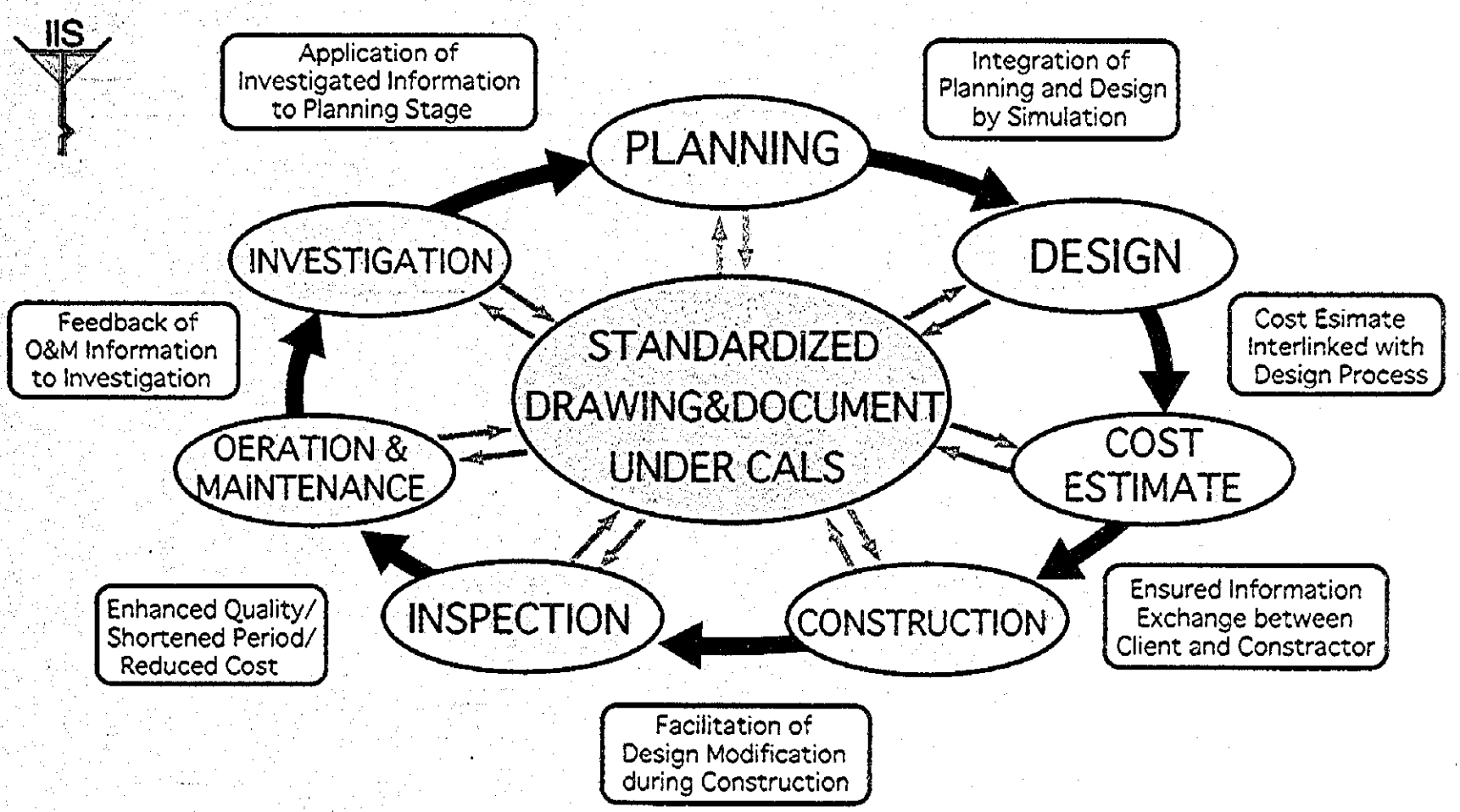


Figure 2.4.1 Project Cycle Management under CALS Concept

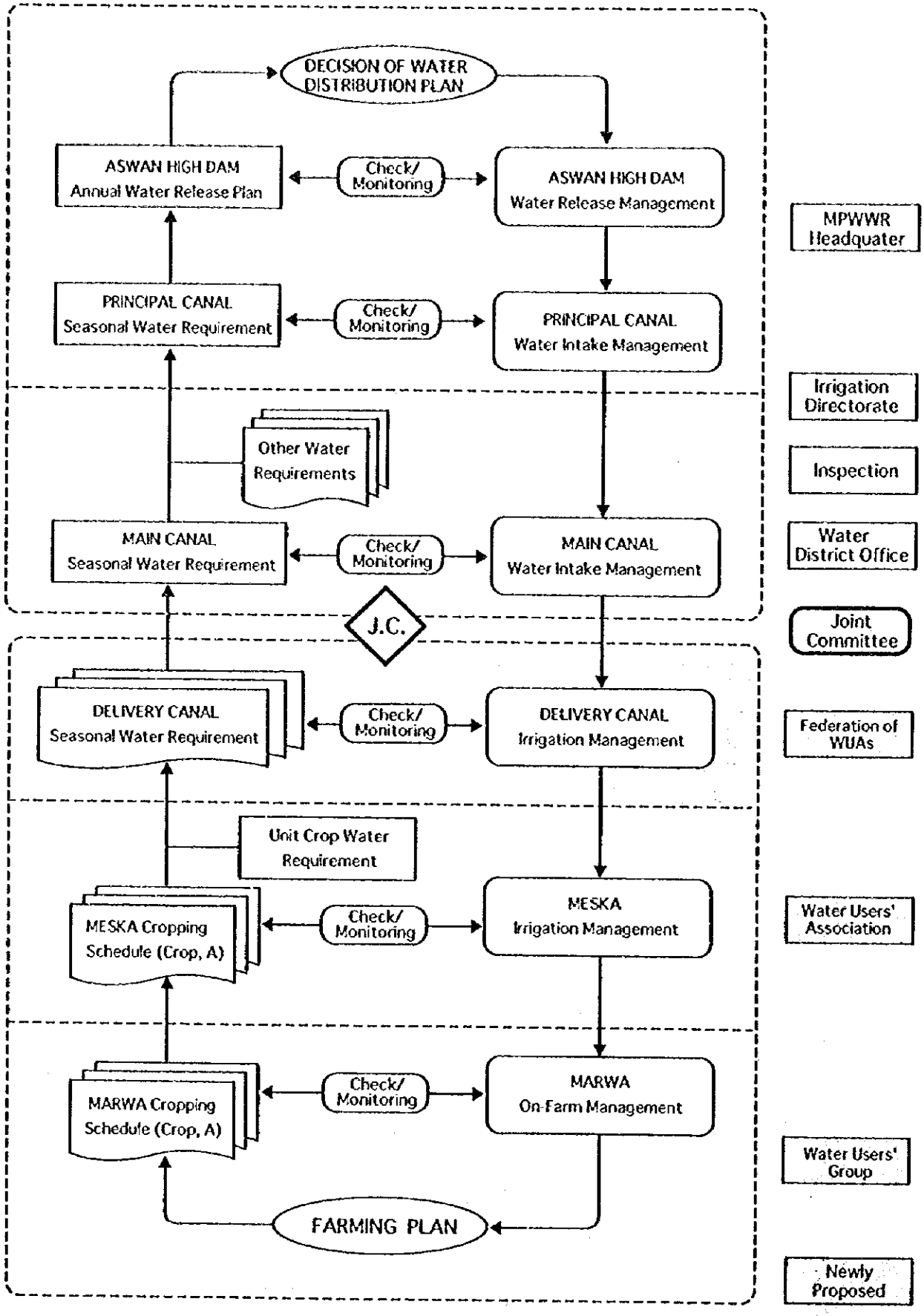


Figure 2.4.2 Institutional Framework on Improved Irrigation Management

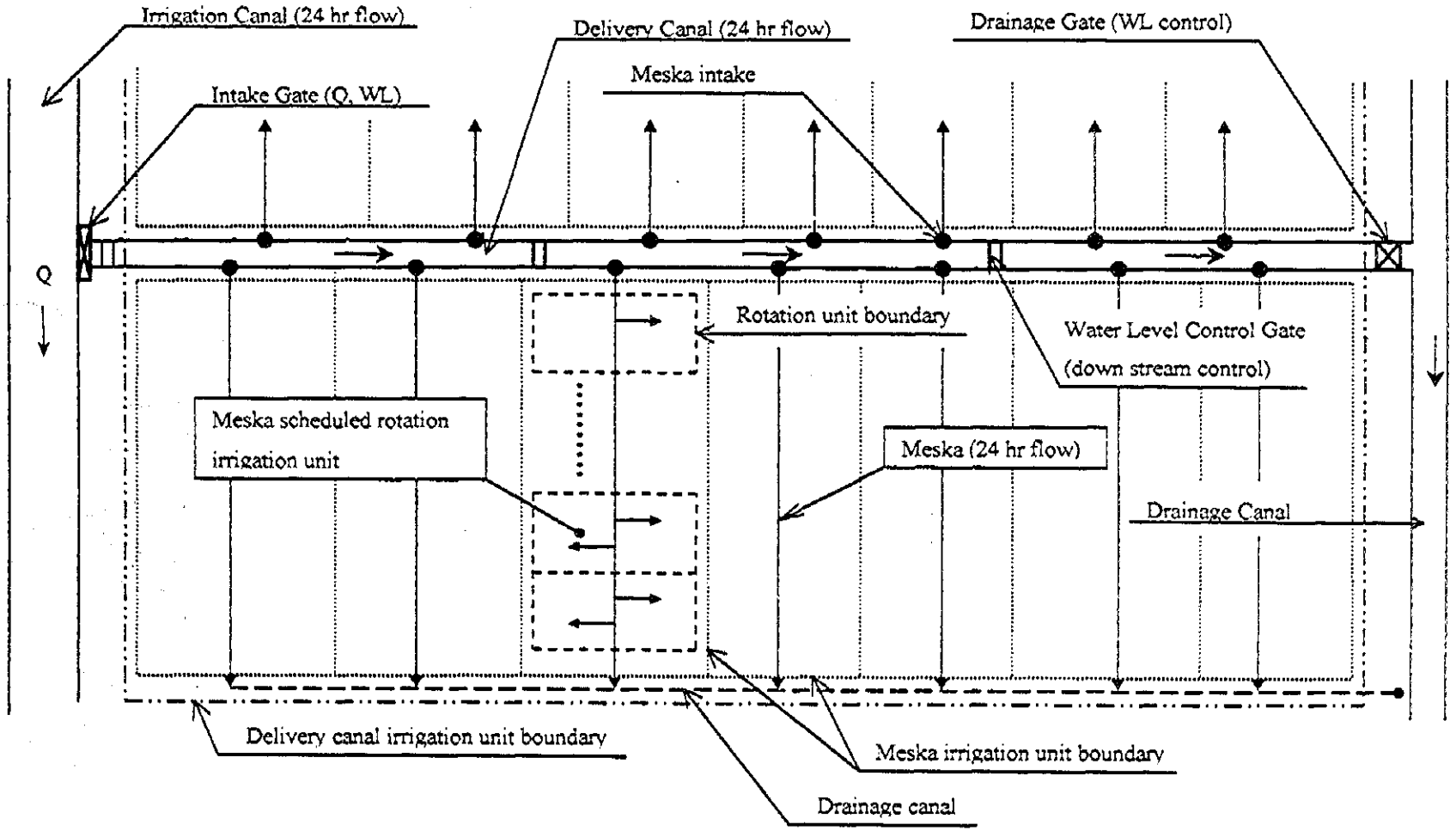


Figure 2.4.3 Plan Map of Improved Irrigation Management

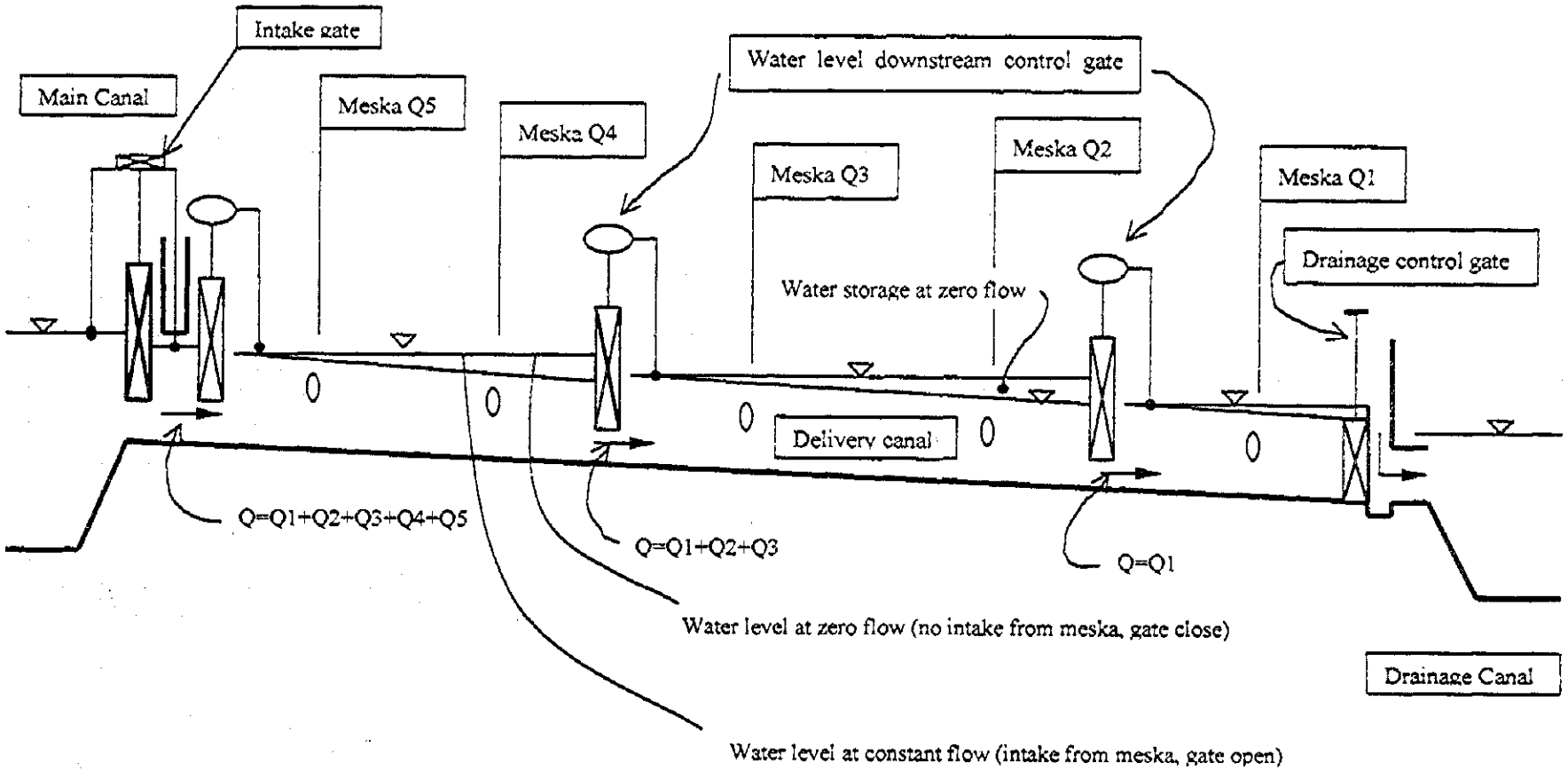


Figure 2.4.4 Profile of Improved Irrigation Management

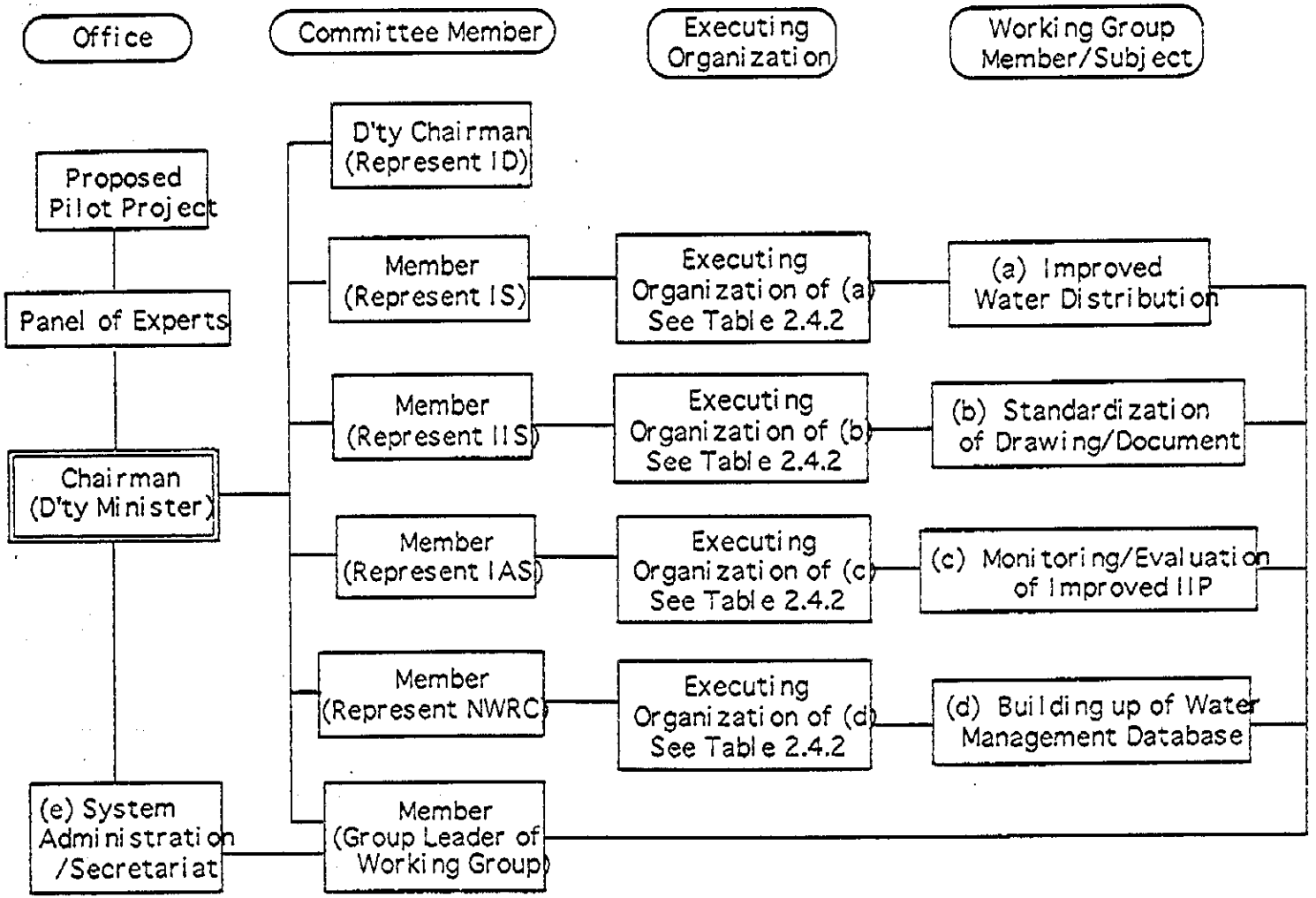


Figure 2.4.5 Proposed Organization Chart on PC Network Plan

2.5 Development Plan of Irrigation and Drainage Facilities

2.5.1 Development Plan of Irrigation Facilities

Development plan of the irrigation facilities to be rehabilitated and/or improved in the Priority Area, consists of improvement of the aged Rahbeen regulator , replacement of the Hamoul MPS , improvement of gate operation by motorization for the intake gate of Bahr Tera main canal and Abshan regulator, establishment of check gate on delivery canals, and Meska improvement as one point lifting system. The approach for the improvement plan is described as follows;

(1) Improvement of Rahbeen Regulator

a) Basic Concept for Improvement

It seemed that raising the sill by 1.95 m is one of the reason why deep scouring has occurred. Its dam height would be reduced by 30 to 50 cm to increase the flow area of the barrage. The gates on the barrage will be improved by double leaf gate system for easy operation. The superstructure used as a road with width of 7.6 m including the 1.0 m side walk on both sides of the structure, would be expanded by 12 m road way including 1.0 m side walk on both sides of the structure. The design load would be T-70 for improvement based on the design criteria of the Ministry of Transportation. As a countermeasure for scouring, concrete block with riprap, etc. would be proposed as a scouring protection.

b) Alternative plans

Taking into consideration the above conditions, the following alternative plan would be proposed basing on the study of increasing flow area without fixed dam up concrete work. (Refer to Figure 2.5.2)

Plan A : Present regulator width 66.5 m : main regulator 37.5 m + lock width 11m + sub-barrage 18 m

Plan B : same as Plan A, however, gate width will be enlarged, but lock is same

Plan C : same as Plan B, however the lock facility will be removed.

Plan D ; same as Plan A, however main regulator will be shifted at left side of the lock inplace of right side.

As a result of the alternative study, the Plan A is recommmended for the cost is the cheapest. A gate width of five 5.0 m is commonly used in Egypt and maximum width for manual operation in emergency such as blackout. It is difficult for the gate with more than 5.0 m width to operate as well as maintenance in Egypt. The temporary work is almost same for each alternative plan. The water way at the temporary work will be conducted at the left and right bank area where there is no need for land acquisition.

c) Gate operation and watching

An operation board will be erected in the building at near site. The gate operation will be conducted by touching push button provided on the board with several gate opening meters, water level meters and calculating discharge together with monitoring devices according to the Tanta water operation instructions for the Rahbeen regulator operation.

While, the proposed graphic panel board in the Tanta water distribution office shall display these data sent from the gate sites, so that the staff of the office can control the gates by remote operation system. On the panel board, gate opening conditions of Rahabeen barrage, Bahr Tera intake and Abshan lock, etc. could be displayed. The discharge variation in accordance with the gate opening will be calibrated and processed by a computer and the results of calculation will be displayed on the board. (Refer to Figure 2.5.3)

(2) Improvement of Bahr Tera Intake and Abshan Lock (Regulator)

There are already water level observatory and telemetry equipment installed on the structures. The observed data of water level at US and DS of the Bahr Tera intake are sent to the Tanta water distribution office and the same kind of data on the Abshan lock to the Kafr El Sheikh water distribution office. By motorization of gate hoist, the operation work would be easy. The gate opening data observed by a newly attached gate opening meter would be sent to both the offices in Tanta and Kafr El Sheikh through the existing telemetry system and these data will be displayed on the graphic panel board. (Refer to attached drawings FS-04 and FS-05)

(3) Embankment of Bahr Tera Main Canal

The right bank of Bhar Tera main canal will be made as same level of the left bank elevation along the main canal distance of about 19 km within station 3.5 to 35.5 km at four (4) locations for recovering flow section. The embankment height about 0.5 m to 2.0 m and width about 4.0 m to 6.0 m. (Refer to attached drawings DD-25)

(4) Replacement of Hamoul Mixing Pumping Station (Hamoul MPS)

The fact that a cavitation phenomena occurs at the suction water head of −10 cm means lack of water head. While the the drainage water flow in Gharbia drainage canal will be down caused by the IIP progress with the enhancing irrigation efficiency toward the future. Accordingly an improvement plan is conducted to lower the suction pit water operation head for safety pump operation while the degraded old pump equipment will be replaced near the location where the land belongs to MED.

Suction head water elevation will be -5.0 m below existing elevation and installed preventing device for air mixing at suction pit. Pump capacity will be 10 m3/s as existing and 2,000 mm bore, and vertical axial flow pump. In compare with the existing included axial flow pump type, the merits of the proposed type are 1) small pump house, 2) economical standard for motor, 3) long life by a few trash involved air due to below direction of pump mouth, and 4) easy maintenance work by no concrete fixed for part of main pump body (Refer to attached drawings FS-06)

(5) Improvement of Delivery Canals

Automatic check gates will be installed in the delivery canals to secure a certain water level to supply water to Meska. Transitions at upstream and downstream side of the check gate will be installed to minimize the head loss. The check gate will be Egyptian made. The position of the check gate will be selected to keep the water level of a delivery canal stable. Water level will be controlled according to that of downstream reaches considering prior water distribution into the downstream reaches and night storage. To set the check level, downstream water level is targeted with reference to two-third of design water depth in upper part from the check gate. (Refer to attached drawings FS-12)

In the village area, since there are many portions with side slope sliding on the delivery canal, the slope protection by pitching is proposed to keep a stable side slope of the canal and to ensure the suitable flow of the canal. However, the rural people should be told not to dump the garbage of their houses into the canal. (Refer to attached drawings DD-25)

(6) Meska Improvement

The existing IIP follows the farmer's wills to select the improved type of Meska of either pipeline or raised open canal. However, only few kinds are presented and from view point of easy and cheaper maintenance, it seems to be rather difficult to repair these improved Meska.

From the viewpoint of easy maintenance, improvement method including canal types, lifting methods, etc. would be proposed. The Meska improvement plan includes single lifting methods, pavement method of Meska itself, and turn-out structures. The improvement measure would be studied from the viewpoint of reduction of the construction cost shouldered by farmers. The results of the preliminary study of the improved measure of Meska are presented as follows.

a) Condition of the study

The study of Meska improvement shall be conducted regarding the conditions as 1) the construction cost will be paid by beneficial farmers, 2) the operation and maintenance will be easy for farmers, 3) farmers' participation in constructing will be easy, 4) materials for the construction will be easy to get, etc.. Especially the plan with shifting Meska route or necessity of land acquisition will be considered to be a constraint referring to Islamic land holding system.

b) Meska improvement method

Meska consists of three (3) parts which are intake works including pump, head race works and division works.

1) Intake works

Improvement of intake works will be intake without diversion or pumping. Intake without diversion is a present method and the inflow into Meska depends on the water level of a delivery canal. Therefore the equitable water distribution into Meska from a long delivery canal is difficult according to the result of the hydraulic analysis as mentioned above. For an operator of a delivery canal, discharge control is complicated with the necessity of discharge observation at Meska intake points. For farmers, the present intake method will give security because of they are accustomed with it.

Pumping method will be taken as either one-point lifting pump, which IIP has been implementing or appropriating small pumps owned by farmers to an unified intake. The former method is flexible with pump head and capacity but costly. The latter method does not cost to set the pumps but has constraints with pump head and capacity. Furthermore the pumping operation is costly and complicated with usage of multiple pumps and the pump head will be short for pipeline works of head race.

2) Head race work

The improvement methods of head race will be utilizing a present earth Meska, filling in the present Meska and construct a new open Meska on it, and laying pipeline in the present Meska.

The method of utilizing a present Meska will be conducted by expanding the cross section or slope protection with concrete lining or pipeline. The method of constructing a new open Meska on the filled present Meska will be taken with three (3) alternatives as J shape Meska, rectangular Meska using bricks and trapezium Meska using bricks. The method of pipeline Meska is categorized with a natural pressure pipeline and a low pressure pipeline. These two (2) types will be set in the present Meska. As for the natural pressure pipeline made of concrete, the caliber of the pipeline needs 1,000 mm so that a man can get inside for maintenance such as removing sediment and it also needs manholes.

3) Division works

The form of division works is rather dependent on the method of head race. For the pipeline method, valves are required for the division works while the open Meska requires gates. In case of the intake without diversion and earth Meska, farmers will divert the water by their own pumps as present situation.

The study above is summarized as following tables;

Table 2.5.1 Comparison of intake method

Item	Intake without diversion	Pumping	
		Utilize present pumps	Set a new pump
Merit	1. Farmers will feel secure for it is a present method. 2. land can be appropriated in case of pipeline Meska.	1. No cost for pump set 2. Individual irrigation is possible. 3. Water management of delivery canal is easy. 4. Pumps are operated by farmers themselves.	1. Pumping cost is cheap. 2. Cost sharing is easy. 3. Water management of delivery canal is easy. 4. Pipeline type Meska improvement is possible. 5. Conveyance loss will be cut in case of pipeline Meska 6. Land can be appropriated in case of pipeline Meska
Demerit	1. Intensive maintenance is required for easy sediment and growing weed. 2. Water management of delivery canal is difficult. 3. Inflow depends on water level of delivery canal. 4. Water shortage in downstream reaches can easily happen.	1. Individual operation will weaken WUA. 2. Cost sharing for pumping among farmers will be less clear. 3. Multiple pumping is complicated. 4. Some of the existing pumps are old enough to replace. 5. Sharing pumps of individual property is difficult. 6. Pipeline Meska improvement is impossible. 7. Discharge control is difficult for the pupms have different capacity.	1. Pump set is costly. 2. Because of new method for farmer, instruction and training is required. 3. Repair site is required. 4. Instruction and training on the Meska irrigation system is required to farmers. 5. the present pumps owned by farmers are not utilized.

Table 2.5.2 Comparison of Head Race

Item	Open Meska	Pipeline Meska
Merit	1. Farmers will feel secure since the water can be seen. 2. Maintenance is easy. 3. Trouble is easily found. 4. Discharge can be seen. 5. Pump head is lower. 6. Repair is easy.	1.No land is required but surface rights registration is required. 2. Conveyance loss is very small. 3. Timely and adequate water distribution is possible. 4. Configuration of ground does not affect to take water. 5. Crossing structure is not required. 6. No waiting time for taking water.
Demerit	1. Land is required. 2. Crossing structure is required. 3. In case of undulating land, the canal is banked and it is inconvenient. 4. Water loss by evaporation. 5. Water can be leaked from construction joints. 6. Damage by agricultural machinery can easily happen.	1. Construction cost is expensive. 2. Much equipment, so that instruction for farmers is required. 3. Water surface can not be seen. 4. Damage of a part of pipe leads to full stop of the system. 5. Temporary repair is difficult.

Table 2.5.3 Comparison of Division Works

Item	Gate	Valve
Merit	1. easy operation with sluice gate. 2. cheap 3. Gate opening can be seen.	1. Water is supplied constantly by valve operation/ 2. Distribution management is easy.
Demerit	1. Leakage from gate can occur. 2. Repair is difficult in case the gate lost. 3. Water shortage can occur if the irrigation rule is broken. 4. Difficult to prevent illegal operation by children	1. Repair by farmers is difficult in case of trouble. 2. costly 3. Water level can not be seen. 4. Protective structure is required. 5. Damage of protective structure by machinery can easily happen.

Considering the facts above, the intake without diversion is not suitable for saving water by delivery canal-wise water management because farmers can operate their own pumps by themselves and it is difficult to offer their own pumps for common use. A method with a farm pond requires a land for the pond and it is against the Islamic custom. Moreover the land acquisition is difficult and the utilization of the land created by Meska improvement will bring about the shift of field boundary. Therefore the proposed Meska improvement alternatives are the four (4) cases with one-point lifting pump except for the method with a farm pond shown below. Among the comparison of these alternatives, the Trapezoid Raised Open Meska is the cheapest because of the closeness to hydraulic advantageous section, hence the small-scale section. (Refer to Figure 2.5.5 and 2.5.6)

Items	Case1	Case2	Case3	Case4
Meska Type (Proposed)	J-Shape Raised Open	Rectangular Raised Open	Trapezoid Raised Open	Pipeline
Materials	Concrete	Brick	Brick	PVC pipe
C.Cost (Rough Estimate)	2,513	2,145	2,041	2,839
Ratio(%)	123	105	100	139
Priority	d	B	a	c

Note: (1) C.Cost means Construction Cost per feddan in LE including civil works, pump equipment, and other necessary costs.

(2) In Cases 1 to 3 raised open canal type is applied and Cases 4 is pipe line Meska

(3)The cost of each case will drastically vary according to the number of division works etc..

Above four (4) alternatives will be applied by farmers' own decision in the Priority Area. Although the scale of the improvement structure is small, the construction volume is big. From view point of simplicity of design and construction, improvement of construction quality, strictly keeping a construction period, easiness of maintenance of proposed facilities

by farmer's themselves, the improvement measure would be studied. (Refer to attached drawings DD-21 to DD-25)

2.5.2 Development Plan of Drainage Facilities

There is a drainage system including main and branch drainage open canals, drainage pump stations and on-farm open drain on the field and sub-surface drain. Except for the subsurface drain, no serious problem is found on the drainage system. However, in the northern part of the Priority Area, the subsurface drainage system is not installed yet. Therefore, the system should be introduced to improve soils and the farm land. These areas are estimated at about 13,350 feddan (about 5,610 ha) under the command areas of the delivery canals of El Banawan El Asfal, Banawan Branch, Ragheb Basha, Ganabia No. 10 Right and Zobaa.

On the other hand, the aged subsurface drainage system under the past projects implemented more than 20 years ago are reported to be under poor conditions, especially Foda and El Shorafa command areas of about 2,500 feddan (about 1,050 ha) in total, which needs rehabilitation of the tile drainage facilities. (Refer to attached drawings DD-25)

Figure 2-5-1
Location Map of
Major Facilities
in Priority Area

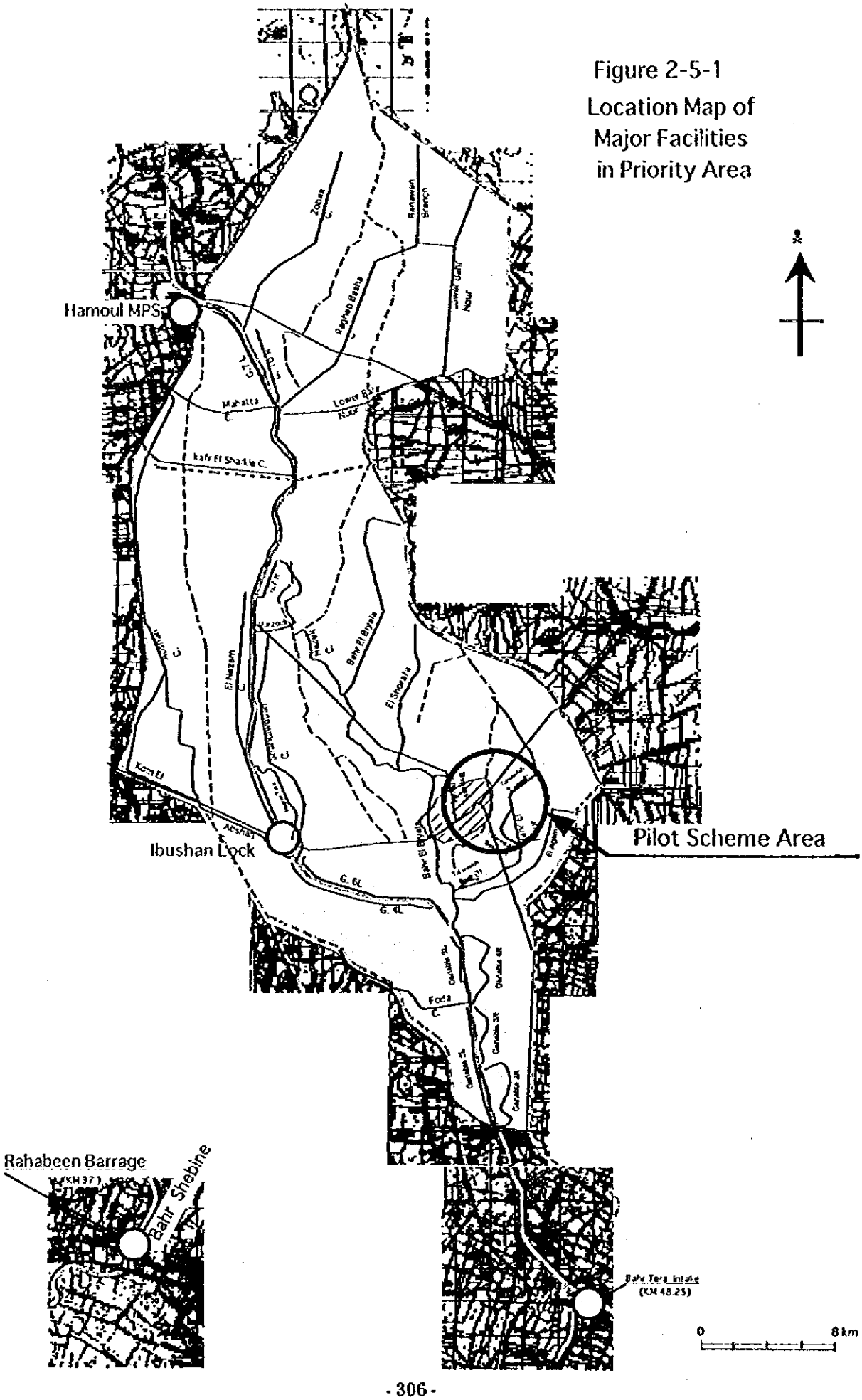
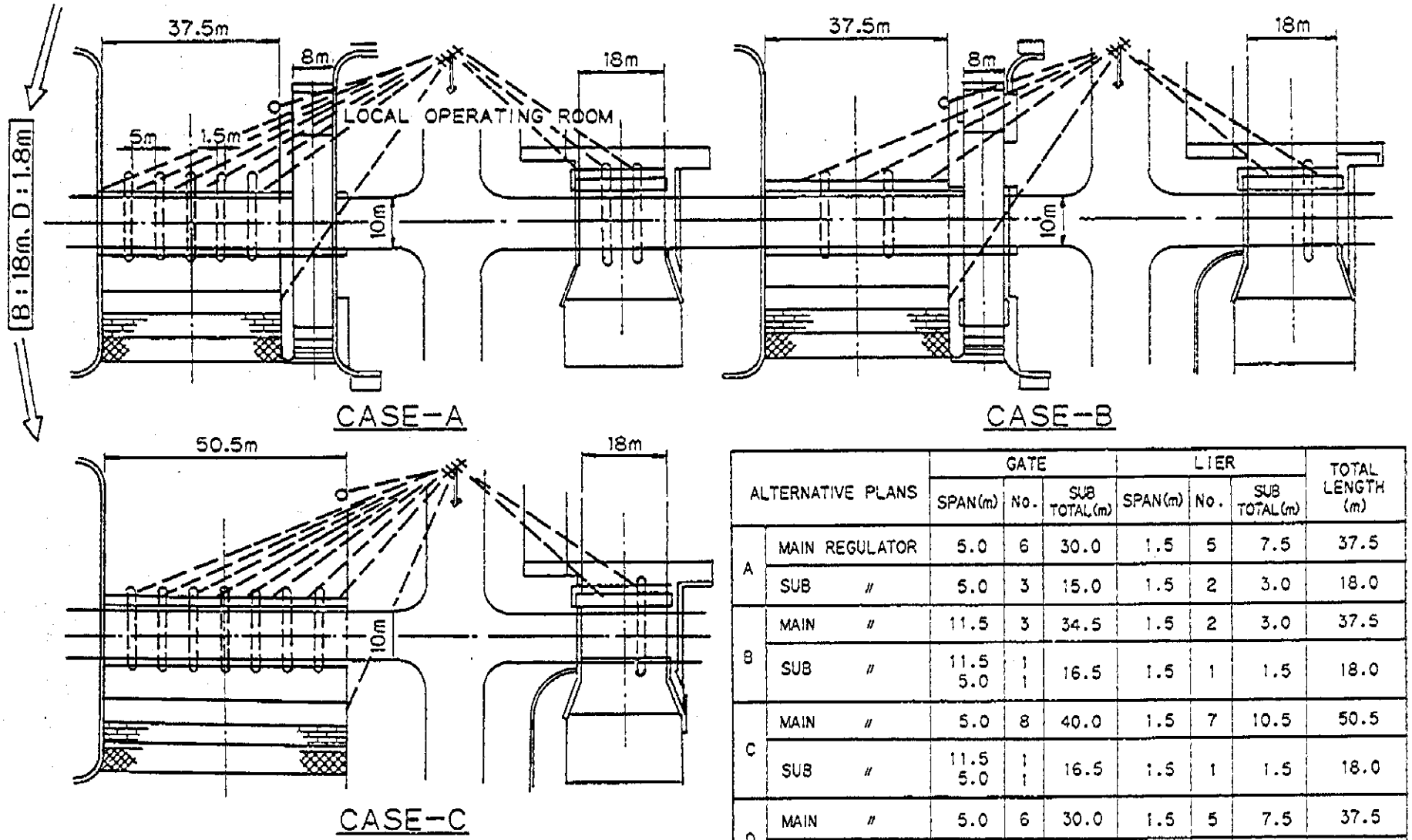


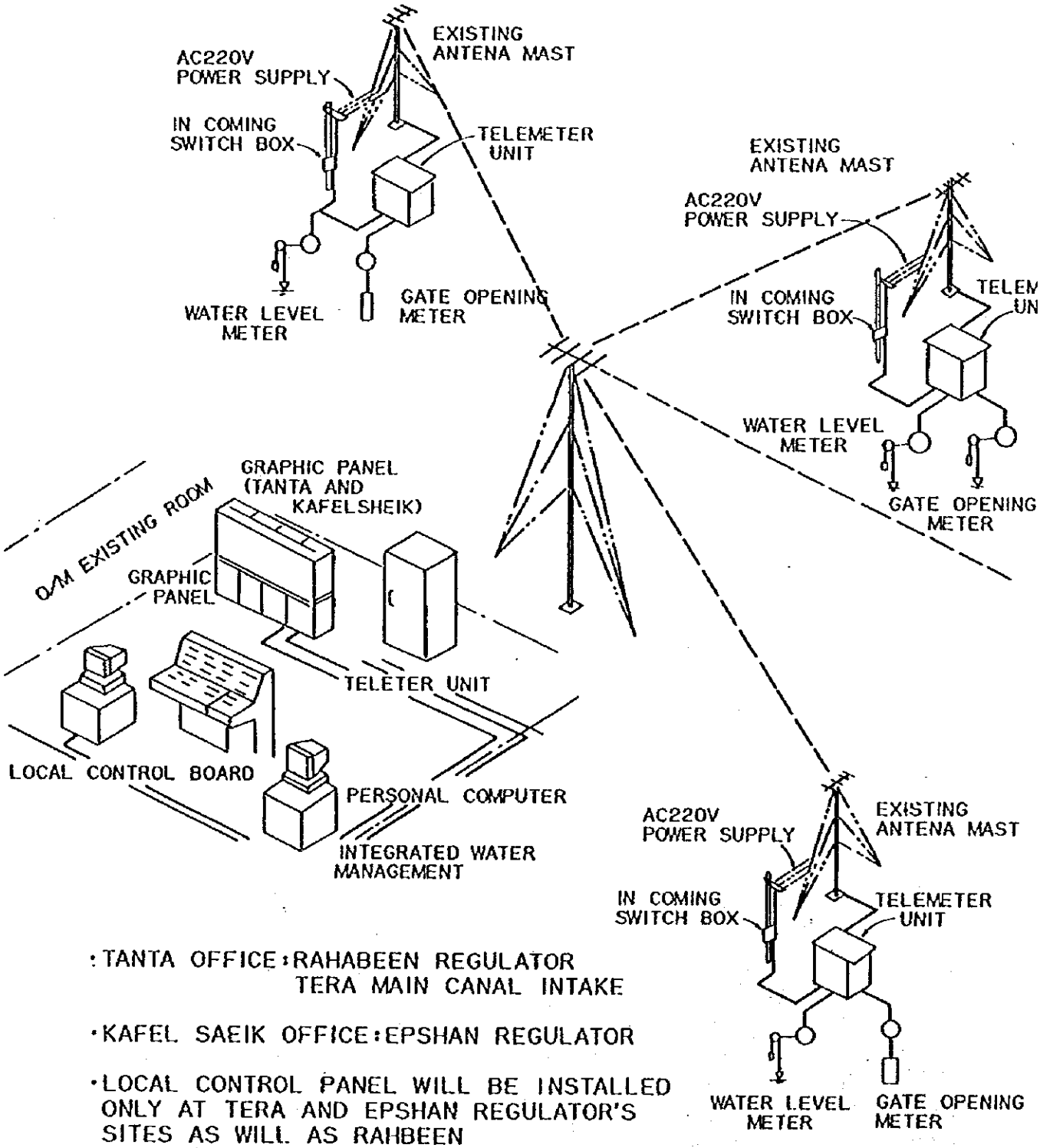
Figure 2.5.2
Alternative Plan of Rahbeen Regulator to be Improved



ALTERNATIVE PLANS		GATE			LIER			TOTAL LENGTH (m)
		SPAN(m)	No.	SUB TOTAL(m)	SPAN(m)	No.	SUB TOTAL(m)	
A	MAIN REGULATOR	5.0	6	30.0	1.5	5	7.5	37.5
	SUB //	5.0	3	15.0	1.5	2	3.0	18.0
B	MAIN //	11.5	3	34.5	1.5	2	3.0	37.5
	SUB //	11.5 5.0	1 1	16.5	1.5	1	1.5	18.0
C	MAIN //	5.0	8	40.0	1.5	7	10.5	50.5
	SUB //	11.5 5.0	1 1	16.5	1.5	1	1.5	18.0
D	MAIN //	5.0	6	30.0	1.5	5	7.5	37.5
	SUB //	5.0	3	15.0	1.5	2	3.0	18.0

Figure 2-5-3

Wanet Management, Operationa nd Control System



: TANTA OFFICE : RAHABEEN REGULATOR
TERA MAIN CANAL INTAKE

- KAFEL SAEIK OFFICE : EPSHAN REGULATOR
- LOCAL CONTROL PANEL WILL BE INSTALLED ONLY AT TERA AND EPSHAN REGULATOR'S SITES AS WILL AS RAHBEEN

- EXISTING POWER SUPPLY FOR THE WATER LEVEL METER IS USING SOLAR ENERGY
- IN CASE OF THE POWER SUPPLY IS NOT ENOUGH FOF ADDITIONAL GATE OPENING METERES

Figure 2.5.4

Typical Cross Section of Proposed Meska

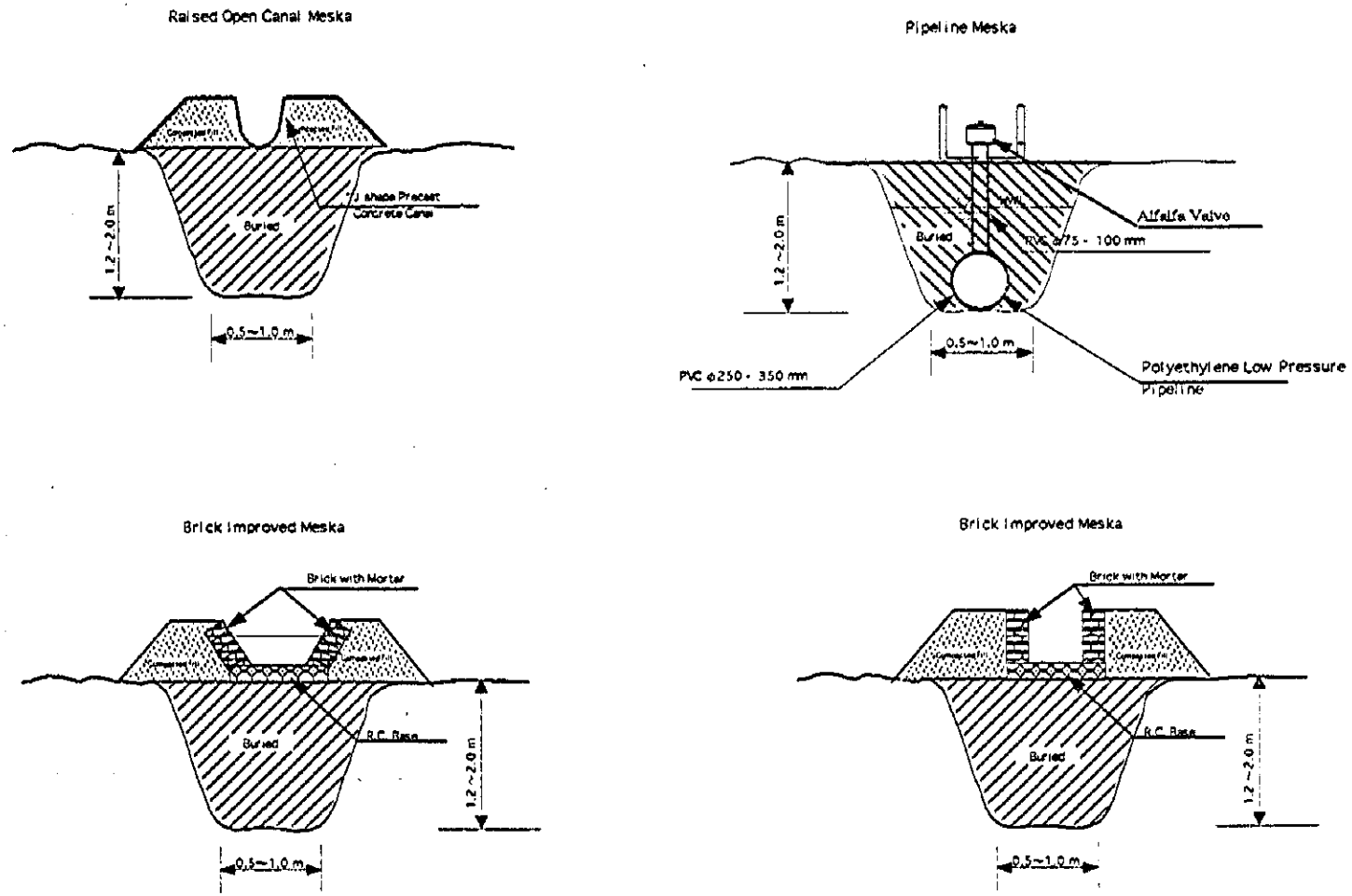


Figure 2.5.5 Meska Improvement Method

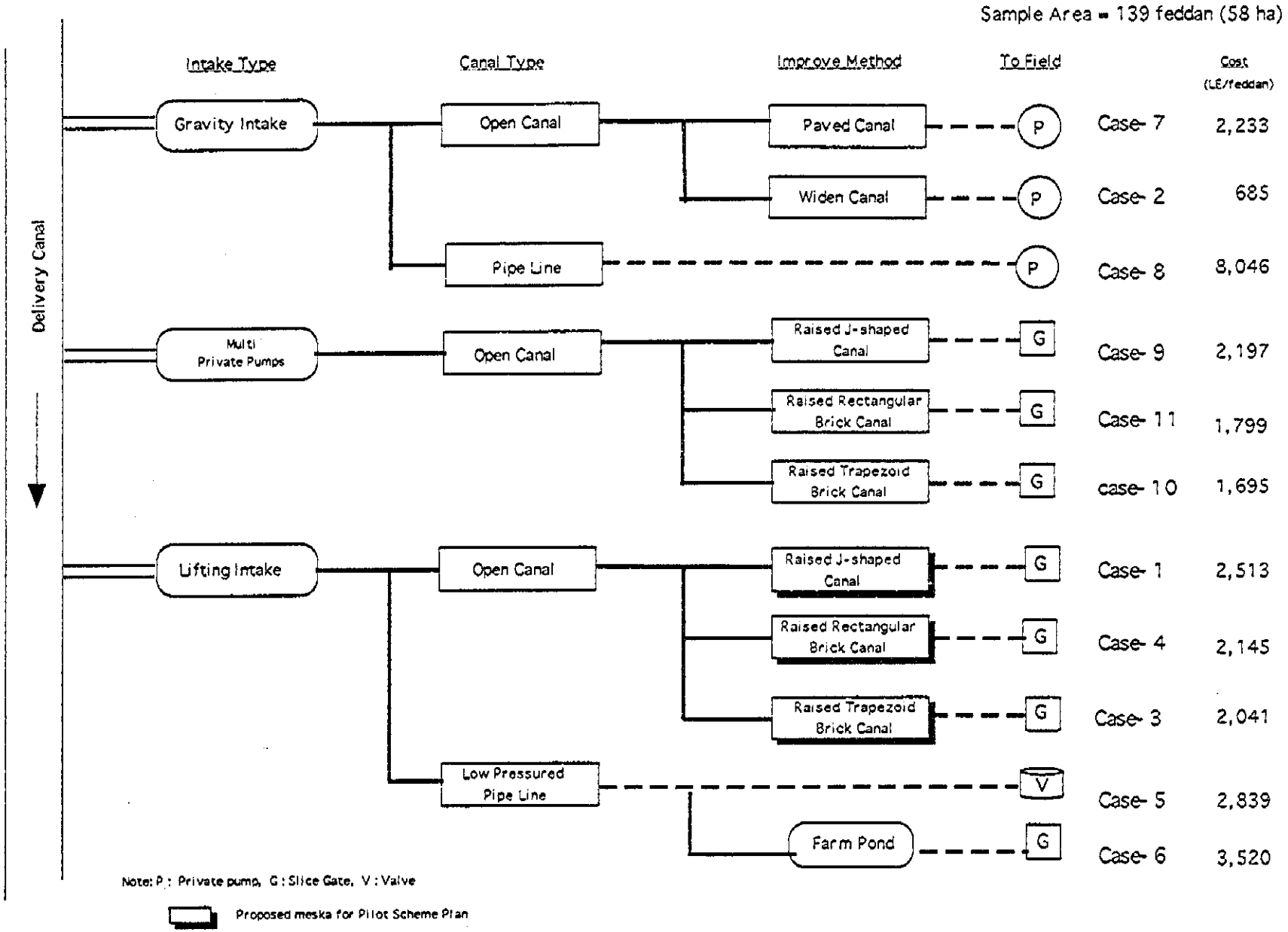


Figure 2-5-6 Comparison of Alternative on Improved Meska