c. Abu Tarfaya Sub-area

Pump Station:	Abu Tarfaya Pump Station
Drainage:	Main drainage Lateral drainage Sub-lateral drainage

d. Khor el-Hitan Sub-area

Pump Station:	Khor el-Hitan Pump Station
Drainage:	Main drainage Lateral drainage Sub-lateral drainage

Special considerations should be paid to the power sources of pump stations in relation to the development of this component. Plural units of pumps are planned for the proposed pumping stations. The operation cost of these pumps will be bothered for beneficiaries in the area in future. For eliminating the bother, the possibility of introducing special power sources such as solar energy, wind-mill energy, etc., should be carefully studied during the detailed design. At present these power sources are just under development stage in the world. Therefore, initial cost of facilities will be a little bit costly in comparison with ordinary power sources such as diesel generators and electricity. However, if the operation cost can be reduced by the particular power sources, such power sources should be introduced convenience for beneficiaries.

According to the Ministry of Irrigation, the Fayoum office of Irrigation Department, the General Authority for Covered Drainage Projects at Beni Suef Governorate is conducting the study on the implementation of this drainage pump station. When the said plan is realized, this proposal will be revised during the detailed design.

4.2.5. Reclamation Plan

Crop growing will be started after completion of three-staged reclamation works including deep harrowing, soil dressing and leaching. The reclamation area in North Wahby and Com Osheem is a

desert area at present, and more than 70 percent of the area is composed of sandy soil. However, about 80 percent of the area in North Wahby and all the area of Com Osheem are covered by hard pan at the top layer or sub-layer. Therefore, the reclamation of the area should firstly be made by the deep harrowing and then followed by soil dressing and leaching.

(1) Deep Harrowing

Deep harrowing of the desert area aims to improve soil at the top layer or sub-layer for successful soil dressing, leaching, and cropping. It is considered to plan the deep harrowing work by the soil profile, soil classification, depth of the deep harrowing by basis of crop to be introduced in the area.

As the result of study, it is proposed to make the deep harrowing by bulldozer (capacity of 32 tons class) with ripper at the initial stage of the reclamation. The deep harrowing prefers to make ripping by crossing way until the scheduled depth.

The depth of deep harrowing is decided depending on crops to be introduced to the area. According to the proposed cropping pattern for the reclamation area, the crops consists of fodder crops, cereal crops and some vegetables to be planted in 75 percent of the area, and fruits as perennial crops in the rest area equivalent to 25 percent of the area. According to the soil survey and the proposed cropping pattern, about 60 centimeters will be necessary for deep harrowing in top layer for common crops, while more than 60 centimeters in top and sub-layer for fruits crops. The deep harrowing would be executed at the first stage of reclamation in the area.

According to experiments in the other reclamation project, it was observed that hard pan layer revert back nearly to its initial form upon irrigating. Therefore, it is recommended to repeat the said deep harrowing once every three to four years during the cultivation.

(2) Soil Dressing

The soil dressing in the reclamation area usually have two ways; one is to supply soil dressing materials and the other to dose gypsum. And there will be two kinds of materials available for soil dressing: barn yard manure and sedimented materials available by canal dredging. At the initial stage of the reclamation of the Project, manure of by-products of animal husbandry is not available while the sediments for soil dressing will be easily available by Bahr Wahby and Gomhouria canals which run in parallel with the reclamation area of North Wahby and Com Osheem. In generally costs of soil dressing is very high, however, in this Project, the said materials will easily be obtained with low cost. The supply of the dredged materials at the early stage of the reclamation would be recommended.

On the other hand, soil survey and physical and chemical analyses of soil samples found that the exchangeable sodium percentage in the area is mostly very low. Therefore, gypsum supply is not required. However, the possibility of increasing soil alkalinity after leaching is expected. Due to a low exchangeable sodium percentage in the area, gypsum application is estimated for a half of the area at a rate of one ton per feddan for future contingency during the detailed survey and design. Application rate of gypsum at one ton per feddan in a half of the area is intended to include some over quantity as future contingency. Because soil survey was made by the basis of semi-detail soil survey.

(3) Leaching

In the most part of the Project Area with arid or semi-arid climate, saline soils exist, and the natural leaching and transport of soluble salts to the downstream is not completely made as compared with humid areas. Salt accumulation generally occurs in the top soils. Salt affected soils may be classified into two,

soils topographically accumulated due to a high groundwater table or low permeability of soil, and soils of which salt is accumulated by irrigation. The following two leaching methods can be considered for the improvement/reclamation of such soils; one is to wash away salt in the top soils and the other is to reduce the causes by lowering groundwater table and selecting irrigation methods with less salt accumulation.

For the reclamation of the area in North Wahby and Com Osheem, depending on the contents of salt, leaching by means of sprinkler facilities would be carried out at the initial stage and during the maintenance stage, an adequate amount of leaching water would be supplied by sprinkler facilities before the beginning of the cultivation.

The necessary amount of leaching water that enters into soils by spreading determines how much salt would be removed from the soil. It is generally accepted that, when water is leached through soil, a surface depth of 150 millimeters of water for every 300 millimeters of plant root zone will leach out 50 percent of salt. A 300 millimeters of water for every 300 millimeters of root zone leaches out 80 percent of salt. A 600 millimeters of water per 300 millimeters of root zone leaches out 90 percent of salt. If leaching water is added to a field by methods other than ponding, more water will be required to accomplish the same results.

(4) Leaching Water

During the first field work in February and March, 1984, the field leaching test was carried out in North Wahby and Com Osheem areas by providing a nylon sheet frame about two meters long, one to 1.2 meters wide, and 40 to 50 centimeters deep. When the frame was provided, certain soil samples at five, 25 and 35 to 40 centimeters depth were taken for salt analysis of soils, and then some volume of leaching water was supplied to the frame. After 24 hours or two

days, or sometimes three to four days depending on the filtration of supplied water, the second soil samples at the same depth as the first time were taken in order to confirm the movement of salt contents. After sampling was made, the second leaching water was supplied in a certain volume to the frame. The same procedures were followed for the third and fourth samples. Analysis of salt contents of soils was made by the Soil Laboratory of the Faculty of Agriculture, Cairo University in Fayoum, in the course of the first field work.

According to the analysis of the field leaching test, the leaching curve for North Wahby and Com Osheem areas are analyzed and the salt leaching curves show an idea of leaching water requirement in the top soils at the initial stage. (Refer to Appendix F-2.3)

For estimate of leaching water requirement, several empirical and experimental formulae were recommended by researchers/doctors. The formulae of L. Rozov, USSR (1936), V. Kovda (1957) and V.R. Volobuev (1960) are considered for the study of the Project. (Refer to Appendix F-2.3)

Applying formulae, leaching water requirement were estimated. However, in the field, the field leaching test was conducted by the study team and the said test observed more practical information. The result shows that supply of 250 millimeters depth of water with about 200 parts per million salt contents at the initial stage would easily leached out to tolerable degree of salt contents at the top layer. As a result, leaching water requirement at the initial stage of the Project is determined at 300 millimeters depth considering losses.

For leaching water to be supplied during the maintenance stage of crops, leaching water will be estimated based on tolerable salt contents to the selected crops and salt contents of irrigation water in order to prevent the accumulation of salt at the top soils.

Taking into consideration the electrical conductivity of the irrigation water in mmhos per centimeter for averaging mixed salinity of Batts Drain and Bahr Wahby which is assumed at about 1.2 mmhos per centimeters (785 ppm), leaching water requirement for crop maintenance stage and month to be supplied leaching water are estimated as follows;

Crops	Leaching Water Requirement	Month to be Supplied
Berseem	359 cu.m/fed.	October
Wheat	295	November
Tomato	335	August
Sorghum	485	May
Watermelon	508	February
Groundnuts	350	April
Fruits	350	September & October

Timing of supply of leaching water is considered just before planting crops and the month in low total irrigation water demand. (Refer to Appendix F-2.3)

4.2.6. Irrigation Plan

Discussion of irrigation plan in this paragraph is concentrated for the reclamation areas in North Wahby and Com Osheem.

(1) Irrigation Area

Irrigation area in North Wahby area is 4,200 feddan (1,760 ha) in net area out of land holder area of 4,420 feddan (1,850 ha) while the irrigation area in Com Osheem is 3,000 feddan (1,260 ha) in net area, out of land holder area of 3,160 feddan (1,330 ha). In addition, the Model Farm would be established for demonstration and training of the modernized irrigation facilities to be introduced into the reclamation area, which covers 310 feddan (130 ha) in gross and 250 feddan (105 ha) in net.

Irrigation method is applied sprinkler and drip. As discussed in the latter paragraph, several case studies on the combination of irrigation blocks and number of blocks from the engineering and economical point of view. As a result, it is proposed five pump stations in North Wahby area and three pump stations in Com Osheem area.

Each pump station covers the following net irrigation area;

Area	Pump Station	Net Service Area (feddan)
North Wahby	P1	684
	P2	676
	P3	699
	P4	1,367
	P5	774
Sub-total		4,200

Area	Pump Station	Net Service Area (feddan)
Com Osheem	P6	750
	P7	1,200
	P8	800
	Model Farm	250
Sub-total		3,000
Total		7,200

Each area is provided by a pump station and pipelines to distribute irrigation water to farm lots and windbreak.

(2) Irrigation Method

In cultivated land in Fayoum, irrigation for plant growth is being made by flooding or by means of furrows so far. The existing canal system in Fayoum is designed based on a water duty of 30 cubic meters per feddan per day.

Irrigation in Fayoum is of gravity. Gravity irrigation is hardly seen in this country, and is practicable in Fayoum since it has a comparatively steep topographic slope about 1:500 on an average from the hilly eastern mouth of Fayoum depression to Lake Qarun in the west.

Two large scale canals, Bahr Hassan Wassef for the western area and Bahr Yusef for the eastern and middle areas cover irrigation in Fayoum depression. Bahr Yusef divert irrigation water for the eastern area through Bahr Wahby. Bahr Wahby runs along the eastern boundary of Fayoum depression. After changing its course to west, Bahr Wahby flows along the northern part of Tamiah district which adjoins North Wahby area, part of the Project Area. Several canals branch off at the upstream reaches of the diversion point to Gomhouria canal which serves the southern Com Osheem area, part of the Project Area to be reclaimed.

For reclamation of North Wahby and Com Osheem areas, reuse of drainage water was planned as new water resources of irrigation by Fayoum Governorate. A result of the feasibility study conducted by a study team of Dutch Government shows that a new water resources of maximum 4.5 cubic meters per second will be lifted up from the Batts drain at Tamiah to Bahr Wahby and mixed it with fresh water of Bahr Wahby providing irrigation water with tolerable extent of salinity. By utilizing this water resources, it is expected that the reclamation of North Wahby and Com Osheem areas and improvement of the irrigation water shortage at Wahby Downstream area. Available water resources for these area is 4.5 cubic meters per second which is able to deliver irrigation water of 24 cubic meters per day per feddan at the peak stage for North Wahby and Com Osheem areas and about ten cubic meters per day per feddan for Wahby Downstream area as supplemental to the irrigation water of about 14 cubic meters per day per feddan at present.

Irrigation is generally defined as the application of water to soil for the purpose of supplying the moisture essential for plant growth. Irrigation method for the application of water to the soil used to be in five different ways: (1) by flooding; (2) by means of furrows; (3) by sub-irrigation; (4) by sprinkling or (5) by drip.

Irrigation methods vary in different parts of the world and on different farms. A irrigation method would be selected based on the following consideration: (1) Natural conditions such as soil, topography, climate and availability of water resources under consideration of irrigation efficiency; (2) conditions of farm management as to kind of crops to be grown and farming techniques; (3) economic conditions in investment cost and operation and maintenance cost; and (4) extent of intake rate which is rate of entry of water into soil under field conditions.

One of factors on selection of irrigation method is the basic intake rate. During the first field work in February and March, 1984, the intake rate was observed in North Wahby and Com Osheem areas and then careful analyses of all observed data were made. According to the result, about 30 percent samples are below 7.6 millimeters per hour of the basic intake rate and the rest 70 percent are above 7.6 millimeters per hour. In general, it may be said that sprinkler or drip irrigation is preferable to apply for the land where the basic intake rate has more than 7.6 millimeters per hour. (Refer to Appendix F-2.2)

Aside from the above-mentioned fact, soil conditions particularly in salinity contents in North Wahby and Com Osheem areas are also preferable to introduce the sprinkler or drip irrigation. These reclamation areas are located at the right bank of Bahr Wahby and Gomhouria Canal. Elevation of the areas ranges from 15 to 28 meters above mean sea level in North Wahby area and from ten to 28 meters in Com Osheem area. For irrigation in these

areas, pump facilities have to be provided for lifting up water of Bahr Wahby. In this regards, it is also one of advantages in introduction of sprinkler and drip irrigation method into this areas.

Taking into consideration several factors for choice of irrigation method and also social and economic developing stage of Fayoum Depression, irrigation method for North Wahby and Com Osheem areas would be adopted by sprinkler and drip irrigation methods.

(3) Irrigation Water Requirements

Irrigation water requirements for raising agricultural crops would be estimated based on crop water requirement (ETcrop), leaching water requirements (LWR) and irrigation efficiency (Ea). The effective rainfall is not considered in the Project Area because rainfall is negligibly small. The crop water requirement is calculated by an equation of ETcrop = Kc. ETo. The crop coefficient, Kc is given by the growing stage of crops. Reference crop evapotranspiration (ETo) is predicted usually by four formulae; Blaney-Criddle, Radiation, Modified Penman and Pan Evaporation. The detailed discussion on this matter is reported in Appendix F-2.2.

The Crop coefficient (Kc) is presented to relate ETo to crop evapotranspiration (ETcrop). The Kc value presents evaporation of a crop grown under optimum conditions producing optimum yields. Factors affecting the value of the crop coefficient Kc are mainly the crop characteristics, crop planting or sowing date, rate of crop development and length of growing season, climatic conditions and, particularly the frequency of rain of irrigation during the early growth stage. (Refer to Appendix F-2.2)

Irrigation water requirement can be estimated based on acreage of proposed cropping pattern and crop water requirement (ETcrop) in adding leaching water for crop maintenance stage and some of miscellaneous water. (Refer to Appendix F-2.2)

As a result, irrigation water demand at the peak will be appeared in July and the total discharge will be 2.46 cubic meter per second (equivalent to about 24 cubic meters per day per feddan)

As for irrigation during the winter closure, irrigation method is considered by crop basis. Berseem will be cut during the said period while tomato will be made cutting back. And also, it is noted that at present in Fayoum depression, winter crops have no trouble to grow during the said period.

(4) Irrigation Efficiency

Irrigation efficiency is defined as a ratio of the total irrigation water requirement against the total of crop water requirement (ETcrop). Difference between the two is so-called irrigation loss which is composed of conveyance loss, operation loss and application loss.

As for the Project, conveyance loss is determined at five percent each between Bahr Wahby and pump station of the Project and pipelines between pump station and farm lot, resulting conveyance loss of 10 percent. The operation loss and the application loss are determined based on the irrigation method. For the drip irrigation, combined efficiency of operation and application is applied at 90 percent while for the sprinkler irrigation, it is adapted at 85 percent.

System irrigation efficiency for the respective irrigation method are calculated as follows;

Sprinkler Irrigation : $(1-0.10) \times 0.85 = 0.765$
Drip Irrigation : $(1-0.10) \times 0.90 = 0.81$

4.2.7. Drainage Plan

Drainage is generally planned for the purpose of eliminating surface runoff and removing excessive moisture in the soil. The drainage plan aims mainly for removing excessive soil moisture to lower the groundwater table and also for eliminating surface runoff taken place by the initial leaching.

According to geological investigation in North Wahby and Com Osheem areas, there exist no groundwater table and it takes a long period to form groundwater table when sprinkler and drip irrigation will be continued. Assuming that irrigation efficiency for drip and sprinkler irrigations are at 81 percent and 76.5 percent, respectively, the total runoff from the reclamation area of 8,800 feddan in North Wahby and Com Osheem areas would be 0.56 cubic meter per second only.

Notwithstanding the provision of drainage facilities are not required in the reclamation area during a period of about ten to 15 years after completion of reclamation and commencement of irrigated agriculture, it is proposed to construct open drainage canal by the Project for safe. However, improvement of the existing drains such as Nazzaz Saweres Drain, Azzam Drain and El Wastany Drain will be implemented latter.

To confirm formation of groundwater and appearance of groundwater table in the reclamation area several years after the commencement of the irrigated agriculture, it is proposed to provide observation well with perforated PVC casing and piezometers. The observation well with perforated PVC casing of 50 millimeters in diameter will be installed by boring with six meters in depth and 65 millimeters in diameter. The said well is planned to set at 15 places in North Wahby area and at ten places in Com Osheem area. (refer to Appendix F-3)

For observation of groundwater table, two set of water level indicators will be prepared by the Project.

4.3. Agricultural Development Plan

4.3.1. Agricultural Production

(1) North Wahby and Com Osheem Areas

1) Selection of Crops

The study on the crops to be introduced to the reclamation area of North Wahby and Com Osheem areas from various crops is carried out in taking into consideration the conditions of the area, salt tolerance, water requirement, adaptability, domestic demand and export demand. Particularly, high salt tolerance, suitability to the desert land and requirement of less irrigation water are severally considered.

Consequently, the following crops are selected as suitable crops to be introduced for the area.

Winter Crops.....	Berseem, wheat, beans
Summer Crops.....	Sorghum, maize, sesame, groundnuts
Vegetables	Tomatoes, watermelons
Fruit & woody trees ...	Olives, mangoes, citrus, guavas, grapes, casuarina

2) Proposed Cropping Pattern

The cropping pattern is planned considering the followings;

- Forage crops will be cultivated in summer and winter in order to increase supply of organic matter to the soil;

- Vegetables will be cultivated as much as labor power is available in order to increase the farm income;

- Fruit trees will be cultivated because the land to be reclaimed is suited to the trees and the marketing place is located near the areas.

- Annual crops will be cultivated on a two or three year rotation basis.

- Forage crops will be cultivated as intercrops in the fruit cultivation area until the fruit trees are matured.

Five alternative cropping patterns are studied on proposed cropping. Water requirement, requirement of labor power and economics of the production are taken for the said the study (refer to Appendix D-2.1). As a result of the study, the following cropping pattern is proposed for the Project.

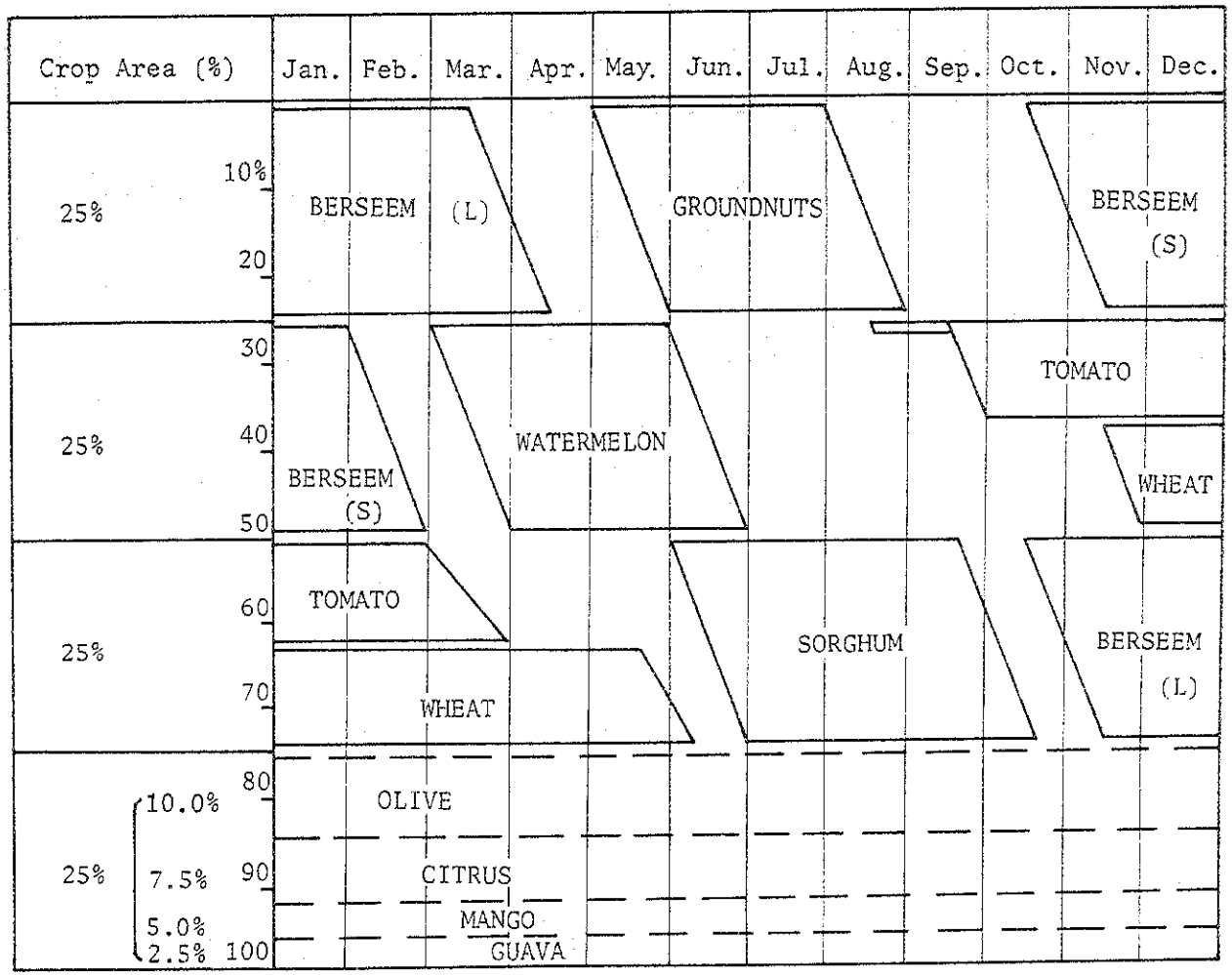
Winter		Summer	
Crop	Acreage	Crop	Acreage
Berseem	25%	Watermelon	25%
Berseem(s)	25	Groundnut	25
Tomato	12.5	Sorghum	25
Wheat	12.5		
Fruits	25	Fruits	25

For introducing the above cropping pattern, the following conditions are considered to be practiced.

- The depth of the cultivated soil should be more than 60 centimeters, and that for fruit trees should be more than 150 centimeters.

- Since low salt density is necessary, crops will be introduced by degrees after the land reclamation and leaching.

Fig. 4-1 Proposed Cropping Pattern



Note: (S) short (L) Long

- Also, since organic matter is required by the orchard area, fruit cultivation will start at the end of first year or the beginning of the second year.

In addition, the fruit is studied on cases of zero percent, ten percent, 20 percent, 25 percent and 30 percent of the total area. When the fruit area becomes 30 percent of the total area, labor power of a small sized farm (50 man-months) can not afford to manage farming in spite of increasing income. Consequently, 25 percent of the total area is proposed for the orchard.

3) Requirement of Input Materials

Required seed varieties, fertilizers and agricultural chemicals should be defined based on the extension data from the organization. However, some practice in handling agricultural chemicals are necessary to decrease any harmful effects.

4) Yield and Production

Yield of crops may show rapid increase by means of the decrease in salt density and the uniform field. Growth of yield, cropping area and production by crop and by year at the private farm and crop production at the Cattle Breeding and Fattening Farm are shown in Tables 4-3 and 4-4.

In case of fruit, production will start in the second or the third year after the settlement and reach full production stage in the fifth or sixth year after transplantation. In the 15th year after the settlement, crop production will reach its highest stage, and in the 18th year after the settlement, fruit production will achieve the highest stage.

Table 4-3 Growth of Yield by Crop for the Reclamation Area

(Unit: ton/feddan)

Crop	Year									
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Upland Crops										
Berseem*	1.3	2.1	2.5	4.0	5.0	5.0	5.0	5.0	5.0	5.0
Tomato	-	-	11.0	12.0	15.0	15.0	15.0	15.0	15.0	15.0
Wheat	-	1.1	1.7	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Groundnuts	-	-	0.4	0.6	0.8	0.8	0.8	0.8	0.8	0.8
Watermelon	-	-	7.0	9.0	10.0	10.0	10.0	10.0	10.0	10.0
Sorghum	4.5	10.0	16.2	17.0	18.0	18.0	18.0	18.0	18.0	18.0
Fruits										
Olive	Settle plant		-	0.7	1.0	3.0	5.0	7.0	7.0	7.0
Mango	"		-	-	0.6	1.0	1.5	3.0	5.0	6.0
Orange	"		-	0.8	2.0	4.0	6.0	8.0	8.0	8.0
Guava	"		-	0.7	2.0	5.0	7.0	7.0	7.0	7.0
Grape	"		-	0.6	1.5	3.0	5.0	6.0	6.0	6.0

Note: * .. one cut yielding

Table 4-4 Proposed Cropping Area for the Reclamation Area

(Unit: feddan)

Crop	Block	8th	9th	10th	11th	12th	13th	14th	15th	16th
Berseem (long)	1	1245	623	415	415	415	415	415	415	415
	2	-	1785	893	595	595	595	595	595	595
	3	-	-	1620	811	540	540	540	540	540
	Total	1245	2408	2928	1821	1550	1550	1550	1550	1550
Berseem (short)	1	-	-	415	415	415	415	415	415	415
	2	-	-	-	595	595	595	595	595	595
	3	-	-	-	-	540	540	540	540	540
	Total	-	-	415	1010	1550	1550	1550	1550	1550
Sorghum	1	1245	773	415	415	415	415	415	415	415
	2	-	1785	1155	595	595	595	595	595	595
	3	-	-	1620	1148	540	540	540	540	540
	Total	1245	2558	3190	2158	1550	1550	1550	1550	1550
Wheat	1	-	623	208	208	208	208	208	208	208
	2	-	-	893	298	298	298	298	298	298
	3	-	-	-	811	271	271	271	271	271
	Total	-	623	1101	1317	777	777	777	777	777
Tomato	1	-	-	208	208	208	208	208	208	208
	2	-	-	-	298	298	298	298	298	298
	3	-	-	-	-	271	271	271	271	271
	Total	-	-	208	506	777	777	777	777	777
Groundnuts	1	-	-	415	415	415	415	415	415	415
	2	-	-	-	595	595	595	595	595	595
	3	-	-	-	-	540	540	540	540	540
	Total	-	-	415	1010	1550	1550	1550	1550	1550
Watermelon	1	-	-	415	415	415	415	415	415	415
	2	-	-	-	595	595	595	595	595	595
	3	-	-	-	-	540	540	540	540	540
	Total	-	-	415	1010	1550	1550	1550	1550	1550
Berseem (long intercrop)	1	-	-	73	73	73	-	-	-	-
	2	-	-	-	102	102	102	-	-	-
	3	-	-	-	-	86	86	86	-	-
	Total	-	-	73	175	261	188	86	-	-
Berseem (short intercrop)	1	-	-	293	293	293	-	-	-	-
	2	-	-	-	407	407	407	-	-	-
	3	-	-	-	-	344	344	344	-	-
	Total	-	-	293	700	1044	751	344	-	-
Watermelon (short intercrop)	1	-	-	293	293	293	-	-	-	-
	2	-	-	-	407	407	407	-	-	-
	3	-	-	-	-	344	344	344	-	-
	Total	-	-	293	700	1044	751	344	-	-
Orchard	1	415	415	415	415	415	415	415	415	415
	2	-	595	595	595	595	595	595	595	595
	3	-	-	540	540	540	540	540	540	540
	Total	415	1010	1550	1550	1550	1550	1550	1550	1550

(2) Wahby Downstream Area and South Area of Lake Qarun

1) Present Conditions

Although a cultivated area per one farmhousehold is rather big, the cropping intensity, especially in summer, is low due to poor water conditions. And Nili crops are widely cultivated. Unit yield is almost the same as the average unit yield of Fayoum Governorate.

2) Proposed Crop Production

a. Wahby Downstream Area

Present crop production was estimated using the agricultural statistics. Proposed cultivated area and crop production have been estimated taking into consideration the unit yield and cropping intensity in Aslan where locates near the Project Area.
(refer to Table 4-5)

b. South Area of Lake Qarun

Present crop production was estimated using by the agricultural statistics. Proposed cultivated area and crop production have been estimated taking into consideration the highest production year and also the result of the other areas where locate around the Project Area. (refer to Table 4-5)

Table 4-5 Cropped Area, Yield, Production with and without Project
(Wahby Downstream Area)

	Without Project			With Project		
	Area	Yield	Production	Area	Yield	Production
Berseem (per one cut)	5,179	4.7	24,341	6,497	4.7	30,536
Wheat	3,285	1.4	4,599	4,123	1.6	6,597
Barley	976	1.1	1,074	1,226	1.1	1,349
Beans	428	0.9	385	537	0.9	483
Tomato	1,087	9.5	10,326	1,371	12.0	16,452
Onion	-	-	-	-	-	-
Others (Winter crop)	10	-	-	74	-	-
Cotton	360	0.8	288	549	0.9	494
Maize	2,837	0.9	2,553	4,345	1.0	4,345
Millet	4,357	1.3	5,664	6,060	1.4	8,484
Sesame	149	0.4	60	229	0.4	92
Sunflower	234	0.8	187	360	0.8	288
Others (Summer crop)	104	-	-	830	-	-

Total land	14,620 feddan	15,364 feddan
Cropped in winter	10,965 (75%)	13,828 (90%)
Cropped in summer	8,041 (55%)	12,373 (80)

Note: Unit of Area ..... feddan
Unit of Yield ..... ton per feddan
Unit of Production ... ton

Table 4-6 Cropped Area, Yield, Production with and without Project
(South Area of Lake Qarun)

	Without Project			With Project		
	Area	Yield	Production	Area	Yield	Production
Berseem (per one cut)	2,162	4.7	10,162	2,804	4.9	13,782
Wheat	975	1.3	1,293	1,254	1.6	1,954
Barley	94	1.3	123	126	1.6	199
Beans	226	0.6	141	295	0.9	271
Tomato	99	7.0	693	117	7.0	819
Onion	15	9.0	135	17	9.0	154
Others (Winter crop)	12	-	-	21	-	-
Cotton	844	0.9	760	1,076	1.1	1,180
Maize	1,049	1.4	1,468	1,224	1.6	1,934
Millet	1,289	1.7	2,191	1,730	1.8	3,083
Sesame	-	-	-	-	-	-
Sunflower	88	0.6	53	89	0.6	54
Others (Summer crop)	4	-	-	6	-	-

Total land	5,345 feddan	5,610 feddan
Cropped in winter	3,583 (67%)	4,634 (83%)
Cropped in summer	3,274 (61%)	4,125 (74%)

Note: Unit of Area ..... feddan
Unit of Yield ..... ton per feddan
Unit of Production ... ton

4.3.2. Livestock Farming

(1) Animal Selection

The managing types of animal husbandry could be roughly divided into two; the small-scale type which grows one to three head of baladi cow or buffalo, and the large scale farm which raises a lot of cattle including friesian.

Small-scale farmers raise baladi cow for meat and agricultural practices and also buffalo for milk. Buffalo milk is processed by farmers themselves to white cheese and drinking milk.

Two times field surveys revealed that more farmers raise baladi cow for fattening than buffaloes for milk. Farmers explained that the above-mentioned fact is attributable to that buffaloes require much more green fodders than baladi cows and also calving interval is longer than baladi cows.

Meanwhile in the large-scale farms, baladi cows and buffalo are bred for fattening and friesian for milk production using milking machines. Milk produced by large-scale farms is transported to milk processing factories in Cairo.

As aforesaid, the management types are clearly divided into two, and it is considered that these two types would last in future unless small-scale farmers could have some capitals for agriculture. Therefore, baladi cow and buffalo will be applied for small-scale farmers, while friesian inclusive of baladi cow and buffalo for large-scale farmers such as governmental farms.

Sheep are bred on stubble grazing and agricultural by-products. Sheep meat is necessary for Egyptian people, and it is considered that the combination of cattle and sheep would be reasonable from the view point of fodders utilization.

Recently a large-scale chicken breeding is managed industrially by using hybrid in Fayoum Governorate, and seem to supply enough amounts for demand. Consequently, the animal husbandry development should aim at meat and milk production which have been imported to meet increasing demands.

Taking into consideration these circumstances, baladi cow, buffalo, friesian and sheep should be selected for the Project Area. The Department of Agriculture has carried out "Cattle Breeding and Fattening Project" since 1983 in Com Osheem area. According to the report for the project, eight units will be established; two units for baladi and buffalo and six units for friesian. Each unit has 1,000 head of adult cattle and needs 250 feddan (105 ha). One unit had been established in 1983. The Department of Agriculture expects to improve baladi cow at these farms by crossing with friesian bulls. A net area of 1,000 feddan (420 ha) will be served for four units (three units for friesian and one unit for baladi cow) in Com Osheem area for the Fayoum Agricultural Development Project.

(2) Fodder Resources

Among the crops proposed for the Project, those that can be used to the animals are berseem, sorghum, wheat straw. In the absence of berseem during summer, sorghum and wheat straw become the main roughage and some concentrate the protein source in animals feeds.

Fodder production by year calculated based on the proposed cropping pattern for the Project.

At the full development stage, 26,250 tons of berseem in North Wahby, 12,500 tons in Com Osheem and 20,000 tons in the Cattle Breeding and Fattening Farm will be produced. As for sorghum 18,900 tons in North Wahby 9,000 tons in Com Osheem and 18,000 tons in the Cattle Breeding and Fattening Farm would be produced as well. (refer to Table E2-8 in Appendix E).

Feeding plan for the Project is given in Table E1-12 in Appendix E.

In the Fayoum Governorate farm by-products which is used for animal feeds in the largest amount is wheat straw.

Starch equivalent of wheat straw is not low as shown in Table E2-7 in Appendix E but digestible protein content is merely low. Therefore, in order to supplement digestible protein something with high content of protein should be added.

It would be effective to add molasses and brans to wheat straw due to increase nutrients value and paratability for animals. If these raw materials are processed into pellets, present situation of concentrate supply would be improved.

In addition, blood and bone produced as by-products in the proposed slaughterhouse established in North Wahby area also would be utilized as blood meal and bone meal, respectively. These two by-products is effective to make a nutritious compound feeds as well as the molasses. In any cases some factory equipped mixing and pelleting facilities would be needed.

Further, in order to increase grazing capacity new varieties of fodder crops should be taken into consideration in the near future. At present, berseem (Egyptian clover) is the best fodder crops from the viewpoint of tolerance for salinity and high yield and nutrient value. But it is considered significant to examine adaptability of new fodder crops such as Alsike Clover (Trifolium hybridum L.) and Birdsfoot Trefoil (Lotus Corniculatus L.) and so forth.

(3) Estimation of Nutrients Requirement

It is important to know a suitable nutrients requirement for each animal's performances in order to save green fodders resources or to get more production. In Egypt, feeding standard which has

been used is that recommended by Kellner, Mollgard and Ghoneim. As a measure of daily nutrients requirement, starch equivalent (SE) and digestible protein (DP) is used. Daily requirement for maintain and production is vary with the live body weight and amount of milk production of the cattle.

Ordinary 100 kilograms of live body weight of cow requires 0.58 kilograms of starch equivalent and 50 grams of digestible protein and 0.51 kilograms of starch equivalent, 50 grams of digestible protein for buffalo, respectively.

Additional nutrients should be offered in accordance with the amount of daily milk production and pregnancy period.

Estimation of nutrients requirement to be used for the Project was calculated based on the aforesaid feeding standard. Detail explanation is given in Appendix E.
(refer to Tables E2-1 to E2-6 in Appendix E).

(4) Number of Animals by Year

Number of animals in each year was calculated based on the fodder production, nutrients production, nutrients requirement. According to the results of calculation, in North Wahby 4,030 head (about one head per feddan) of baladi cow and buffalo which is converted using conversion factor as a adult cow, and as well, 2,010 head (about one head per feddan) in Com Osheem area for settlers would be introduced at the full development stage. In addition, three unit (3,000 head of adult cows) of friesian and one unit of baladi cow will be introduced to the Cattle Breeding and Fattening Farm in Com Osheem area
(refer to Tables E2-10 and E2-11 in Appendix E).

Some case study was also carried out taking into consideration a change of herd structure in number in the future as follows:

	Buffalo	Baladi
Case-1	30%	70%
Case-2	40	60
Case-3	50	50
Case-4	60	40
Case-5	70	30

In each case the number of sheep to be bred is fixed due to feed on stubble grazing and by-products.

(5) Production of Animal Products

1) Wahby Downstream Area and South Area of Lake Qarun

There are no data available showing the production of animal products in both areas. As a result, productions were estimated based on the number of slaughtered livestock and the number of animals taking into consideration herd structures by age and potentiality for productions. The following shows the estimated production in the both areas.

	Without Project	With Project	Incremental
Milk	5,877 tons	7,708 tons	1,831 tons
Beef	245 "	295 "	50 "
Sheep Meat	8 "	10 "	2 "

2) Newly Reclaimed Areas

The production of animal products in the newly reclaimed areas could be estimated based on the feedable number of cattle and potentiality for production.

As for Com Osheem area, the Department of Agriculture has a plan to establish "Cattle Breeding and Fattening Farm" in

order to breed good strains of cattle by crossing with friesian bulls. According to this project, three units of friesian (1,000 head per unit) and one unit of baladi cow will be introduced to 1,000 feddan area (net area) and the remainder will be disposed to the settlers who breed baladi cow and buffalo as made in North Wahby area.

As a representative of sheep and goats group, sheep is used for estimating breedable numbers by stubble grazing and by-products. Following show the animal production at the full development stage and production in each year are given in Tables E2-13 to E2-16 in Appendix E.

(Unit: tons)

	North Wahby	Com Osheem	Total
Milk	1,599	11,471	13,070
Beef	222	535	757
Sheep Meat	11	5	16
Wool	1,350	645	1,955

Note: Production in Com Osheem includes the amount from the Cattle Breeding and Fattening Farm.

The production in the case study taking into consideration a change of herd structure in number in the future was estimated as follows:

(Unit: tons)

	Milk	Beef
Case-1	13,153	753
Case-2	13,271	753
Case-3	13,348	753
Case-4	13,427	749
Case-5	13,537	752

(6) Forecast of Demand for Animal Products

The FAO statistical data indicate that the daily calory intake per capita in Egypt was 2,949 kilocalories during 1978 to 1980. The said data also suggest that the calory intake is concerned the

nutritive condition of Egyptian people is on a relatively high level in comparison with that in other countries specially in Africa and Middle East (refer to Appendix G2).

The "Statistical Indicators" published by the Central Agency for Public Mobilization & Statistics show that the annual per capita consumption of animal products in 1978 was 12.0 kilograms for meat and poultry, 47.5 kilograms for dairy products, 3.3 kilograms for eggs, 4.7 kilograms for fish, respectively. (refer to Appendix G2).

In accordance with an increase of population at the rate of 2.5 percent on an average during ten years, recently import of beef have been increasing.

Estimation of per capita consumption was carried out using regression equation and as a result 17.7 kilograms for meat and chicken and 49.1 kilograms for dairy products are calculated as of the year 2000.

Meanwhile, population in 2000 in the Fayoum Governorate and the whole Project Area is estimated at about 2.2 million and 124,000, respectively. In 2000, consumption of meat and chicken would be reached 2,200 tons and also 6,090 tons for dairy products in the Project Area. Since about 80 percent of the consumption of meat and chicken is occupied by red meat, consequently 1,760 tons of red meat will be consumed in the Project Area.

As mentioned in the section of animal husbandry 20,780 tons of milk and 305 tons of red meat would be produced in the Project Area, of which 13,700 tons of fresh milk would be transported to the Fayoum City in the form of fresh milk and other dairy products, as for the red meat 1,455 tons will be supplement by importation from other areas.

4.3.3. Plan for Marketing and Processing of Farm Products

(1) Marketing of Farm Products

According to the New Five Year Plan, the degree of domestic self-sufficiency on vegetable and fruits are forecasted at 99.4 percent and 100 percent, respectively in 1986/87.

The farm products with high marketability are tomato, watermelon, fruits, and milk. According to the information of the Central Wholesale Market in the Fayoum city, tomato and watermelon are the most sensitive crops on fluctuation of market prices. At present, about 86 percent of total production of tomatoes production in the Fayoum area is marked to outside the area.

The quantity of winter tomato to be produced in the new reclamation area correspond to about three percent of the total production in Fayoum. Several recommendations are made to keep a high marketability of tomato in future although its incremental production by the Project is not so much as compared with the total production in Fayoum.

The first is to promote the common marketing through the agricultural cooperatives. The second is to make grading of farm products by sized and quality by machinery to be introduced in the Project Area. Presently the selection and grading are made by young boys, and the quality and size are not uniform, and are different in accordance with the request of middlemen. Consequently, many losses occurs in harvesting. The third is to improve packing cages to decrease transportation losses. The fourth is the motorization of transport to decrease losses caused by the present limited number of motor cars in harvesting seasons. Export of fresh tomato produced in winter shall be important strategy of marketing in the Project Area. The tomato grading station would be projected as shown in Appendix D-5.

The quantity of fruits to be yielded in the reclamation areas correspond to 20 to 50 percent of the present production of fruits in Fayoum. The production of orange and guava can not meet demand in the Fayoum. This shortage would be resolved by the Project in future. Olive is almost transferred outside the Fayoum. The possibility on the processing of olive for pickle would be studied. The North Wahby and Com Osheem areas are considered as one of the most suitable place for mango production.

It is considered that mango is high class fruits and consumer price is comparatively higher than other fruits. Hence the consumption per capita has been stagnant. Though mango production would increase the marketable volume by this Project, it is able to contribute stabilization of market price.

At present watermelon is estimated as overproduction. However, since the yield per feddan is stagnant, the future produce in the Fayoum shall not meet an expanding demand due to increase of population. This Project would resolve this shortage.

Many friesian cow in the proposed Cattle Breeding and Fattening Farm would produce an amount of milk. Such milk would be processed in the factory proposed in the North Wahby area.

(2) Processing of Agricultural Products

Establishment of tomato processing factory on agro-industrial development by the Project is necessary to project tomato growers who will be suffered from overproduction in future. Tomato paste with high quality acceptable in the international market can only be produced from good quality tomatoes.

Tomatoes for processing would be supplied from the project area and overall area of Fayoum Governorate. Though there are many unknown-factors on supply of raw tomatoes, major material source for

processing tomato shall be considered based on the incremental production in the Project Area and overall area of Fayoum Government. Material collected from the overall area of Fayoum Governorate is conservatively estimated.

Alternative case studies on tomato paste factory capacities are shown in Table 4-7.

Material source for the tomato paste factory in alternative Case A is estimated at 6,900 ton per annum which is equivalent to 60 percent of the production in 1998 in North Wahby and Com Osheem areas taking into consideration quantity of high quality tomato.

Material source produced in Wahby Downstream Area and South Area of Lake Qarun in Case E and F is estimated based on the incremental production proposed at the full development stage in 1994 as the target of the material supply. The amount of material on Case E and Case F are estimated at 30 percent of total production or 4,995 ton and 40 percent or 6,660 tons, respectively. Material source for the factory combining the quantity of the Case A and the above in cases E and F are 11,895 tons and 13,560 tons, respectively, and daily capacity of both cases are 151.8 tons and 172.1 tons, respectively.

Average production of tomato in 1981/82 in Fayoum Governorate amounts to about 432,500 tons excluding Wahby Downstream Area and South Area of Lake Qarun. Part of the incremental production projected in 1998 is added to the material source. By using four percent of annual growth rate, the incremental production of 377,500 tons in Fayoum Governorate is forecasted. Out of the said incremental production 18,800 tons or five percent, 37,700 tons or 10 percent and 75,500 tons or twenty percent are considered as additional material source to that in the Project Area. The material source for the factory on Cases G, H and I are estimated at 32,360 tons, 51,260 tons and 89,060 tons per year, respectively

Table 4-7. Factory Capacity

(Unit: ton)

Alternative Case	Material Source	Available Raw Tomato per Year	1/ Capacity per Day	2/ Capacity per Hour
A	60% of North Wahby & Com Osheem	6,900	92	6.1
E	60% of North Wahby & Com Osheem and 30% of the in Wahby Downstream and incremental South Area of Lake Qarun	11,895	151.8	10.1
F	60% of North Wahby & Com Osheem and 40% of the incremental in Wahby Downstream and South Area of Lake Qarun	13,560	172.1	11.4
G	Case F and 5% of the incremental in Fayoum Governorate	32,360	337.1	22.4
H	Case F and 10% of the incremental in Fayoum Governorate	51,260	504.1	33.6
I	Case F and 20% of the incremental in Fayoum Governorate	89,060	836.7	55.8

Note: 1/ Capacity per day means quantity of tomato per day at the peak stage in dividing the monthly total by 25 days.
2/ Quantity of tomato per hour estimated based on a daily working hours of 15 hours with three shifts a day.

which the daily processing capacities are also calculated at 337.1 tons, 504.1 tons and 836.7 tons, respectively.
(refer to Appendix G-1.2)

Economic evaluation on alternative cases are conducted by using the profitable prices of LE 60, LE 80 and LE 100 per ton, respectively. As a result, the Case A is economically not feasible because of less material. The Case E shows EIRR of 9.3 percent with low price of material at LE 60 per ton and it can be said also unfeasible.

The alternative cases which the greater part of material is supplied from the outside of the Project Area, show economically feasible. EIRR of the Case G is evaluated at 28.6 percent in case of the profitable price of LE 60 per ton and at 14.2 percent in case of LE 80 per ton.

Although the Case G is economically feasible in conditions providing that the price of tomato is more than LE 80 per ton and about 75 percent of the material source shall be collected from the outside of the Project Area, the program of the tomato paste factory seems not practical for the execution by the Project. It is rather recommendable that the said factory is implemented by the other isolated project.

(3) Processing of Animal Products

There are no processing factories in Fayoum Governorate excepting 12 slaughterhouses which are neither hygienic nor modernized. The necessity to construct new factories for slaughtering and milk processing is well recognized by the Governorate personnel concerned. Actually, a Swedish team made a feasibility study on the establishment of slaughterhouses and milk factories in 1981, but the plan is not yet realized.

The animal breeding in Fayoum Governorate is very important to maintain soil productivity for crop production in supplying barnyard manures. Furthermore, Fayoum is located at 75 kilometers southwest of Cairo where is the biggest consuming area in Egypt. Actually, a great amount of vegetables, milk and live cattle are transported to Cairo every day. Such situation of Fayoum as a supplier of agricultural and animal products for Cairo would not be changed and its role goes on increasing with an increase in population in Cairo.

Therefore establishment of slaughterhouse and milk factory in the Project Area will be expected to contribute to increase of employment opportunities and to make improvement nutrient condition for the people's health. As mentioned in the Paragraph of "Animal Farming" following amount of milk and meat will be processed in the factories established in the Project Area of North Wahby. Some amount of milk should be offered to calves for nursing.

Amount of Animal Products for Processing

Milk	31,100 ton/year
Cattle	6,210 head/year
Sheep	1,230 head/year

4.3.4. Farm Management Plan

(1) Farm Size

The farm size disposed in North Wahby and Com Osheem areas after reclamation is decided taking into account the following conditions;

a. A sufficient income to manage a suitable living standard inclusive of education, capital funds, techniques, etc., should be ensured for the settlers;

b. A sufficient income should be given the settlers to be able to afford to rise living standard in future and the repayment of the amortization of lands and buildings etc.;

c. The farm size distributed to the settlers is generally from four to six feddan for most settlers, and from ten to 20 feddan for a limited graduate settlers. Since the graduate settler will be leader among settlers, the number of them should be limited and

d. Alternative studies on net income by different farm sizes are carried out as follows.

Item	Alternative of Land Disposal (feddan)						
	3.0	4.0	5.0	7.0	10.0	15.0	20.0
Gross Income	5,280	7,040	8,805	12,330	17,610	26,415	35,220
Production Cost	1,580	2,110	2,645	4,500	7,790	13,332	17,024
Farm Income	3,700	4,930	6,160	7,830	9,820	13,083	18,196
Amortization	910	1,130	1,360	1,810	2,830	4,100	5,370
Water Charge	300	400	500	700	1,000	1,500	2,000
Disposal Income	2,490	3,400	4,300	5,320	5,990	7,483	10,826
Cost of Living	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Balance	-510	400	1,300	2,320	2,970	4,483	7,826

Note: The forecasting living cost of farmhousehold in 2000 is estimated by using annual growth rate of GDP per capita based on the Five Year Plan.

The following farm size to be distributed to the settlers is recommended in consideration of the above-mentioned matters;

Small holders ..... 5 feddan

Graduates

Graduates from agricultural secondary schools . 15 feddan

Graduates from universities ..... 20 feddan

(2) Cropping System

According to the alternative studies mentioned in Chapter 4.3.1., which analyses the farm income, labor distribution, and

irrigation water management in critical seasons, upland crops, animals and fruits would be managed by one farmhousehold to be settled. Irrigation water would be supplied by drip or sprinkler system. One farm lot would be divided into two, one for crops and the other for fruits farming. Moreover, the field for crops farming is divided into three field lot in consideration of the three-year rotational farming. (detail is given in Chapters 4.4.1 and 4.4.2)

(3) Farm mechanization and Farm Labor Balance

As a result of labor balance study, the following farm machines would be necessary for the newly reclaimed area.

	Total	Reclaimed Area	Cattle Farm
Tractor, 65 ps class	25 units	18	7
Moldboard plow	10 "	7	3
Rotavator	11 "	5	6
Tooth harrow	10 "	7	3
Ridger	11 "	11	-
Cultivator	2 "	2	-
Sprayer, 600 cc	10 "	10	-
Thresher, small size	10 "	10	-
Forage harvester	8 "	-	8
Manure spreader	4 "	-	4
Broad caster	4 "	-	4
Farm wagon	8 "	-	8

A tractor with a rotavator would be introduced for plowing and grading. The rotavator can plow and stamp at the same time so that it has high working efficiency. However, its blade is shortly used up and the plowsole would be arised. So that a plow will be used for breaking the plowsole after two years using the rotavator. For disease protection, group work by a sprayer is recommended. For threshing wheat, a thresher will be used. A cooperative organization for management of those machinery should be established in each hamlet and also should be well maintained at the work shop.

Labor power of a small sized farmhousehold is not sufficient at the peak farming period so that seasonal hired labor would be necessary. As for a middle sized and a large sized farmhouseholds, four to five employed labors for the former and seven to eight employed labors for the latter farmer would be necessary through the farming period.

4.3.5. Agricultural Supporting Institution

(1) Extension Services

An inspector would be selected among the deputy inspectors in the district office, and would be in charge of instruction and management of agricultural extension. Furthermore, an agriculture engineer for the extension work is appointed for villages, and agricultural supervisors are responsible for the practical extension of villages.

One agricultural supervisor covers an area of 500 feddan so that about 15 agricultural supervisors would be necessary in the newly reclaimed area. To promote the activities of agricultural supervisors, it is proposed various training, increase in number of vehicles and inspection of the demonstration farm or modernized agriculture in the desert lands. And they should be concern about the marketing. For the sufficient transfer of agricultural technique by agricultural supervisors to farmers, visual education is recommended.

(2) Cooperative Activities

According to the law (No. 122/1980), a multipurpose cooperative should be established in the cultivated area of each 750 feddan to promote agricultural production. In the newly reclaimed area, one land reclamation cooperative and its branches would be established. They are in charge of the following matters;

- Study and decision of cropping pattern;
- Selection of seedlings, fertilizers and agricultural chemicals;
- Introduction and lending of farm machinery;
- Transmission of marketing information;
- Services of commodities necessary for agricultural production;

- To mobilize idle private capital;
- To make employment opportunities for landless farmers and
- To educate the farmers participating in the Cooperatives to be independent farmers.

A specialized cooperative for animal husbandry would be established with the multipurpose cooperative, and be in charge of the following matters;

- Introduction of cattle;
- Transmission of information about animal health, diseases, breeding, production of forage crops and so forth;
- Services of commodities necessary for animal husbandry and
- Management of the slaughterhouse and the milk factory in cooperation with the Government and the Governorate.

4.3.6. Model Farm

Model Farm in the agricultural development project aims to promote the situation in engineering and in sociology for the development. The Project is composed of two major components which are to reclamation project in the desert area and the improvement project in existing cultivated land. For the successful implementation of the Project, establishment of the model farm is significant role, especially for the agricultural development in the area.

The reclamation of the desert area and irrigated agricultural development by introducing modernized irrigation facilities and techniques would be the first experience in this area. Most farmers to be settled in the Project Area have no experience in the said facilities and farming, too.

For successful implementation of the Project and for fruitful development of the Project Area the training and practice in relation with these matters will be quite necessary. In advance to the implementation of the entire Project, the establishment of the "Model Farm" in Com Osheem area is eagerly proposed. The Model Farm will function for the Project as the promotor of the Project and leader/pilot of the development of the area. The function of the Model Farm will be beneficial not only for the Project Area but also for the other areas in Fayoum depression since Fayoum Governorate has various strategies to develop desert areas located at the rim of the depression. The Model Farm will function as the right pilot for the said development.

The location of the Model Farm is selected at part of Com Osheem area, taking into consideration the easiness in constructing water source facilities and land acquisition and use. An area of 310 feddan (130 ha) in gross and 250 feddan (105 ha) in net arable land will be necessary for the Model Farm. (Refer to Appendix H-8)

The major functions of the Model Farm are expected as follows;

a. Demonstration and practice operation of modernized irrigation facilities;
b. Operation and maintenance of the new facilities
c. Water management with modernized irrigation facilities;
d. Agricultural practice with livestock farming in the newly reclaimed areas by using new facilities and agricultural machineries; and
e. Training of farmers, leaders, staff of the Land Reclamation Cooperatives, and officials concerned for each items mentioned above.

For these purposes, the Model Farm should be provided with the following components;

a Reclamation of 310 feddan (130 ha) of the desert;

b. Construction of irrigation facilities;

c. Construction of social infrastructure;

d. Provision of agricultural machinery, construction equipment and materials;

e. Training and demonstration facilities; and,

f. Research, laboratory and administrative office buildings.

4.4. Physical Planning

4.4.1. North Wahby Area

(1) Reclamation

As described in Chapter 4.2.5 "Reclamation Plan", the reclamation of desert area would be undertaken by three stages of works before starting cultivation of crops, which are deep harrowing, soil dressing and leaching. The reclamation works will start after construction of road network.

1) Deep Harrowing

Deep harrowing would be made by bulldozer (capacity of 32 ton class) with a ripper by means of cross ripping at the initial stage of the reclamation.

There exit layer of hard pan in the area and the said layer should be ripped otherwise the cultivation can not be commenced. The effective initial leaching can also be made through the deep harrowing.

Taking into consideration that hard pan layer reverted back nearly to its initial form upon irrigating, it is recommended to repeat the said harrowing once every three to four years during the cultivation.

2) Initial Soil Dressing

After the deep harrowing, the initial soil dressing would take place and it schedules to supply soil dressing materials gotten from the dike along Bahr Wahby in a basis of 30 tons per feddan for the entire area in North Wahby.

As for improvement soil alkalinity, application of gypsum is estimated at one ton per feddan in a half of North Wahby area as safe due to a study conducted by the basis of the semi-detail soil survey.

3) Initial Leaching

Initial leaching will be taken place from the highest area of reclamation area by spreading water by sprinkler to be introduced to the project as the on-farm irrigation facilities.

After the initial leaching of the reclamation area, cultivation will be followed.

(2) Irrigation Facilities

1) General

The available water of the Area is the re-use water from the Batts Drain and the water will be discharged at the just upstream of the Abudul Hadi weir of the Bahr Wahby, located at the far-eastern part of the Area. The water quantities are assumed at 4.5 cubic meters per second through 24 hours and the salinity concentration of the mixed water with the Bahr Wahby water are assumed at around 800 parts per million.

The irrigation method applied in the Area are both sprinkler and drip irrigation one. The ratio of application of each irrigation method in the Area are 62.5 percent for the sprinkler one and 37.5 percent for the drip one.

The Area will be divided into 18 villages and its average-size is around 283 feddan, based upon the rural development plan.

Considering the above-conditions, the following two comparative studies have been performed in order to determine the most appropriate plan for the Project.

a. Selection of Numbers of Pumping Station (Comparative Study A)

Considering the long and narrow shape of the Area, the following four cases are examined by model as follows (refer to Appendix H-1.1):

*	Case-I	Construction of	9 pumping stations
*	Case-II	- do -	6 pumping stations
*	Case-III	- do -	3 pumping stations
*	Case-IV	- do -	1 pumping station

b. Comparative Study of Water Conveyance System and Water Distribution System (Comparative Study B)

- The irrigation area is about three to 16 meters high and about 1.5 kilometers in average apart from the water sources.

- There is no available high land (more than 70 m above MSL) within or near-by the Area, where can make possible the sprinkler irrigation method will be done by gravity through ponds after pumping up the water from the water sources.

- The water from the water source shall be taken through 24 hours due to the re-use program of the Batts drain water.

- Easy operation and maintenance.

Considering the above conditions, the following two cases have been examined at the P3 irrigation system in North Wahby area as model (refer to Appendix H-1.2);

Case-A : Direct conveyance and distribution system through main pumping station with pressure tank

Case-B : Individual system of water conveyance and distribution providing both farm pond and booster pumping station with pressure tank

From the above-mentioned intake condition and irrigation hour of 16 hours a day at on-farm level, Case-A shall be obliged that main pumping station has three irrigation blocks as minimum size of irrigation division and also at least has to irrigate the three irrigation blocks per day through 24 hours operation.

On the other hand, main pumps for Case-B will be operated through 24 hours, however, irrigation hour of on-farm level will be done by 16 hours, since the farm pond is provided as regulating reservoir of the time lag of eight hours between main pumps and on farm.

As a result, the followings are found out,

- The construction of around six pumping stations are the most economical from the comparative study A.

- Case-A (Direct system) is the most economical, however, valve operation of on-farm level is a little bit complicated and 24 hours irrigation will be required.

Concerning the water conveyance and water distribution system it is recommended the direct system for water conveyance and water distribution from the view point of engineering and economy.

2) Design Discharge

Based upon the on-farm development plan, the conditions the main pumping station has three irrigation blocks as minimum size of irrigation system and has to irrigate the three irrigation blocks per day through 24 hour operation, the unit water requirement for all irrigation systems is estimated at 0.0268 cubic meter per minutes per feddan.
(refer to Appendix H-2.1)

Thus, the total discharge for main pumps and pipelines can be calculated as follows;

$$Q = qdo \times A$$

where, qdo : water duty in cu.m/min/feddan, 0.0268
A : net irrigation area in feddan

As for the unit discharge of each pump (qp) is estimated based upon the rotational operation of pumps (operation time of each pump is 16 hour on and eight hour off) due to the restriction of intake condition (24 hour intake).

3) Design of Intakes

Each intake is provided at Bahr Wahby for each pumping station and location of each intakes are selected under the following conditions;

- Re-use water from the Batts drain will be discharged at just upstream of the Abudul Hadi weir
- Nearest point to the irrigation area as much as possible
- No existing intake for outside of the reclamation areas
- Easy construction including feeder canal

Each intakes are consists of inlet, pipe culvert, outlet and, transition to the feeder canal. Model 54 of vents type, which is practiced generally in the areas, is provided for each intakes as regulating facilities.
(refer to Appendix H-3.1 and Drawing)

It should be noted that each design intake water level are estimated from the longitudinal profile provided by MOI, Fayoum without a consideration of increase amount of irrigation water from the Batts drain.

4) Design of Feeder Canals

Feeder canals are provided after each intake from the economical point of view, the technical point of view for the water hammer of pipelines and the operational viewpoint of pumping station. Each feeder canals are designed as an earth canal and cross-section of each feeder canal is designed after Kennedy formula, considering the velocity of each canals shall be fallen within the non-silting and non-eroding velocity.

As a result, the canal dimensions are adopted as bottom width of one meter, side slope of 1:1.5 and longitudinal slope of 1:2,000. (refer to Appendix H-3.1 and Drawings)

5) Design of Suction Pit

The suction pit consists of a transition and a suction pit. The shape of plan and longitudinal section are designed, taking into considerations the vortex in the pit shall not be appeared during the pump operation.

The suction water level for each pump is taken at the water level of the end of each feeder canal minus five centimeters as a loss head of screen. The reinforced concrete

type of structure is adopted for a suction pit and the wet masonry type of structure is adopted for a transition. (refer to Appendix H-3.2 and Drawings)

6) Design of Pumping Station

a. General

As mentioned before, the construction of around six pumping stations are the most economical from the comparative study and also the direct conveyance and distribution system through a main pumping station are selected as the recommendable plan, so that each main pumping station have to have three irrigation blocks (consists of three villages) as minimum size and have to irrigate the three irrigation blocks through 24 hours.

Taking into considerations the above, on-farm development plan, rural development plan, site conditions, construction and operation and maintenance, the construction of five pumping stations is determined. (refer to the Drawings)

b. Design of Pumps

- Number of pumps and unit discharge per pump

Based upon the design discharge mentioned in Chapter 4.4.1, and the operation and maintenance, six units with equal discharge is determined for P1, P2, P3, and P5 pumping station which have three irrigation blocks or villages as the irrigation division, while nine units with equal discharge is determined for P4 pumping station which has six irrigation blocks or villages. Daily operation hour of pump facilities is adopted as 16 hours. Moreover,

one stand-by unit of pump provided for each pumping station. (refer to Appendix H-3.2)

- Type

Studying on various types of pump, such as horizontal axis single suction multi-stage volute pump, vertical axis single suction multi-stage volute pump and vertical axis multi-stage mixed flow pump, the horizontal axis single suction multi-stage volute pump is selected as the most appropriate.

For the study, it is carefully considered cost is the cheapest among three type, easy maintenance works, no fear for the submergence from the flood, no problem for suction head (cavitation problem) and high pump efficiency of volute pump.

- Diameter of Pumps

Based upon the discharge per unit of pump and the total head required, the diameter of pumps for each pumping stations are determined at 200 millimeters for P1, P2, P3 and P5, and 250 millimeters for P4. (refer to Table H3-4 in Appendix H-3.2)

- Prime Mover

The pumps will be driven by electric motor since new sub-station for the Project will be constructed (refer to Rural Development Plan). The power required for each pumps is estimated at 90 kilowatts for P1, P2 and P3 pump station, 120 kilowatts for P4 pump station, and 110 kilowatts for pump station per unit based upon the unit discharge per pump and the total head required (refer to

Appendix H-3.2). The motor will be operated by 380 volts after receiving the power from 10.5 kilovolts transmission line through newly provided sub-station.

- Generator

Considering the unexpected power cut, the generator is provided for each pumping station. The generating capacity provided is a fourth of peak demand for each pumping station, considering the power cut is only continued for short time since the individual sub-station are going to construct for the Project.
(refer to Rural Development Plan)

- Operation and Control Method of Pumps

The manual operation, one-man control and on-off control with pressure tank are applied.

- Design of Pump House

In consideration of the enough space for pumps with motor, electric equipment, entrance for the equipment during the construction and operation and maintenance periods, space for the maintenance of pumps and the dimensions of each pump house is designed. The reinforced concrete type of structure with brick wall is adopted.
(refer to the Drawings)

Moreover, a guard house, fencing works and lighting facilities are provided at each pumping station.

7) Design of Conveyance Pipe and Distribution Pipe

a. General

As mentioned in the former paragraph, each main pumping station have to have three irrigation blocks (consists of three villages) as minimum size and have to irrigate the three irrigation blocks per day through 24 hours.

Considering the above, it is considered that two third of each irrigation blocks are irrigated always at the same time.

Due to the long pipeline, the pressure and discharge control facilities such as pressure relief valve and orifice plate are provided in order to distribute the irrigation water uniformly.
(refer to Appendix H-3.3)

b. Alignment

Taking into the considerations of on-farm development plan and operation and maintenance point of view, the conveyance pipes are buried at the shoulder of the trunk road, while most of distribution pipes are buried at the shoulder of the farm road. plan and operation and maintenance point of view, the conveyance pipes are buried at the shoulder of the trunk road, while most of distribution pipes are buried at the shoulder of the farm road.

The alignment of each irrigation system are presented in the Drawings and Appendix H-2.2.

c. Diameter of Pipes

Taking into consideration that the design velocity is around 1.5 to 2.0 meters per second and applying Hazen-Williams formula for pipelines, the diameter of pipes for each pipeline is estimated at 200 to 700 millimeters.

d. Kinds of Pipe Applied

For the selection of pipes for the Project, it is studied on various pipe such as ductile iron pipes, steel pipes, core type prestressed concrete pipes, asbestos pipes, unplasticized poly-vinyl chloride pipes (PVC pipe) and fiberglass reinforced plastic mortar pipes (FRPM pipes), considering the pipe diameter (200 mm to 700 mm), pipe laying plan and also the design water pressure.

Among those, steel pipes are rejected from its anti-corrosive characteristic against the saline water (around 800 ppm). Although the said pipes with mortar lining could be introduced, the damage during importation and construction seems to be unavoidable. Except steel pipe, the unplasticized poly-vinyl chloride pipes are determined as the most economical one for the pipe size of 300 millimeters or below so that unplasticized poly-vinyl chloride pipes will be applied for the pipes less than 300 millimeters as a rule. For the pipe sizes more than 350 millimeters under the give conditions, the available size for each kind of pipes is;

- Ductile iron pipe
  - 3rd class: 75 mm to 2,400 mm
  - 4th class: 350 mm to 2,400 mm

- Core type prestressed concrete pipe
  - 1st class: More than 500 mm

- Asbestos pipe:
  - 1st class: 250 mm to 600 mm

- FRPM pipe:
  - 1st class: 250 mm to 1,350 mm
    (Up to the design water pressure of 12 kg/sq.cm)

Among those, asbestos pipe is the cheapest, however, the damage due to the resistance against external forces (esp. live load and impact) has been observed in the past field experiences.

Consequently, the ductile iron pipe class III is selected for the pipes more than 350 millimeters as a rule as the most appropriate one considering the above-mentioned as well as the followings;

- The length of pipe, which has the diameter of more than 500 millimeters, is around 40 percent of the total length of pipe which has the diameter of more than 350 millimeters.

- One kind of pipes shall be applied from the maintenance point of view.

- Safeness of pipes when unexpected up-rise pressure occurs due to the water hammer of which figure is presently estimated at 40 percent of the static water pressure.

- First class of fiberglass reinforced plastic mortar pipe is not produced at present.

e. Pipe Laying

Considering the pipes with 200 to 700 millimeters diameter are laying at the shoulders of the road, the pipe laying is designed based on earth coverage of 60 - 80 centimeters and sand bed with 180 degree and thickness of ten to 20 centimeters. (refer to Drawings)

In case that pipes are crossing the road, the protection works, such as covering with reinforced concrete is required.

f. Related Structures

The following related structures are provided at each pipeline.

Valve

The sluice valve facilities are provided at an each junction in the pipeline, blow-off facilities and river crossing points. The valve of more than 400 millimeters in diameter shall be facilitated with by-pass. The valve box, which are composed of reinforced concrete slab, concrete block wall and manhole, are provided.

Blow-off

The blow-off facilities are provided at the concave point, beginning point of each ascending conveyance and distribution pipeline, and end point of each descending distribution pipeline. The diameter of blow-off pipe will be 1/2 to 1/4 of main pipes. The blow-off box is provided.

Air Valve

The air valve facilities are provided at convex points in the pipeline, the beginning point in the descending pipeline, just downstream of sluice valve facilities and every 400 meters in the level portion of long pipeline. The high speed air valve is adopted and the valve box, which are composed of plain concrete bed, precast concrete pipe and manhole, is provided.
Further details are presented in Appendix H-3.3.

(3) Drainage Facilities

As discussed in the previous Chapter 4.2.7 "Drainage Plan", notwithstanding the provision of drainage facilities are not required in the reclamation area during a period of about ten to 15 years after completion of the reclamation and commencement of irrigated agriculture, it is proposed to construct the open drainage canals along the boundary between the reclamation area and the existing cultivating land.

The open drainage canal has 18.1 kilometers long in total and it will be connected to the existing drains.

Aside from the above mentioned drainage canals, 15 places of observation wells should be installed in order to confirm formation of groundwater or appearance of groundwater table in North Wahby area.

(4) On-farm Facilities

1) Farm Consolidation

a. Farm Unit

There are some units of farmland. The minimum sized unit for farming is called a field lot. To decide the shape of the field lot, the study has been carried out taking into consideration the following factors:

- Use of farm machinery
- Labor's working efficiency
- Irrigation methods
- Topographic conditions
- Land tenure

Consequently, 100 meters is adopted as the length of the standard field lot mainly involving the workability of labors for vegetable cultivation and the hydraulic conditions of irrigation method. The land tenure of a farm household is at 5, 15 and 20 feddan. However, there is a plan that 25 percent of the land is for fruit cultivation at the special block in cooperation with several households, and the rest of 75 percent of the land is for three year rotational cultivation. Therefore, the shape of the standard field lot is decided at 100 x 52.7 meters (1.25 feddan). And the shape of a farm lot which is comprised of three field lots for three year rotational cultivation is at 100 x 157.5 meters (3.75 feddan).

A block which is comprised of several farm lots is called a farm block. To decide the shape of farm block, the following factors have been studied;

- Arrangement of roads
- Distance between farmers' house and their farm land
- Rotation irrigation

Consequently, the shape of farm block is decided at 315 x 800 meters, that is, 60 feddan which is comprised of 16 field lots. The largest unit is called a irrigation block which is comprised of four farm blocks of 240 feddan, 60 feddan for fruit cultivation and 180 feddan for three year rotational cultivation.

b. Road

Roads in the Project Area are classified as a trunk road, branch roads and farm roads depending on their respective functions.

The main features and the total length of each proposed road are summarized below.

	Trunk Road	Branch Road	Farm Road
Total width	12.0 m	8.0 m	5.5 m
Effective width	8.0 m	6.0 m	4.0 m
Pavement	Gravel	Gravel	none
Percentage of chamber	2.5%	2.5%	2.5%
Total length	16.0 km	1.7 km	106.3 km

c. Windbreak

Casuarina is planted as a windbreak to protect the strip of adjacent land and crops from strong wind. Windbreak is allocated along roads, both sides of the trunk road and one side of the other road.

d. Irrigation

Irrigation water comes to the field through pipelines which are laid under the shoulder of each road. The size, length and allocation of the pipes are determined by irrigation methods and systems.

e. Drainage

The groundwater level in the Project Area is not high excepting some portions. The possibility of soil salinization caused by groundwater capillarity is imperceptible. And also, sprinkler and drip irrigation systems which do not need much irrigation water are introduced so that it is not considered to take any special countermeasures for field drainage at the early stage of the development.

2) Field Irrigation Facilities

a. Selection of Irrigation Methods

In general, irrigation methods are categorized as follows;

Surface irrigation	Furrow method
	Border method
	Basin method

Sprinkler irrigation ..... Hand move type
Solid type
Side wheel type
Central pivot type

Drip irrigation

To select a suitable method for the Project, the factors of topographic conditions, wind, crop varieties, quantity of water, construction cost and so forth have been taken into consideration.

Consequently, the sprinkler irrigation (hand moved type) method for forage crops and field crops, and the drip irrigation method for fruits and vegetables are selected for the Project.

b. Basic Criteria of Irrigation

- Irrigation Water Requirement

Irrigation water requirement in summer peak are as follows;

* Sorghum (Sprinkler irrigation)
  8.44 mm/day / 0.85 = 9.93 mm/day

* Watermelon (Drip irrigation)
  6.32 mm/day / 0.9 = 7.02 mm/day

* Groundnuts (Sprinkler irrigation)
  5.66 mm/day / 0.85 = 6.66 mm/day

* Fruit (Drip irrigation)
  5.22 mm/day / 0.9 = 5.80 mm/day

- Application Efficiency

Application efficiency in the field is as follows;

*	Sprinkler irrigation	0.85
*	Drip irrigation	0.90

- Rooting Depth

The rooting depth of crops are 120 centimeters for fruit trees and 100 centimeters for other crops based on FAO Irrigation and Drainage Paper No.24.

- Irrigation Interval

On the basis of available soil water and crop evapotranspiration, the irrigation interval in summer peak has been computed at four days based on the data from FAO Irrigation and Drainage Paper No.24.

- Water Requirement per Irrigation

Water requirement per irrigation is determined as follows;

*	Sorghum	9.93 mm/day x 4 days = 39.7 mm
*	Watermelon	7.02 mm/day x 4 days = 28.0 mm
*	Groundnuts	6.66 mm/day x 4 days = 26.6 mm
*	Fruit	5.80 mm/day x 4 days = 23.2 mm

- Irrigation Hours

In the peak irrigation period, the maximum irrigation hours are 16 hours per day.

c. Rotation Irrigation

An intermittent operation will be carried out for the Project applying an irrigation interval of four days in summer peak. Scale of rotation blocks is determined to ease the water management and to decrease the construction cost taking into consideration three year rotational cultivation and irrigation facilities. One rotation block for three year rotational cultivation is 7.5 feddan comprised of two farm lots, and that for fruit cultivation is 15 feddan comprised of four farm lots.

d. Model Plan of Irrigation

Model plan of irrigation by sprinkler and drip system is designed. The unit water requirement is computed as follows;

Fruit area (Drip)	:	0.0227 cu.m/min/feddan
Three year rotation area	:	0.0413 cu.m/min/feddan

Dimension of the sprinkler irrigation model is computed by using 8.44 millimeters per day of ETcrop (Sorghum) as follows;

Amount of irrigation	:	39.7 mm
Irrigation hours per day	:	16 hr
Movement per day	:	3 times
Irrigation hours per placement	:	5.33 hr
Irrigation area per day	:	3.75 feddan
Sprinkler interval	:	12 m x 18 m
Sprinkler discharge	:	28.5 lit/min
pressure	:	2.5 kg/sq.cm
spray diameter	:	28 m

Irrigation intensity	:	7.6 mm/hr
One rotation block (4 days interval)	:	5.0 feddan

Dimension of the drip irrigation model for fruit is computed by using 5.22 millimeters per day of ETcrop as follows;

Amount of irrigation water	:	23.2 mm
Irrigation hours per day	:	16 hr
Plant interval	:	5 m x 5 m
Dripper capacity	:	36 liter/hr
Amount of flowing per one line	:	10.8 liter/min
One rotation block (4 days interval)	:	15 feddan

Dimension of the drip irrigation model for vegetable is computed by using 6.32 mm/day of ETcrop (Watermelon) as follows;

Amount of irrigation water	:	28.0 mm
Irrigation hours per day	:	16 hr
Movement per day	:	2 times
Irrigation hours per time	:	8 hr
Plant interval	:	0.5 m x 1.2 m
Dripper capacity	:	2 liter/hr
Amount of flowing per one line	:	6.0 liter/min
One rotation block (4 days interval)	:	2.5 feddan

(5) Agro-industry

1) Introduction

At present, processing of agricultural products in Fayoum Governorate is carried out on a small-scale basis such as the government operated date processing factory at Biyahmo.

Processing of vegetables grown in the Nile Delta region is done by two governmental companies Kaha and Edifina the closest factory to Fayoum is located in Giza Governorate. At the factory, besides vegetables, fruits can also be processed. Presently, the factory is operating at far below capacity and it is possible to procure products from other areas for processing.

The major portion of the crops selected to be cultivated in the Project Area are planned to be marketed as fresh produce, however, it is necessary to also consider whether a portion could be transported to the above mentioned factory for processing or whether a new factory for processing them is required by the Project.

2) Availability of Materials

Since the Project Area enjoys favorable climate, soil and marketing conditions as well, the proposed crops for vegetables and fruits have been selected considering these favorable conditions and ones which will give high benefits were chosen. Therefore, crops which are meant only for processing were not selected. In studying the possibility of processing production from the Project Area only those crops which might be in surplus were considered.

Tomato is selected for the Project because of its processing versatility, amount of production and perishability.

3) Tomato Processing

As mentioned in Chapter 4.3.3. and Appendix G-1.2., alternative case studies on the tomato paste factory are conducted taking into consideration the available of material source and the profitable prices of tomato for the management of the factory.

As a result, provision of the tomato paste factory in the Project is not recommended from the engineering and economical points of view.

4) Production of Animal Products

As mentioned in Chapter 4.3.2, production of animal products in the Project Area are estimated as follows:

	Milk (tons)	Beef (tons)
North Wahby	1,599	222
Com Osheem	11,471	535
Wahby Downstream area and South Area of Lake Qarun	7,708	295

But when an annual capacities of slaughterhouse and milk factory are decided, the Cattle Breeding and Fattening Farm in Com Osheem which have been carried out by Department of Agriculture since 1983, should be taken into account.

Department of Agriculture expects to establish eight units of Cattle Breeding and Fattening Farm in Com Osheem area for four years, of which four units would be included to the Project.

According to the Department of Agriculture one unit have 1,000 head of cattle and items of eight units are as follows;

Baladi Cow	1 unit
Buffalo	1 "
Friesian	6 "

As a result of calculation conducted taking into account these remaining four units and animal products from the Project Area and amount of milk to be offered to calves for nursing, 31,100 tons of milk would be processed.

In the same manner, 6,200 head of cattle and 1,230 head of sheep will be slaughtered and dressed in the proposed slaughterhouse.

5) Commodities of Products

Fattened cattle will be slaughtered and dressed and some of them stored in the freezing room.

Milk will be processed into drinking milk (UHT milk), yoghurt and white cheese taking into consideration Egyptian peoples' preferences.

6) Capacity and Location

Supposing these facilities operate 300 days annually, daily capacity of slaughterhouse and milk factory is estimated as follows;

Slaughterhouse	25 head of cattle and sheep
Milk Factory	104 tons

As for location, it is considered that a portion along the road to Cairo in the North Wahby area will be suitable for transportation of raw materials and processed commodities.

7) Costs

The capital including price contingency cost for the slaughterhouse is estimated at LE 2,310,000 and LE 7,700,000

for the milk processing factory, respectively. In estimating the processing equipments costs, the standard equipment have been taken into consideration and priced at CIF at Alexandria Port.

8) Operating Costs

Operating costs will be composed of material costs and overhead cost. Gross cash flow calculation was carried out based on the assumptions of the material costs that prices of raw milk are LE 0.25 and LE 0.20 per kilogram and prices of cattle are LE 1.50 and LE 2.00 per kilogram of live body weight. (refer to Tables G2-8 and G2-13 in Appendix-G)

9) Financial Evaluation

Financial evaluation was carried out taking into consideration commodities price, project life of 25 years, construction period and so on. Replacement cost for vehicles and equipments is estimated at five years and ten years, respectively.

Followings show the results of financial evaluation.

Milk Factory		Slaughterhouse	
Raw Milk	FIRR	Cattle	FIRR
LE 0.25/kg	22%	LE 2.0/kg	-1%
LE 0.20/kg	41%	LE 1.5/kg	28%

10) Layout of Factories

The factory would need to have a well-equipped laboratory staff and veterinarians for carrying out check and control of the incoming raw-milk quality and animals to be slaughtered. They also control processing operation and monitoring of the quality of products leaving factories. Layout of the milk processing factory and slaughterhouse is given in the Appendix G.

(6) Rural Development

1) Settlement Plan

a. Settlement Form

The administrative organization in Fayoum Governorate is divided into five levels, namely government, district, local unit, village and hamlet. There are five districts and 37 local units in Fayoum Governorate.

One local unit has a population of about 30,000 and many public facilities and infrastructures are located there. One village has a population of about 8,500 and an area of about 4,300 feddan on the average in Tamiah and there is a primary school, stores and mosques. One hamlet is comprised of approximately 20 to 30 households and the houses are gathered together in a central place.

North Wahby and Com Osheem areas will be comprised into a part of Tamiah upon execution of the Project, so that the administrative organization in the Project Area should be basically the same as the present system stated above.

Therefore, the settlement plan of the two areas is made based on the existing system. Furthermore, three organizations of local unit, village and hamlet will be settled taking into consideration the operation and maintenance of agriculture or water management.

- Local Unit

One local unit will be settled in the Project Area. Public offices and the office of infrastructures will be established at the center of the Area.

- Village

One village will be established in North Wahby area. At the center of the village, a primary school, a store and a branch office of the agricultural cooperative association will be established.

- Hamlet

The hamlets will be comprised of about 30 households (average 280 feddan) gathered together in a central place. A mosque will be established in four or five hamlets.

b. Alignment of Settlement

The center of the Local Unit will be located in an area along the Cairo Highway in North Wahby area as a unit of North Wahby and Com Osheem areas. There will be one village in North Wahby area taking into consideration the size and the distance to and from the primary school. There will be 18 hamlets of about 30 households each considering the topographic conditions and the alignment of the road.

c. Household and Population

Number of household in the Project Area is as follows:

Name	Number of household
Small Farmer (5 feddan)	442
Large Farmer (15 feddan)	74
Large Farmer (20 feddan)	55
Sub Total	571
Non-Farmer	80
Total	651

The number of farmers' houses is 571 and that of non-farmers' houses is 80 giving a total of 651 households and a total population of 3,255. The population has been estimated based on the assumption that one household has five persons. The average number of farmers' houses in each hamlet is 32 which has a population of 160.

2) Housing

Five types of houses are planned such as small farmers' houses, large farmers' houses, director's houses, technician's houses and laborer's houses.

The lot of the small farmer's house is 220 square meters, and it has 34 square meters of building area. The lot of the large farmer's house is 350 square meters and it has 46 square meters of building area.

Minimum required building size is planned at the early stage of development, however the area has enough space for expansion in the future. All the houses are planned to be made of brick walls with wooden roofs.

3) Infrastructure

a. Village Facilities Plan

- Settlement

The administrative organization in the Project Area will be comprised of the local unit, village and hamlet. At the center of the local unit, a development office, primary and preparatory school, medical clinic, post office, etc. are established.

- Education

  Two primary schools and one preparatory school will be built in North Wahby area and each school has an enrollment of about 250 students or six classes. After preparatory school, they will attend the secondary school in Tamiah city.

- Health

  A medical clinic is built in the town.

- Mosque

  Mosques are provided by the Government. Four mosques are built in North Wahby area. One mosque has charge of about 160 households.

- Agricultural and Irrigation Services

  Agricultural extension service and O & M of irrigation are executed by the agricultural cooperative association which will be established in the town. A representative person of the cooperative association is selected from among the farmers at the village and the hamlet levels.

- Commercial

  Several stores will be established in the town and one store at the center of the village.

- Others

  A police station, a fire station, a post office, a bank and a telephone office are established as social service facilities in the town.

b. Road Network

Three types of roads; trunk road, branch road and farm road will be constructed in the Project Area. A trunk road with a width of 12 meters will pass through the middle of the Project Area and be connected to the roads to Tamiah and Aslan. This road is a important connecting road to Tamiah city which is the center of the district.

Branch roads with a width of eight meter connect the trunk road with the hamlets. Farm road with a width of 5.5 meters is used for access to the farm land. The length of the trunk and branch roads are 16 kilometers and 1.7 kilometers, respectively.

c. Potable Water

- Water Quantity

In Fayoum about 60 liters per day per person is supplied at the present. However, extension of the treatment plant is planned because of lack of water quantity. In the Project Area, water quantity per person is planned at 100 liters per person based on the future plan in Fayoum. Estimated water requirement is decided taking into consideration 20 percent increase in population, 50 liters per day per head for cattle and irrigation water for the trees in the housing lot. Total estimated water requirement of North Wahby and Com Osheem areas is 950 cubic meters per day.

- Water Supply

Existing water supply facilities extend to near Bahr Wahby. However, the pipe facilities are not enough to

supply sufficient water to both areas of North Wahby and Com Osheem, though there are potable water treatment plants in Fayoum and Tamiah. Therefore, a new water treatment plant is established at the upper stream side of Bahr Wahby in the Project Area, for supplying water to the area.

The potable water treatment plant which will be established to have a capacity of 1,100 cubic meters per 16 hours a day including ten percent water loss. The total length of the pipeline is estimated at about 16 kilometers.

d. Sewage System

Treatment methods of sewage from houses considered follows (a) to be conveyed by nearby ditch to outside of the area, (b) to be conveyed by pipeline to simple treatment facilities, or (c) to be conveyed by pipeline or trucks to a public sewage treatment station.

From the viewpoint of population in the hamlet and number of hamlets in the area to be reclaimed, it is not considered necessary or economical to construct a public sewage treatment station. Therefore, method (b) above sewage from each house is conveyed by pipeline to the simple treatment facilities located around the hamlet for its settling and evaporation is most suitable for the Project.

e. Electrification

Consumptive electric power in the Project Area will be about 1,100 kilowatts for houses and offices, and about 4,200 kilowatts for irrigation pumps and potable water station. This electric power is supplied from Tamiah

sub-station of transformer which will be completed in 1986 to the Project Area with 66 kilovolts ampere and it is transformed from eleven kilovolts ampere to 380 volts ampere or 220 volts ampere at the entrance of the hamlet.

f. Telephone

At least, 30 telephone lines is necessary in the town and one village. The line is from Tamiah station to the telephone office in the town, and then to each house and office.

4) Construction Schedule

The construction will be implemented from 1987 to 1992. Settlement order is as follows;

1st year	195 households
2nd year	261 households
3rd year	195 households

4.4.2. Com Osheem Area

(1) Reclamation

Taking same way of work as North Wahby area, the reclamation works would be made by the deep harrowing and followed by the initial soil dressing and the initial leaching.

1) Deep Harrowing

For the first stage, an unit of bulldozer (32 ton class) with a ripper would be provided in Com Osheem area and cross ripping would be made in the area. During the cultivation of crops, the said deep harrowing should be repeated once every three to four years as mentioned in North Wahby area.

2) Initial Soil Dressing

The same procedures and the same quantities of soil dressing materials as explained in North Wahby area are also proposed in Com Osheem area, too.

3) Initial Leaching

The same way with North Wahby area of the initial leaching are recommended in Com Osheem area.

(2) Irrigation Facilities

1) General

The Com Osheem area is located at the right bank of the Gomhouria canal and its gross area and net irrigable area are 3,390 feddan and 2,750 feddan, respectively. (except to Model Farm)

Referring to 1 to 10,000 topographic map, the area lies at the desert land around 1.1 kilometers from Gomhouria canal up to the southern project boundary except the far eastern portion of the area of which southern boundary lies along the Canal.

The shape of the area is long from east to west, and a farm of about 600 feddan owned by a private enterprise is located at the central southern part of the area, dividing the area into two.

Most of the irrigation area extends at an elevation ranging between 15 to 28 meters above the mean sea level.

The land slope of the area is rather steep, and its gradients are 1/120 to 1/180. The direction of slope are

descending from west to east at the eastern portions from the point about 3.5 kilometers west of the National Highway (Cairo-Fayoum) and at the western portions of the above-mentioned point, the land descends from north to south.

The available water of the area is the same as North Wahby area. However, intakes will be provided at Gomhouria canal, one of the branch canals of Bahr Wahby.

The irrigation method applied in the area are both sprinkler and drip one. The ratio of application of each irrigation method is 73 percent for sprinkler and 27 percent for drip due to the introduction of the Cattle Breeding and Fattening Farm located at the eastern portions of the area (925 feddan in gross).

The area is divided into nine villages except the aforesaid Farm, based upon the rural development plan.

2) Design Discharge

The unit water requirement applied are;

- P6 irrigation system (Cattle Breeding and Fattening Farm)

  qdo_1 = 0.0352 cu.m/min/feddan
  (refer to Appendix H-2.1)

- P7 and P8 irrigation system (only irrigation area)

  qdo_2 = 0.0268 cu.m/min feddan
  (refer to Appendix H-2.1)

3) Design of Intake

Each intakes are provided at Gomhouria canal for each pumping station and location of each intakes are selected under the condition described in Chapter 4.4.1 and also irrigation system shall be provided at outside of the public enterprise area. Model 36 vents of type is provided for each intakes as regulating facilities. (refer to Appendix H-31 and Drawings)

4) Design of Feeder Canals

A feeder canal is provided at only P8 irrigation system, since the elevation of intake site at P6 and P7 is already high enough and the topography. A feeder canal is designed as a earth canal under the condition described in Chapter 4.4.1. and the canal, which have the bottom width of one meter and the bottom slope of 1/2,000, is adopted.
(refer to Appendix H-3.1 and Drainage)

5) Design of Suction Pit

The shape of plan and longitudinal section are designed, considering the vortex in the pit shall not be appeared during the pump operation.

6) Design of Pump Station

a. General

Based on the same reasons mentioned in Chapter 4.4.1, the construction of three pumping stations is determined especially from the restriction of the public enterprise land and also each pumping station have to have three irrigation blocks (three villages) as minimum size of irrigation division. The location of P6 and P7 pumping

stations are near-by Gomhouria canal and the P8 pumping station is located at the Project Area.
(refer to the Drawings)

b. Design of Pumps

- Number of Pumps and Unit Discharge per Pump

Based upon the same idea as mentioned in Chapter 4.4.1, six units with equal discharge is determined for all pumping stations. One unit for each pumping station is provided for stand-by from the view point of emergency.

- Type and Diameter of Pumps

The horizontal axis single suction multistage volute pump is selected as the most appropriate from the same reason mentioned in Chapter 4.4.1. Based upon the discharge per unit of pump and also total head required, the diameter of pumps for each pumping station is determined at 250 millimeters for P6 and P7 and 200 millimeters for P8. (refer to Appendix H-3.2)

- Prime Mover

The pump will be driven by electric motor. The power required for each pump is estimated at 130 kilowatts per unit for P6 pumping station, 160 kilowatts per unit for P7 pumping station and 110 kilowatts per unit for P8 pumping station, based on the unit discharge per pump and the total head required. (refer to Appendix H-3.2)

The motor will be operated by 380 volts for less than 150 kilowatts and 3,300 volts for greater than 150 kilowatts after receiving the power from 10.5 kilovolts transmission line through newly provided sub-station.

- Generator

Considering the unexpected power cut, the generator is provided for each pumping station, and the generating capacity provided is a forth of peak demand for each pumping station.

- Operation and Control Method of Pumps

Manual operation, one-man control, and on-off control with pressure tank are applied.

- Design of Pump House

Based upon the same criteria described in Chapter 4.4.1. the dimensions of each pump house is designed.
(refer to the Drawings)

7) Design of Conveyance Pipes and Distribution Pipes

a. General

The water distribution method is same as that of North Wahby area and alignment of pipes for each irrigation system is applied, based upon the same criteria as mentioned in Chapter 4.4.1.

b. Diameter of Pipes

Based upon the same criteria mentioned in Chapter 4.4.1, the diameter of pipes for each pipeline is estimated at 200 to 700 millimeters.
(refer to the Drawings)

c. Kind of Pipes Applied

From the same reasons mentioned in Chapter 4.4.1., the kind of pipes are applied that PVC pipes for less than 300 millimeters diameter and ductile iron pipes class III for more than 350 millimeters diameter.

d. Pipe Laying

The same criteria described in Chapter 4.4.1., are applied. (refer to Drawings)

e. Related Structures

The pipeline is provided with various related structures such as sluice value facilities, blow-off facilities and air value facilities (refer to Appendix H-3.3).

(3) Drainage Facilities

As discussed in the previous Chapter 4.2.7. "Drainage Plan" and in North Wahby area, construction of the open drainage canals are proposed in Com Osheem area. The total length of the said canals is 15.9 kilometers long.

The observation wells at ten places are also proposed to confirm the formation of groundwater and appearance of groundwater table in the area. (refer to Appendix F-3)

(4) On-farm Facilities

All the on-farm facilities and their design will correspond to those of North Wahby area. However, the area for livestock breeding is planned to be established in an area of 925 feddan in gross.

Only forage crops will be cultivated there so that drip irrigation system is not necessary. Sorghum and berseem will be cultivated by sprinkler system throughout the year. Yet, the size of each block is the same as that of North Wahby area. The total length of each proposed road is as follows;

Trunk roads :	8.3 km
Branch roads:	3.8 km
Farm roads :	98.0 km

(5) Agro-Industry

As discussed in the Chapter of North Wahby area, a plan for a processing of agricultural products is not recommendable in the area.

It would be advisable to transport agricultural products to the nearby Kaha factory for processing. However, animal products produced in the area will be transported to the factories to be established in North Wahby area.

(6) Rural Development

1) Settlement Plan

a. Settlement Form

Settlement form for Com Osheem area is the same as in North Wahby area. In Com Osheem area, there will be one village and several hamlets each comprised of about 30 households. A Cattle Breeding and Fattening Farm with an area of 925 feddan is planned in the Project Area and it is divided into four blocks. 17 officers from the Governorate will be settled in each block and will organize the hamlets.

b. Alignment of Settlement

Center of the local unit is settled in North Wahby area. 12 hamlets are organized into one village. Settlement in the hamlets will be established along the trunk road which runs through the middle of the Project Area.

c. Household and Population

Household and population in the Project area are estimated as follows:

Name	Number of Households
Small Farmer (5 feddan)	208
Large Farmer (15 feddan)	36
Large Farmer (20 feddan)	26
Sub-total	270
Non Farm	78
Total	348

Number of the farmers' houses is 270 households and that of non-farmers' houses is 78 households, which has a population of 1,740 in total.

2) Housing

The lot of the small farmer's house is 220 square meters, and it has 34 square meters of building area. The lot of the large farmer's house is 350 square meters, and it has 46 square meters of building area. All the houses are to be built of bricks with wooden roofs.

3) Infrastructure

a. Village Facilities Plan

- Settlement

Buildings which is built in the village and the hamlet are the same as North Wahby area. 17 houses are built in the hamlet of the Cattle Breeding and Fattening Farm.

- Education

One primary school is built at the center of the village.

- Others

Other facilities are shared with North Wahby area.

b. Road

A trunk road will be constructed through the middle of the areas and connected to the National Highway. The length of the trunk roads and the branch road are 8.3 kilometers and 3.8 kilometers, respectively.

c. Potable Water

In Com Osheem area, 320 cubic meters per day of potable water is required. It supplies to the Area coming through North Wahby area. Irrigation water is used for cattle in the Cattle Breeding and Fattening Farm.

d. Sewage

Sewage system is the same as North Wahby area.

e. Electric Plan

Consumptive electric power in the area is planned at about 620 kilowatts for houses and offices, and about 2,800 kilowatts for irrigation pumps. It is supplied through North Wahby area.

f. Telephone

At least, eleven telephone lines will be necessary for the primary school, the Cattle Breeding and Fattening Farm and the directors' houses.

4) Construction Schedule

The construction will be implemented from 1987 to 1992. Settlement order is as follows;

1st year	70 households
2nd year	122 households
3rd year	156 households

4.4.3. Wahby Downstream Area

Wahby downstream area is defined as an area suffering shortage of irrigation water and located at rather downstream of Bahr Wahby covering about 17,200 feddan (7,220 ha). To solve the recent problem in the area, the following countermeasures are proposed;

- Rehabilitation/renovation of the existing irrigation facilities;
- Construction of supplemental laterals and canal structures;

- Strengthening operation and maintenance system and organization and
- Establishment of model farm for betterment of water management.

(1) Rehabilitation/Renovation of the Existing Irrigation Facilities

The existing irrigation facilities are not functioning as originally designed. Design are theoretical made except measuring the flow. The whole irrigation system is provided based on proportional distribution of irrigation water without measurement and control by discharge basis. Therefore, the distortion of the irrigation facilities will take disproportionate distribution of irrigation water and accelerate the another distortion of the facilities. To restore the original function of the irrigation facilities, rehabilitation/renovation of the facilities, at the first, should be made with well cooperation of farmers concerned.

The existing irrigation facilities in the area are main canal of Bahr Wahby of 21.3 kilometers long, three branch canals of 10.1 kilometers long and seven lateral of 21.7 kilometers long. (refer to Appendix F-4) All canals would be rehabilitated by dredging the canal and by trimming the canal side slope. And canal structures would renovated or reconstructed to gain original function of the canal.

(2) Construction of Supplemental Laterals and Canal Structures

One of reasons for shortage of irrigation water in the area is unbalanced distribution which means that farms located at the upstream reach of Bahr Wahby are receiving irrigation water sufficiently while that at the downstream reach it will be shortage. Especially, farms received directory from Bahr Wahby are getting rather surplus water and number of such vents of Bahr Wahby are providing much troubles and a lot of obstructions for water

management. In this connection, construction of supplemental laterals aligned along Bahr Wahby in unifying some of vents directly receiving water from Bahr Wahby which is so-called "Ganabiah Canal" are proposed. Five such laterals or Ganabiah Canals should be constructed to take away the directly receiving vents along Bahr Wahby. (refer to Appendix F-4)

Besides, construction of two laterals such as "New Hayar Canal" and "New Koddoba Canal" are recommended.

Irrigation area neighboring Casr Rashuwan is receiving irrigation water through Bahr El Hayar and Bahr Koddoba and suffering much from the shortage of irrigation water. The said area is located along the sub-lateral canal which is extremely far from the intake of Bahr Wahby. Sub-lateral of Bahr El Hayar is extent from the end of Bahr Fanous which has 5.5 kilometers long and sub-lateral of Bahr Koddoba is connected with the end of the above-mentioned sub-lateral of Bahr El Hayar. Thus, long lateral or sub-lateral canal would provide farmers more difficulties to receive irrigation water sufficiently and timing. Construction of new laterals would present farmers in the area much happiness.

Total length of new Ganabiah canals proposed is 10.0 kilometers long and length of two new lateral canals is proposed at 7.4 kilometers long. (refer to Appendix F-4 and Appendix H-6)

(3) Improvement of Water Management

Aside from the above-mentioned problems on the irrigation system and facilities, present operation and maintenance system and organization should be improved and strengthened. Otherwise, even if the said system and relevant facilities could be upgraded or rehabilitated/improved, without proper operation and maintenance, the present problems on the shortage of irrigation water can not be solved.

One of ways for strengthening of the said system is to increase number of engineers in charge of operation and maintenance of the system in spite of assignment of numbers of policemen. And also training the said staff on proper water management would be conducted as described in the other chapter.

In addition to all countermeasures to solve the problems on the shortage of irrigation water, the final solution on this matter is supplying additional water resources. Supplemental water resources can be expected to receive from the program on the reuse of drainage water. According to the observation of discharge on Bahr Wahby, the upstream reach from Gerza (34.66 km) of Bahr Wahby is receiving a water duty of about 20 cubic meters per day per feddan while at the Bahr Green (49.71 km) it is about 14 cubic meters per day per feddan only on an average. (refer to Appendix B-2)

Available water resources for the project is expected at a discharge 4.5 cubic meters per second by lifting water of Batts Drain to Bahr Wahby. Out of 4.5 cubic meters per second, about 2.5 cubic meters per second of water will be supplied at the peak stage to the reclamation area in North Wahby and Com Osheem areas. The rest of water resources can be supplied to this area accounting about ten cubic meters per day per feddan as supplemental to the original water of Bahr Wahby. It will be enough irrigation water for maintaining crops in Wahby downstream area providing that proper water management shall be made.

4.4.4. South Area of Lake Qarun

South Area of Lake Qarun is defined as an area suffering directly and/or indirectly by the high water level of Lake Qarun and located along the south coastal of the lake covering farm land of about 6,770 feddan (2,830 ha). (refer to Appendix F-5)

(1) Improvement of Drainage Facilities

Run-off on the relevant catchment area is, the first, studied as discussed in Appendix F-5.

Though no observation of run-off on respective drain is found, monthly mean drain modulus in the whole Fayoum basin basis is considered for the study on the said run-off. As a result, the month of December shows the highest monthly mean drain modulus and the month of March is the second. On the other hand, the run-off from the direct drainage area is estimated at the drainage modulus of 3.31 cubic meters per second per 100 square kilometers.

Appling the said drain modulus, drain discharge of each sub-area are calculated and pump capacity of each sub-area is also planned based on the said discharge and eight hours per day operation basis. (refer to Appendix F-5)

The drainage of the area aims not only discharging the excess water to Lake Qarun also lowering groundwater table on the area for restoring agricultural productivity. To keep the groundwater table at least 1.5 meters deep, water level of the main drain and pump station is planned as follows:

Elevation of bottom	-47.0 m
Low water level	-46.0 m
Normal water level	-45.0 m
High water level	-43.0 m

Number of units of pumps is decided based on exchangeability of parts and adaptability of fluctuation of drain discharge at four units including a stand-by for Bats Said pump station at three units including a stand-by for Abu Harawa and Abu Tarfaya pump stations and at two units including a stand-by for Abu el-Rahman and Khor el-Hitan pump station. Capacity of each pump is planned by mixed flow volute pump, pump bore of 250 millimeters, total dynamic head of 5.5 meters and power of 18 horse powers except for Abu el-Rahman Pump Station of 200 millimeters pump bore and nine horse powers.

Improvement of the area is also included construction of dike and improvement of Batts drain in Harawa sub-area and in other sub-area construction of main and improvement of lateral drains and sub-lateral drains. The components of the works are summarized as follows; (refer to Appendix H-7)

1) Harawa Sub-area

Construction

Qarun Dike	Length 3,500 m
Abd el-Rahman Pump Station	Mixed Low Volute pump 2 units-ϕ200 x 9 PS 3.6 cu.m/min/unit
Abu Harawa Pump Station	Mixed Flow Volute Pump 3 units-ϕ250 x 18 PS 5.4 cu.m/min/unit
Main Drain	Length 3,500 m along Qarun Dike

Improvement

Batts Drain	Length 2,500 m
Lateral Drain	Length 3,000 m
Sub-lateral Drain	Length 4,000 m

2) Bats Said Sub-area

Construction

Bats Said Pump Station	Mixed Flow Volute Pump 4 units ϕ250 x 18 PS 6.8 cu.m/min/unit
Main Drain	Length 2,300 m

Improvement

Lateral Drain	Length 3,800 m
Sub-lateral Drain	Length 12,000 m

3) Abu Tarfaya Sub-area

Construction

Abu Tarfaya Pumps Station	Mixed Flow Volute Pump 3 units ϕ250 x 18 PS 6.0 cu.m/min/unit
Main Drain	Length 2,800 m

Improvement

Lateral Drain	Length 1,100 m
Sub-lateral Drain	Length 6,200 m

4) Khor el-Hitan Sub-area

Construction

Khor el-Hitan Pump Station	Mixed Flow Volute Pump 2 units ϕ250 x 18 PS 6.4 cu.m/min/unit
Main Drain	Length 2,700 m

Improvement

Lateral Drain	Length 1,000 m
Sub-lateral Drain	Length 2,600 m

(2) Systematizing of Operation

Water level of drain and groundwater table in the area are depending on water level of Lake Qarun and drain discharge reflected by plant growth. Improvement of the area after completion of the Project can be realized by systematic and proper operation of the facilities. For the purpose an organization in charge of the operation and maintenance of the facilities should be established under the Governorate or possibly under MOI.

Drainage of open channel is visual matter so as to recognize the effective operation of the facilities easily, however, movement of groundwater table can not be confirmed by visual way. Moreover the said invisible movement of groundwater table is quite important and severe for improvement of agricultural productivity in the area.

Taking into consideration the fact establishment of operational organization and proper operation and maintenance of ten facilities are eagerly expected.

4.4.5. Model Farm

For successful implementation of the reclamation and fruitful development of the area, training and practice on the modernized irrigation facilities and farming techniques are expected in the Model Farm to be established in Com Osheem area.

The Model Farm covers a reclamation area of 310 feddan (130 ha) in gross and arable land of 250 feddan (105 ha).

The reclamation of the project in North Wahby and Com Osheem areas aims to develop the area by introducing modernized irrigation method such as sprinkler irrigation and drip irrigation. However farmers to be engaged and engineers concerned, have no experience on the said facilities. The training and practice are quite important role for the successful development of the Project.
(refer to Appendix H-8)

For the purpose, provision of the following facilities in the Model Farm are proposed:

(1) Reclamation of the area

In advance to the Project, reclamation of the area of 250 feddan (105 ha) should be made by conducting for deep harrowing and initial leaching. It is also one of tasks for the Model Farm.

(2) Construction of Irrigation Facilities

a. On-farm Facilities

For the Model Farm, drip irrigation of 60 feddan which is minimum rotational unit for the project and sprinkler irrigation of the rest 190 feddan are proposed.

b. Pump Station

Taking into consideration seasonal fluctuation of irrigation water requirement and experimental use of irrigation facilities in the Model Farm the pump station is planned as follows:

Type	:	Horizontal Axis Single Suction Multi-stage Volute Pump 3 stage 4 units
Capacity	:	2.33 cu.m/min/unit
Pump bore	:	ϕ150 mm
Total Dynamic Head	:	90 m (End pressure 40 m)
Power	:	66 KW (50Hz)

c. Pipelines and Irrigation Facilities

The following facilities are proposed:

Pipelines

Main Pipeline	ϕ300 mm	Length	1,620 m
Branch pipeline	ϕ200 mm	Length	1,370 m
Field Pipeline	ϕ200 mm	Length	1,250 m
"	ϕ150 mm	Length	840 m
"	ϕ100 mm	Length	5,420 m

Irrigation Facilities

Drip Irrigation	48 sets for 60 feddan (one set for 1.25 feddan)
Sprinkler irrigation	76 sets for 190 feddan (one set for 2.5 feddan)

d. Intake Structure

Based on the standard design capacity of the Ministry of Irrigation, the "36" Model Vent with opening mouth of 0.31 meter (310 feddan) is planned.

(3) Agricultural Machineries, Construction Equipment and Materials

Agricultural machineries and construction equipment will be procured. (refer to Appendix H-8)

(4) Training and Demonstration Facilities

In the training room, visual educational instrument, and other facilities will be equipped. (refer to Appendix H-8)

(5) Research Laboratory and Administrative Office Building

Buildings necessary for operation the Model Farm will be provided. (refer to Appendix H-8)

4.5. Project Cost

4.5.1. Basis of Estimation

The project cost is estimated on the contract basis through international competitive bidding selected among two methods of force account basis and contract basis.

The unit prices employed as of August 1984 in the estimation of the project cost were surveyed and studied in the Project Area and GARPAD in Cairo. (refer to Table I-2.9 in Appendix I)

4.5.2. Cost Estimate

The project cost is estimated in the following manners.

(1) Unit Cost

The cost of construction works is estimated on the basis of the prevailing unit costs in the MOI, Fayoum and in the Projects of GARPAD as of August, 1984. (refer to Appendix-I)

The unit costs consist of the following components:

Labor Cost	:	Wages of labors, foreman, drivers and other workers
Material Cost	:	Cement, steel bar and other construction materials, fuel and oil, electric charge, etc.
Construction Equipment	:	Depreciation, repair and Administrative Costs

Temporary Work and Overhead Costs : Temporary work costs, contractor overhead and profit. 30 percent of the basic cost is estimated.

(2) Proportion of Foreign and Local Currencies

Proportion of foreign and local currencies for the project cost is applied according to the following table referring to actual figures used in other projects in Egypt by the international agencies and Japan International Cooperation Agency (JICA).

Description	Unit	Unit Cost (LE)	Foreign Currency (%)	Local Currency (%)
Common Labor	/day	5.0	0	100
Skilled Labor	"	8.0	0	100
Operator (Heavy Equipment)	"	10.0	0	100
Operator (Truck/Vehicle)	"	8.0	0	100
Carpenter	"	10.0	0	100
Masonry	"	15.0	0	100
Surveyor	"	10.0	0	100
Steel Bender	"	12.0	0	100
Portland Cement	ton	80.0	50	50
Steel Bar (round)	"	500.0	90	10
Steel Bar (deformed)	"	800.0	100	0
Crashed Gravel	cu.m	6.0	0	100
Coarse Aggregate	"	8.0	0	100
Fine Aggregate	"	5.0	0	100
Timber	"	250.0	100	0
Gasoline	liter	0.15	10	100
Diesel Oil	"	0.03	10	90
Grease	kg	1.15	10	90
Clay Brick (25x12x6 cm)	1000 pcs	60.0	0	100
Pipes			100	0
Pumps			100	0
Construction Equipment				
Depreciation Cost			100	0
Repair & Administration (including spare parts)			50	50
Electric Charge	KWH	0.0245	0	100

(3) Components of the Project Cost

The project cost consists of the following components;

a. Civil Work Costs

Pre-engineering	:	Cadastral survey, soil survey, pre-construction and construction surveys, quality control, negotiation to land acquisition, etc.
Civil Works	:	Construction cost of all civil works including reclamation, irrigation and drainage facilities, etc.
b. Land Acquisition and Compensation	:	Land acquisition of project facilities and compensation for the temporary work area
c. Construction Equipment	:	Procurement of construction equipment and vehicles
d. Agricultural Development	:	Agricultural supporting service and procurement of agricultural machineries
e. Project Facilities	:	Construction cost of office and others for the implementation of the Project
f. Project Administration	:	Administrative charge of government staff to be engaged in the newly organized project office
g. Consulting Services	:	Engineering cost for consultants of foreign and local experts for detailed design, supervision of the project implementation
h. Contingency	:	Ten percent of the basic cost for minor differences between actual and estimated quantities, unforeseeable difficulties in construction, possible change in plan and uncertainties in foundation conditions
i. Price Escalation	:	Price escalation rates for both manufactured goods and civil works. Annual rate of five percent for foreign currency and 12 percent for local currency based on the prevailing rate.

4.5.3. Project Cost

The project cost is estimated based on the aforementioned criteria at a total amount of 105.4 million Egyptian Pound including a foreign currency portion of 57.7 million Egyptian Pound or about 55 percent of the total cost and a local currency portion of 47.7 million Egyptian Pound or about 45 percent of the total cost.

The project cost is summarized in Table 4-8 and the detailed information on the project cost estimate is shown in Appendix-I.

Table 4-8 Project Cost

(Unit: '000 LE)

Item	Total	Foreign	Local
I. Engineering for Detail Design	2,000	1,700	300
II. North Wahby and Com Osheem Area			
2.1 North Wahby Area			
2.1.1 Land Reclamation			
(1) Civil Works	11,600	8,570	3,030
(2) Land Acquisition & Compensation	150	-	150
(3) Construction Equipment	1,170	1,110	60
(4) Agricultural Development	750	530	220
(5) Project Facilities	350	80	270
(6) Engineering and Administration	1,120	-	1,120
(7) Consulting Services	1,390	1,140	250
(8) Physical Contingency	1,670	1,170	500
(9) Price Escalation	9,800	4,300	5,500
Total	28,000	16,900	11,100
2.1.2 Housing & Infrastructure			
(1) Civil Works	5,000	1,790	3,210
(2) Engineering and Administration	400	110	290
(3) Physical Contingency	500	200	300
(4) Price Escalation	4,400	600	3,800
Total	10,300	2,700	7,600
Total of North Wahby Area	38,300	19,600	18,700
2.2 Com Osheem Area			
2.2.1 Land Reclamation			
(1) Civil Works	8,280	6,140	2,140
(2) Land Acquisition & Compensation	90	-	90
(3) Construction Equipment	920	870	50
(4) Agricultural Development	550	430	120
(5) Project Facilities	210	60	150
(6) Engineering and Administration	800	-	800
(7) Consulting Services	920	760	160
(8) Physical Contingency	1,230	840	390
(9) Price Escalation	7,000	3,200	3,800
Total	20,000	12,300	7,700
2.2.2 Housing & Infrastructure			
(1) Civil Works	2,780	1,020	1,760
(2) Engineering and Administration	220	80	140
(3) Physical Contingency	300	100	200
(4) Price Escalation	2,500	400	2,100
Total	5,800	1,600	4,200
2.2.3 Agro-industry			
(1) Cattle breeding and Fattening Center	1,700	1,200	500
(2) Agricultural Products	840	710	130
(3) Animal Products	6,480	5,420	1,060
(4) Price Escalation	5,180	3,070	2,110
Total	14,200	10,400	3,800
Total of Com Osheem Area	40,000	24,300	15,700
Grand Total of Reclamation Area	78,300	43,900	34,400

(Unit: '000 LE)

Item	Total	Foreign	Local
III. Wahby Downstream Area			
(1) Civil Works	2,250	675	1,575
(2) Land Acquisition and Compensation	250	-	250
(3) Construction Equipment	745	705	40
(4) Agricultural Development	200	100	100
(5) Project Facilities	195	50	145
(6) Engineering and Administration	290	-	290
(7) Consulting Services	1,420	1,170	250
(8) Physical Contingency	550	300	250
(9) Price Escalation	3,500	900	2,600
Total	9,400	3,900	5,500
IV. South Area of Lake Qarun			
(1) Civil Works	2,760	925	1,835
(2) land Acquisition and Compensation	250	-	250
(3) Construction Equipment	1,680	1,590	90
(4) Agricultural Development	100	50	50
(5) Project Facilities	200	55	145
(6) Engineering and Administration	400	-	400
(7) Consulting Services	1,170	940	230
(8) Physical Contingency	640	340	300
(9) Price Escalation	4,200	1,100	3,100
Total	11,400	5,000	6,400
V. Model Farm			
(1) Civil Works	1,540	1,110	430
(2) land Compensation	10	-	10
(3) Equipment	990	940	50
(4) Engineering and Administration	210	-	210
(5) Consulting Services	600	510	90
(6) Physical Contingency	350	260	90
(7) Price Escalation	600	380	220
Total	4,300	3,200	1,100
Grand Total of Project Cost	105,400	57,700	47,700

CHAPTER V. PROJECT IMPLEMENTATION AND OPERATION

CHAPTER V. PROJECT IMPLEMENTATION AND OPERATION

5.1. Project Organization

5.1.1. Executing Agency

The Project is quite complex comprising of land reclamation in North Wahby and Com Osheem areas, rehabilitation/upgrading of the existing irrigation system and improvement of the shortage of irrigation water in Wahby Downstream Area, and improvement of arable land in the inundated areas in South Area of Lake Qarun. Each component also involves various elements for the development. The land reclamation includes on-farm development, construction of irrigation and drainage facilities as well as the provision of social infrastructure for villages. The rehabilitation/upgrading of the existing system in Wahby Downstream Area and the improvement of arable land in South Area of Lake Qarun include the rehabilitation/improvement of the existing irrigation and drainage facilities.

Fayoum Governorate should be responsible for overall planning and coordination in implementation of the Project. Under the coordination and administration of the Governorate, the Ministry of Reconstruction, New Communities and Land Reclamation (MORCL) will implement the land reclamation, the construction of on-farm facilities and social infrastructure and the construction of irrigation and drainage facilities related to the land reclamation in the reclamation areas of North Wahby and Com Osheem while the Ministry of Irrigation (MOI) will carry out the improvement and/or rehabilitation of the existing irrigation and drainage facilities. As for the implementation of the Model Farm, the Governorate should also be responsible for the implementation under the cooperation of MORCL, MOI and MOA.

5.1.2. Project Office

For successful implementation of the Project, organization of a Coordination Committee for implementation of the Project and establishment of the project offices are recommended. The Coordination Committee for implementation of the Project should be organized by the chairmanship of the Fayoum Governor with the participation of heads of governmental agencies concerned. Under the control of the Coordination Committee, the project offices of MORCL, MOI and MOA should be established.

The project offices of MORCL, MOI and MOA will undertake the supervision of the works under their responsibility. The each project office should carry out respective works in close cooperation each other under the administration of the Coordination Committee and the Governorate.

5.2. Construction Method and Schedule

5.2.1. Mode of Construction

The construction works in principle should be carried out on contract basis. Among others, contractors for construction of the major works should be selected through international competitive bidding to carry out the works on contract basis.

For convenience of the Governorate or the executive agencies, even small size construction works should be also implemented on contract basis except some of the rehabilitation and improvement works.

5.2.2. Construction Method

(1) Reclamation in North Wahby and Com Osheem Areas

In implementing the reclamation, the construction of trunk roads and branch roads will start first, followed by deep harrowing of the reclamation works. After one year from the beginning of the reclamation, the construction of irrigation facilities will be commenced.

Prior to the above-mentioned works, implementation of the Model Farm in early time is recommended for successful development of the area.

(2) Wahby Downstream Area

The work for the area mostly consist of rehabilitation and improvement works except the construction of laterals. For the effective implementation of these components, the first priority in construction should be given to rehabilitation of the main canal, Bahr Wahby, and then branch canals, followed by the construction of

Ganabiah canals. The construction of Ganabiah canals will bring about great benefits by eliminating illegal intake of irrigation water.

(3) South Area of Lake Qarun

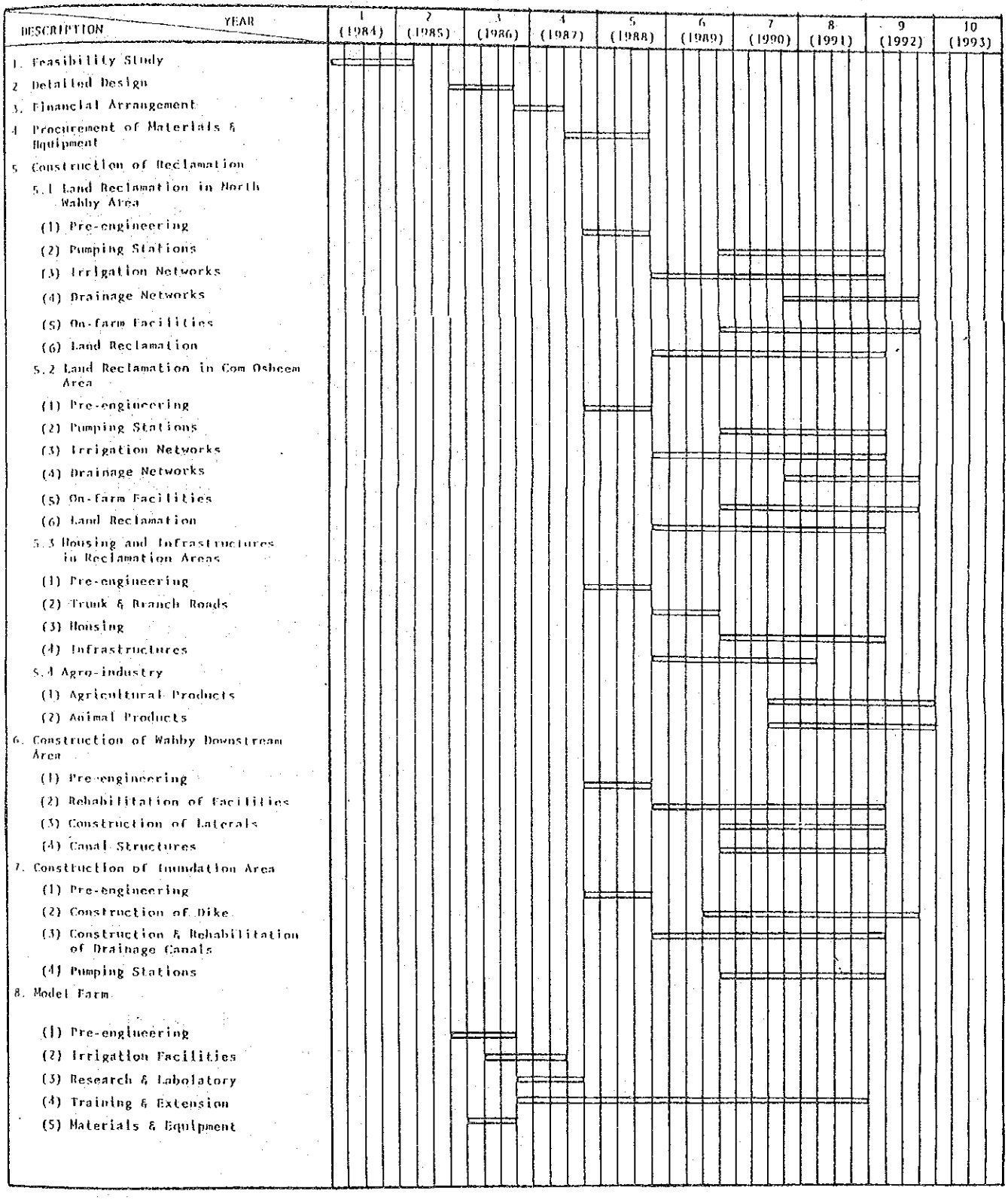
In improving the present situations in the area, the first priority should be given to the construction of Bats Said Sub-area which involves Bats Said Pump Station, Main Drain and Lateral/Sub-lateral Drain. Construction of Abu Tarfaya and Khor el-Hitan Sub-area are followed. The above-mentioned two sub-areas have already the protection dike of Lake Qarun.

By the construction of these two sub-areas, quick benefits can be expected. Construction of Abu Harawa and Abd el-Rahman sub-areas would be made at the last two years of the construction period because the components in the sub-area involves much quantities.

5.2.3. Construction Schedule

The implementation program for the Project is shown in Fig.5-1.

Fig. 5-1 Implementation Schedule



5.3. Operation and Maintenance of the Project

5.3.1. Executing Agency and Organization

The reclamation project, after completion of physical works, will be transferred in its administration to the Ministry of Agriculture, Fayoum in coordination with the Ministry of Irrigation and Land Reclamation Cooperative by the project basis while the projects of Wahby Downstream Area and South Area of Lake Qarun will be continuously operated by the Ministry of Irrigation after the completion.

(1) Reclamation Area in North Wahby and Com Osheem

The reclamation area is just newly developed area and farmers in the area are all settlers. For proper operation and maintenance of the completed system, it is recommended that the Ministry of Irrigation, Fayoum should be responsible for the operation and maintenance of the facilities from the feeder canal up to the end of the pipelines including the pump station. North Wahby area is divided into five irrigation divisions while Com Osheem area has three irrigation divisions. Each irrigation division covers the area of about 700 feddan to 1,400 feddan. Sprinkler line or drip line connected from the pipeline would be operated by farmers concerned under technical assistance of the Land Reclamation Cooperative.

MOI is usually in charge of operation and maintenance of irrigation and drainage facilities such as main, branch and sub-branch canals and their appurtenant structures. In Fayoum Governorate, the MOI has nine Irrigation Districts. An Irrigation Engineer is assigned to each Irrigation District as a chief who is in charge of the operation and maintenance of the irrigation system in the territory.

Aside from the existing nine Irrigation Districts, it is recommended to organize a new Irrigation District under the administration of the MOI for operation and maintenance of the system in the reclamation area of North Wahby and Com Osheem. The Land Reclamation Cooperative (LRC) should be organized among the farmers concerned by the irrigation division basis and for effective operation of the LRC, the Union should be organized among eight LRC to be established in the reclamation area.

(2) Wahby Downstream Area

Major construction works in this area are rehabilitation and improvement of the irrigation system and construction of lateral canals and Canabiah canals. The irrigation system is not changed in principle. Therefore, operation and maintenance of the system in this area should be made by the existing organization of the MOI.

(3) South Area of Lake Qarun

Operation and maintenance of pump facilities for drainage in this area should carefully be carried out.

Over-operation or less-operation of the pumps will affect much for agricultural productivity.

For proper operation and maintenance of the facilities to be constructed, it is recommended that an operation/maintenance team should be organized under direct supervision of the MOI in Fayoum. The said team would be headed by an Irrigation Engineer and under him some of staff such as mechanical engineer, electrical engineer, operators and so on would be hired.

5.3.2. Functions of Operation & Maintenance Organization

The Irrigation District of the MOI prepares irrigation program in cooperation with the MOA in Fayoum and the Union of the LRC and operates and maintains the said irrigation system. To the Irrigation District, an Irrigation Engineer should be assigned and under him some of staff would be hired.

The LRC is in charge of the operation and maintenance of the on-farm facilities such as sprinkler and drip lines and also coordination of farmers in carrying out the rotational irrigation under the supervision of the MOI and MOA.

5.3.3. Operation and Maintenance Cost

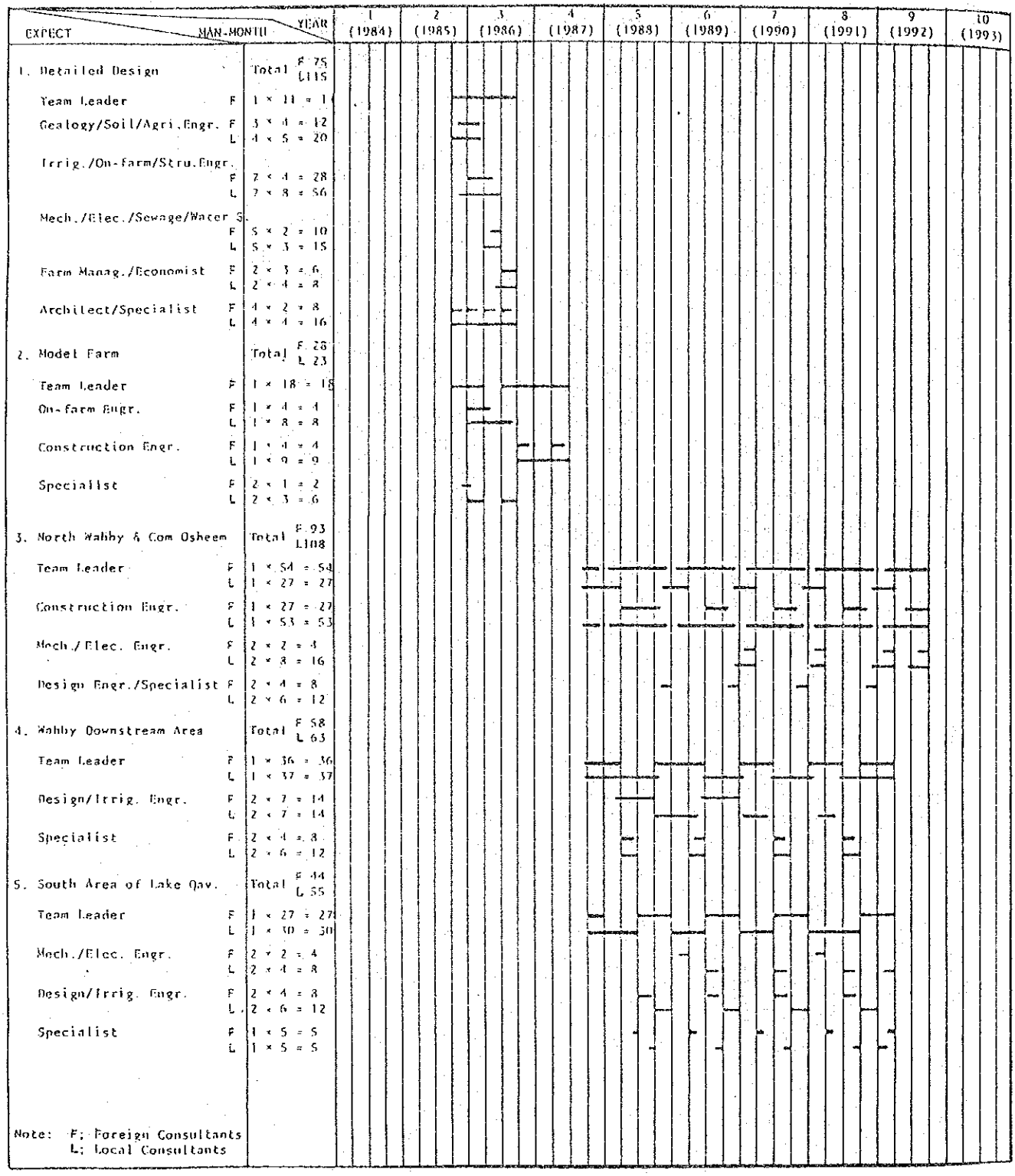
As the operation and maintenance cost, the electric charges for the pumping stations for irrigation, salary and wage for engineers, operators, and laborers, repairing cost of irrigation systems and so on would be considered. The annual operation and maintenance cost for the new reclamation areas would amount to about 0.8 million LE excluding the O & M cost of on-farm facilities which will be borne by farmers themselves. (For further details, refer to Appendix J-5)

5.4. Consultants Services

The participation of engineering consultants having rich experience and knowledge on necessary technical fields would be required for smooth progress of the construction works and for technical knowledge transfer to the local engineers in the fields. The consultants should be in charge of the detailed design and supervision of construction works.

The following major personnel would be necessary, and the total assignment of 190 man-months for the detailed design stage, and 421 man-months for the implementation stage would be necessary. The team leader of consultants, and the specialists for soil science, irrigation, canal, structures, mechanical engineer and so on would be required for the detailed design, and the team leader of consultants, construction engineer, mechanical engineer, design engineer and so on would be needed in the implementation stage. (for further details, refer to Figure 5-2)

Fig. 5-2 Manning Schedule of Consulting Service



CHAPTER VI. ECONOMIC JUSTIFICATION AND FINANCIAL ANALYSIS

CHAPTER VI. ECONOMIC JUSTIFICATION AND FINANCIAL ANALYSIS

6.1. Methods of Economic Evaluation

The measurable economic benefits and costs are expressed in monetary terms and both streams of benefits and costs on the annual basis over the evaluation period are converted into the respective present worth values. The economic internal rate of return (EIRR) is used as the main indicator for the economic justification of the Project.

The Project was evaluated based on the difference between the incremental benefits and required costs for the cases of "With Project" and "Without Project".

The project life of 50 years is adopted for this analysis. The lives of impellers and assemble pump for the pump station are 12.5 years and 25 years, respectively. The lives of sprinkler and drip are ten years and five years, respectively. Their costs are listed as the replacement cost. The life of houses for settlers and social infrastructure is 50 years.

6.2. Economic Justification of Agricultural Development Project

6.2.1. Commodity Prices

(1) Exchange Rate to US Dollar

There are various exchange rates of Egyptian Pound including official rates and prevailing rates. The official rate of LE 0.7 per US Dollar had been constant since 1979. Presently the prevailing rates are about LE 0.82 and LE 1.12. The latter was newly adopted recently. The new rate is specially fixed to attract the saving of Egyptian workers abroad and clamp down on black market dealers in the monetary market. The former rate has been floating around LE 0.82 per US Dollar. According to an English news paper "Egypt Gazette", the average rate was LE 0.833 per US Dollar only July 19, and LE 0.827 per US Dollar on August 23, 1984. Banque de Cairo, Fayoum, suggested that if the Project is included in the governmental budget, the rate will be around LE 0.82 per US Dollar, and if not so, LE 1.17 per US Dollar. Therefore, the exchange rate in this study is applied at LE 0.82 per US Dollar (LE 1.00 = US$1.22).

(2) Exchange Rate to Japanese Yen

The exchange rate of Japanese Yen per US Dollar is estimated at about Yen 240, that is, the average for last two months of August and September, 1984. Hence, LE 1.00 is equivalent to Yen 290.

(3) Price Escalation Rate

The annual price escalation rate to be used in estimation of the Project cost consists of two; one is for foreign costs and the other for local costs. The escalation rate is applied at five percent for foreign cost and at 12 percent for local cost based on the prevailing rates.

(4) Standard Conversion Factor

The prices of some goods received by farmers do not represent the real prices due to the subsidies of the Government. Hence, it is necessary to estimate the economic or shadow prices in economic evaluation. The economic or shadow price is estimated by using the conversion factors. A rate of the standard conversion factor is estimated at 0.8. On the other hand, the World Bank reported the rate of 0.965. (refer to Tables J1-5 and J1-6 in Appendix J-1)

(5) Wage Rate

The actual market wage rate in Tamiah district is LE 3.0 to LE 5.0 per man-day. The conversion factor of rural unskilled labor is 0.22 according to the World Bank Report. However, according to the farm economic survey, the market wage rate in Tamiah district is about 1.5 times higher than that in Fayoum district during harvesting seasons. It is considered that the supply of labor is comparatively short in comparison with the other five districts. The smallest intensity of population in Tamiah district might be one of the main reasons. The social condition shall continue in future. Hence, the conversion factor of rural unskilled labor to be used in the Project Area would be different with that estimated by the World Bank. Shadow wage rate in this analysis is conservatively estimated at 0.5.

(6) Import Item

At present Egypt is an importer of fertilizers. Although there are many investment plans to expand fertilizers production capacity to achieve self-sufficiency, fertilizers are regarded as an import item in this report.

(7) Farm Gate Price

Farm gate prices of commodities used in economic justification are estimated using the conversion factor as follows. (for further details, refer to Tables J3-1 to J3-8 in Appendix J-3)

Farm Gate Prices by Main Commodities

Commodity	Unit	Actual Prices at Present	1995 Economic Prices
Wheat	ton	167	216
Groundnuts	"	467 to 600	595
Watermelon	"	100 to 250	140
Tomato (winter)	"	50 to 130	80 to 160
Olive	"	400 to 500	400
Orange	"	250 to 270	300
Mango	"	500 to 1,250	700
Guava	"	150 to 250	160
Urea	"	130	288
Potash	"	110	190
TSP	"	40	110
Meat	kg	2.2	4.4
Milk	"	25 to 40	24 to 39
Unskilled labor	man-day	4	2