No. 52

THE ARAB REPUBLIC OF EGYPT

FAYOUM GOVERNORATE

FEASIBILITY REPORT

ON

FAYOUM AGRICULTURAL DEVELOPMENT PROJECT
APPENDIX-II
APPENDICES-F,G,H,I & J

MARCH 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

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APPENDIX–II

APPENDIX–F	IRRIGATION AND DRAINAGE
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ABBREVIATION AND GLOSSARY

ABBREVIATION

AOF	Agricultural Office in Fayoum, MOA
ARC	Agricultural Research Center
ARE	Arab Republic of Egypt
COF	Agricultural Cooperative Office in Fayoum
DOB	Drainage Office in Beni Suef
EIRR	Economic Internal Rate of Return
ESD	Egypt Survey Department
Ez	Ezba Hamlet or Small Village
FAF	Faculty of Agriculture in Fayoum, Cairo Univ.
FGC	Fayoum Geological Center
FIRR	Financial Internal Rate of Return
FSA	Farmer Social Association
GARPAD	General Authority for Rehabilitation Project and Agricultural Development
GOE	Government of Egypt
GOF	Governorate of Fayoum
GOJ	Government of Japan
IBRD	International Bank of Reconstruction & Development
IDF	Irrigation Department, Fayoum
IOF	Irrigation Office in Fayoum, MOI
JICA	Japan International Cooperation Agency
LE	Egyptian Pound
MOA	Ministry of Agriculture and Food Security
MOI	Ministry of Irrigation
MOPIC	Ministry of Planning and International Cooperation
MORCL	Ministry of Reconstruction, New Communities and Land Reclamation
O&M	Operation and Maintenance
OECF	The Overseas Economic Cooperation Fund
SSD	Soil Survey Department
UNDP	United National Development Program
USAID	US Agency for International Development
¥	Japanese Yen

UNIT

Length

mm	millimeter(s)
cm	centimeter(s)
m	meter(s)
km	kilometer(s)

Area

sq.m	square meter(s)
sq.km	square kilometer(s)
Fed. or feddan	local unit of acreage = 4,200 sq.m = 0.42 ha
ha	hectare = 2.381 feddan

Weight

mg	milligram(g)
g or gr	gram(s) = 1,000 mg
kg	kilogram(s) = 1,000 g
ton	ton(s) = 1,000 kg

Time

sec	second(s)
min	minute(s)
hr	hour(s)

Content

lit.	liter(s)
cu.cm	cubic centimeter(s)
cu.m	cubic meter(s)
MCM	million cubic meter(s) = 1,000,000 cu.m

Velocity

cm/sec	centimeter(s) per second
m/sec	meter(s) per second
km/sec	kilometer(s) per second

Discharge

lit/sec	liter(s) per second
cu.m/sec	cubic meter per second

Others

V	volt(s)
KVA	kilovolt ampere(s)
KW	kilowatt(s)
KWH	kilowatt(s) hour
Hz	hertz(s)
ps	Pferdestärke = horse power(s)
ppm	part(s) per million
mmhos	millimhos unit for electric conductivity
°C	centigrade degree(s)

CONVERSION TABLE

Metric Cantar	Cotton (Unginned)	157.5 kg
	(Ginned or lint)	50.0 "
Cantar	Other Crops	44.9 "
Ardeb	Wheat	150.0 "
	Maize	140.0 "
	Sorghum	140.0 "
	Millet	140.0 "
	Barley	120.0 "
	Sesame	120.0 "
	Rice (Unhusked)	300.0 "
	Rice (Bleached)	200.0 "
	Beans	155.0 "
	Beans (Crushed)	144.0 "
	Lentiles	160.0 "
	Lentiles (Crushed)	148.0 "
	Grounduts	75.0 "
Dariba	Rice (Unhusked)	933.0 "
	Rice (Bleached)	630.0 "

CURRENCIES

LE	1	=	US$	1.22
US$	1	=	LE	0.82
US$	1	=	¥	240
LE	1	=	¥	290

FISCAL YEAR

JULY to JUNE

APPENDIX F.

IRRIGATION AND DRAINAGE

APPENDIX F. IRRIGATION AND DRAINAGE

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F-1. Present Conditions

F-1.1. Irrigation System in Fayoum

Because of the arid climate, agriculture cannot be practiced in Fayoum without irrigation. The sole source of irrigation water is the Nile river. Water is carried to Fayoum through Bahr Yusef, the main canal running from Dyrout barrage of Ibrahimia canal, which is located some 300 kilometers south of Cairo. Ibrahimia canal itself is fed from the Nile river at Asyut barrage 360 kilometers south of Cairo. Bahr Yusef canal takes a zigzag course of about 276 kilometers until it reaches Fayoum depression through Hawara Gap where Lahon regulator exists. From the immediately upstream and downstream of Lahon regulator on Bahr Yusef, the three canals of Hawaret Adlan, Bahr Hassan Wassef, and El Agouz extend to irrigate 1,448 feddan, 116,466 feddan, and 1,260 feddan, respectively, in the western side of cultivated land of Fayoum. Particularly, Bahr Hassan Wassef is a big canal, and it feeds the two main canals of Gharag and Nazla at El Nazla intake. After diverting water to the above-mentioned canals for the western area of Fayoum, Bahr Wahby branches off at Hawara regulator, which is located some eight kilometers downstream of Lahon regulator, and serves an area of about 71,000 feddan (29,800 ha) in the eastern area of Fayoum. Bahr Yusef flows until it reaches the city of Fayoum. At the downstream end of Bahr Yusef in Fayoum city, six canals branch off to serve farm land in the middle part of Fayoum.

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 Gomhoria canal which serves the southern Com Osheem area, part of the Project Area to be reclaimed. The irrigation system is shown in Figure F4-1 in Appendix F-4.

The canal system 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.

Water levels of canals are controlled by cross weirs of a perfect overflow type, and kept higher than farm land irrigated through vents. The vent is offtake or turnout located at the head of distribution network of on-farm. The crest of vents controlled by one weir has the same design. However, the width of vent weirs is determined to allow a discharge required to irrigate their service areas. The design discharge is based on successive 24 hours and weekly basis operation.

The Irrigation Department in Fayoum is responsible for the operation and maintenance of irrigation system under the supervision of Director General and two Inspectors of the Ministry of Irrigation Fayoum. Each Inspector is responsible for an area of about 180,000 feddan. He is assisted by one senior or junior irrigation engineer assigned to one irrigation district. The irrigation engineer has his office at the main town of the district, and is helped by some technical and administrative staff in carrying out his duties. It is deemed that the number of staff for operation and maintenance of the irrigation system is very small. This organization, thus, should be strengthened properly.

One of the existing problems with relation to the irrigation system is the over-irrigation made through vents in the upstream. Farmers on the upstream reaches illegally lower the crest of vent weirs, resulting in water shortage in the downstream area. It would be found not only in Fayoum but also in the other irrigation systems in Egypt. The uneven distribution of irrigation water in the system should be improved by upgrading the system facilities and also by encouraging farmers concerned in participating in cooperative activities so as to create public spirit on the utilization of limited water resources.

Aside from the above-mentioned improvement of irrigation system, Fayoum Governorate is making great efforts to increase the total irrigation efficiency by way of re-use of drainage water. In this method, drainage water with salinity contents would be mixed with fresh water of the Nile river for providing a suitable water quality for irrigation. It would make new water resources necessary in expanding the irrigation area in the new reclamation area of North Wahby and Com Osheem.

F-1.2. Drainage System in Fayoum

Two main drains of Wadi and Batts drains and 12 small drains dispose drainage water to Lake Qarun. Part of discharge in Wadi drain is diverted to Wadi El Rayan through the open channel and a tunnel constructed in 1974. Wadi drain serves an area about 175,000 feddan, Batts drain about 152,000 feddan, and 12 small drains about 38,000 feddan.

Lake Qarun is a closed basin about 60,000 feddan (252 square kilometers) in size, and has a storage capacity of about 1,150 million cubic meters at the water level of (-)43.2 meters (below mean sea level). The water level of Lake Qarun depends on a balance between the inflow to the lake and evaporation from the lake surface. Artificial control of evaporation cannot be made. Thus, the fluctuation of the water level of Lake Qarun has to depend on the control of a discharge flowing into the lake. The Governorate informs that the lake water level should be maintained not lower than (-)44.3 meters since the lower water level than this will increase the water salinity and affect fishery industry while the highest level in April is not higher than (-)43.8 meters in order to protect roads, structures, and buildings, etc. on the lake shore from flooding, and to conserve cultivated land alongside the lake.

The drainage water flowing into the lake could be controlled by increasing the total irrigation efficiency through decrease of waste water disposed to the drains and also by utilizing drainage water for irrigating crops, so-called the re-use of drainage water.

F-1.3. North Wahby and Com Osheem Areas

North Wahby area is located at the northern part of Tamiah district along the right bank of Bahr Wahby. The Project is expected to reclaim about 5,100 feddan of land. The southern verge of North Wahby area is adjoining to the area already reclaimed and cultivated which is located on the right bank of Bahr Wahby. The elevation of the Project Area ranges between 15 and 25 meters. This is a new area to be reclaimed, and no agricultural facilities were found so far. However, in some part of the Project Area a certain group or company started reclamation of the land for agricultural purpose.

Com Osheem area is located north of the area served by Gomhoria canal and is bounded on the east by Cairo - Fayoum Road. The Project is expected to reclaim about 3,700 feddan of land. In some areas of adjoining the Project Area, land reclamation was started by a private enterprise named Beni Ettman company, making application for water distribution to the Ministry of Irrigation, Fayoum recently. However, the Ministry of Irrigation, Fayoum has not yet given this company the water right. Taking into consideration the progress on the construction of irrigation facilities being provided by Beni Ettman Company the said area covering a land of about 600 feddan would be taken out from the Project Area.

The land reclamation of both North Wahby and Com Osheem areas would depend on the water resources to be created by the re-use of drainage water. According to the information of the Ministry of Irrigation in Fayoum, an engineering group dispatched by Dutch Government is still conducting a study and preparing the detailed design of pumping station and pipeline for the re-use program. According to Water Management Fayoum Oasis Re-use of the Water of *the Batts drain for Agricultural Purposes prepared by* DHV Consulting Engineers in Kingdom of the Netherlands in June 1984, the pre-design of a pumping station shows the following features;

Pump Station

Type	:	Vertical mixed flow pump
Unit	:	Four units inclusive of one unit for stand-by
Capacity	:	1.53 cu.m/sec, Totally 4.6 cu.m/sec
Bore	:	800 mm
Head	:	Maximum static head 31.32 m Minimum static head 28.88 m Total manometric head between 32 and 41 mwc
Pump Speed	:	740 rpm
Motor	:	6 KV, AC 50 Hz, 800 KW

Pipeline

Pipe	:	Locally made by "Egyptian Company for Prestressed Concrete" the local name of the international Company "Société des Tuyaux Bonna" (France)
Length	:	6.2 km approx.
Diameter	:	ϕ1,800 mm , concrete pipe with steel core (Approx. 6 m long) Wall thickness 142 mm
Surge vessel	:	ϕ4,500 mm with a height of 6,500 m

F-1.4. Wahby Downstream Area

As reported in the previous paragraph, Bahr Wahby serves a broad area of about 71,000 feddan. Because of the lack of proper water management and cooperation of farmers concerned, farm land on the downstream reaches of Bahr Wahby suffer from water shortage in aspect of water volume and also timing of irrigation. The total amount of irrigation water supplied to the area was also insufficient to grow crops.

F-1.5. South Area of Lake Qarun

A certain area alongside the southern shore of Lake Qarun suffers from inundation and a high groundwater table. About a half of the Project Area located to the east of Shakshok has a moderate slope from south to north, about 1:200 to 1:300 on an average. On the other hand, another half west of Shakshok has a rather steep topographical slope of about 1:100 to 1:150 on an average. In the former area the land strip about 200 meters wide along the lake shore suffers from inundation, and wasted as non-arable land. Further 1.0 to 2.0 kilometers inland area would suffer from a high groundwater table due to the topographically moderate slope of this area. The high groundwater table also affect agricultural productivity. In the latter area, land affected by the lake water is quite limited.

F-2. Irrigation Plan in Reclamation Area

F-2.1. Irrigation Method

In cultivated land in Fayoum, irrigation for plant growth is being made by flooding or by means of furrow irrigation 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 area 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 Gomhoria canal which serves the southern Com Osheem areas, part of the Project Area to be reclaimed.

For reclamation of North Wahby and Com Osheem areas, re-use of drainage water was planned as new water resources of irrigation by Fayoum Governorate. A result of the pre-design of pumping station conducted by the team of Dutch Government in June 1984 shows that a new water resources of maximum 4.50 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, the reclamation of North Wahby and Com Osheem areas and improvement of shortage area in terms of irrigation water at Wahby downstream area are expected. Available water resources for these areas in 4.5

cubic meters per second which is able to deliver irrigation water of 30 cubic meters per day per feddan at the peak stage for North Wahby and Com Osheem areas and about 10 cubic meters per day per feddan for Wahby downstream area as supplemental irrigation water.

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 trickle.

Irrigation methods vary in different parts of the world and on different farms. A irrigation method would be selected based on the following considerations: (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 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 analysis of all observed data was made. According to the result, about 30 percent of samples are below 7.6 mm/hr of the basic intake rate and the rest 70 percent are above 7.6 mm/hr (See Table F-2.1). In general it may be said that sprinkling or trickle irrigation is preferable to apply for the land where the basic intake rate has more than 7.6 mm/hr.

During the first field work in February and March, 1984, the field investigation and observation of intake rates permeability and leaching tests were carried out by the Irrigation Engineer of the Study Team. The said investigation and observation were performed in the field in cooperation with the staff of the Irrigation Department in Fayoum. The field investigation and observation were carried out at 16 places; seven places in North Wahby area, three places in Com Osheem area, and six places in Wahby Downstream area as shown in Figure F2-1.

The intake rate means an infiltrate ratio of irrigation water, and is measured by furrow intake rate, spray intake rate, and cylinder intake rate. The basic intake rate would be used for determination of the irrigation method and irrigation intensity, and is defined as a rate that one-tenth intake rate is equal to the declining rate of intake rate. According to an experiment in USA made by Dr. Slater, a relationship between spray intake rate and cylinder intake rate shows the following equation;

$$X = 0.239.Y$$

Where, X: Spray intake rate (mm/hr)
Y: Cylinder intake rate (mm/hr)

The results of observation and analyses of the equation and the basic intake rate (cylinder method) are shown in Table F-2.1. As indicated in the said table, the measurement of the cylinder intake rate was made by two times observation at each place.

The measurement of permeability was made by auger-hole permeability test method. The auger-hole permeability test measures the average horizontal permeability of the soil profile from the static water table to the bottom of the hole when an permeable layer is at the bottom of the hole, or to a few inches below the bottom of the hole when an impermeable layer is at some distance below the bottom of the hole.

The observation of permeability was conducted at four places in North Wahby area and three places in Com Osheem area as shown in Fig. F2-1. All of these places are located in desert area to be reclaimed newly, and soils are mostly of a hard pan layer with a very deep static water table which could not be found by auger hole in this area.

A result of analysis on permeability in North Wahby and Com Osheem areas is shown in Table F2-2.

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 sprinkling or trickle irrigation. These reclamation areas are located at the right bank of Bahr Wahby and Gomhoria canal. Elevation of the areas range between 15 and 28 meters above mean sea level (MSL) in North Wahby and Com Osheem areas. 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 sprinkling and/or trickle 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 sprinkling and trickle methods.

F-2.2. 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 (ETcrop) is calculated by an equation of ET (crop) = Kc. ETo. Growing stage of crops are given by the crop coefficient, Kc. Reference crop evapotranspiration (ETo) is predicted usually by four formulae; Blaney-Criddle, Radiation, Modified Penman and Pan Evaporation.

Each method was calibrated against the measured reference crop evapotranspiration (ETo) data collected from different locations and climates. Selection of method to be used to calculate ETo is primarily based on the type of climatic data available for the area of investigation.

(1) Calculation of Reference Crop Evapotranspiration (ETo)

Reference crop evapotranspiration (ETo) is predicted by the following formulae based on meteorological data available.

- Blaney-Criddle

$$ETo = C.P(0.46t + 8.13)$$

where : t : mean of daily maximum and minimum temperature in °C.

p : mean daily percentage of annual daytime hours obtained from the table.

c : coefficient to be adjusted by relative humidity, radiation hour and wind speed.

Result of calculation is shown in Table F2-3.

- Radiation

$$ETo = a + b.W.Rs$$

where : Rs : Solar radiation (mm/day)

$$Rs = (0.25 + 0.50\ n/N)\ Ra$$

n/N : ratio between actual to maximum possible bright sunshine hours.

Ra : extra-terrestrial radiation which is a function of latitude and time of the year.

W : weighting factor which depends on temperature and altitude.

a, b : coefficients given from the Figure.

Result of calculation is shown in Table F2-4.

- Modified Penman

$$ETo = C.W.Rn + (1 - W).F(u).(ea-ed)$$

Where : C : Coefficient to be adjusted by difference of wind speed between daytime and night time and other factors.

W : temperature-related weighting factor.

Rn : net radiation in equivalent evaporation in mm/day.

$$Rn = Rns - Rnl$$

$$Rns = (1 - 0.25)\ Rs$$

$$Rs = (0.25 + 0.50\ n/N)\ Ra$$

$$Rnl = f(t).f(ed).f(n/N)$$

f(u) : wind-related function

(ea-ed) : difference between the saturation vapour pressure at mean air temperature and mean actual vapour pressure of the air in mbar.

Result of calculation is shown in Table F2-5.

- Pan Evaporation

$$Eto = Kp.Epan$$

where : Kp : pan coefficient given by relative humid, wind speed and vegetation.

Epan : pan evaporation (mm/day) which presents the mean daily value of the period considered.

Result of calculation is shown in Table F2-6.

In generally, calculated ETo applying the above-mentioned formulae, may have about ten percent of accuracy for the tropical climate zone and about 25 percent for continental climate zone. According to the opinion of FAO, the Modified Penman method give the most accurate value in summer among the formulae and Pan Evaporation and Radiation methods are the next. Moreover, Blaney-Criddle method presents good results in case that sufficient climatic data are available. Taking into consideration the above-mentioned fact, reference crop evapotranspiration ETo are determined as shown in Table F2-7.

(2) Selection of Crop Coefficient

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 data, rate of crop development and length of growing season, climatic conditions and, particularly during the early growth stage, the frequency of rain or irrigation.

For development plan of the Project, crop coefficient Kc for proposed crops are calculated based on the proposed cropping pattern as shown in Table F2-8.

(3) Irrigation Efficiency.

Irrigation efficiency is defined as a ration 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 for canal between the outlet of the pipeline of the Tamiah Pumping Station and the Pumping station of the Project and for the pipeline of the Project between the Pumping Station of the Project and farm lot resulting conveyance loss of 10 percent. Operation loss and 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) Calculation of Irrigation Water Requirement

Crop water requirement (ETcrop) can be calculated by an equation of ETcrop = Kc.ETo. According to the reference crop evapotranspiration (ETo) and the crop coefficient (Kc) as described in the previous paragraph, ETcrop for the proposed crops were estimated as shown in Table F2-8.

Based on cropping pattern and crop water requirement (ETcrop), monthly water requirement including leaching water are calculated as shown in Table F2-9.

According to Table F2-9, monthly and annual water requirement at maximum and minimum are as follows:

Item		North Wahby	Com Osheem	Grand Total
Annual Total (1,000 cu.m)		33,035	23,196	56,231
Annual mean discharge (cu.m/s)		1.05	0.74	1.79
Monthly Discharge	Max.(cu.m/s)	1.30	1.16	2.46
	Min.(cu.m/s)	0.62	0.46	1.08

On the other hand, the water requirement per day per feddan can be converted from the above-mentioned discharge as follows:

Monthly maximum in July : 24.2 cu.m/day/feddan
Monthly minimum in September : 10.6 cu.m/day/feddan

In prior to the discussion on the above-mentioned water requirement for the proposed cropping pattern, water requirement for alternative cropping patterns, patterns one to five, are estimated as shown in Table F2-10 based on the assumptions that the total cropping area in North Wahby and Com Osheem is 9,000 feddan and crop water requirement (ETcrop) as shown in Table F2-8. The result of this calculation will apply for study on selection of proposed cropping pattern for the reclamation area.

In Fayoum depression, the Ministry of Irrigation, Fayoum is used to apply the standard of the crop water requirement established by the Ministry of Irrigation. For reference, the said standard and the calculation of the water requirement for the crops in 1984 are shown in Table F2-11.

F-2.3. Leaching

In the most part in regions of arid or semiarid climate, saline soils exist and leaching and transportation of soluble salts to the ocean is not so complete as in humid regions. Salt accumulation generally occurs in the top soils. Salt-affected soils may be classified into two, the soils topographically accumulated due to high groundwater table or low permeability of the soil and the soils accumulated by the irrigation.

In generally speaking, two leaching method can be considered for the improvement/reclamation of such soils; one is two wash away the salt in the top soils and the other is to reduce the causes by lowering ground-water table and selecting irrigation methods with less salt accumulation.

For the reclamation of new areas, North Wahby and Com Osheem, depend on the contents of salt, leaching of salt contents would be carried out either by ponding water or spreading water at the initial stage of the reclamation. After the reclamation of the area, adequate amount of leaching water would be supplied with the irrigation water to crops.

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

(1) Estimate of Leaching Water

For estimate of leaching water requirement, several empirical and experimental formulae were proposed by researchers/doctors. The major formulae are as follows;

- L.Rozov, USSR (1936)

$$M = FC - m + n \cdot FC$$

where, M : Amount of water (cu.m/ha)

FC : Field capacity (2,730 cu.m/ha)

m : Water reserved in the soil before leaching (1,500 cu.m/ha)

n : Coefficient 0.5 to 2.0 depending on salinity and mechanical composition of the soil (2.0)

$$M = 2,730 - 1,500 + 2 \times 2,730$$
$$= 6,690 \text{ cu.m/ha}$$
$$= 670 \text{ mm}$$

- V. Kovda (1957)

$$Y = n_1 \times n_2 \times n_3 \times 400 \times m \pm 100$$

where, Y : Depth of leaching water (mm)

m : Mean salt content in the two meters soil profile (20 mmhos/cm = 1.2%)

n_1 : Coefficient depending on mechanical soil composition; sand 0.5, loam 1.0 clay 2.0 (1.0)

n_2 : Water table depth; (1.0)

1.5 - 2.0 m 3.0
2.0 - 5.0 m 1.5
5.0 - 10.0 m 1.0

n_3 : *Groundwater salinity* (1.0)
Weak or medium 1.0
Strong 2.0
Very strong 3.0

$$Y = 1.0 \times 1.0 \times 1.0 \times 400 \times 1.20 + 100$$
$$= 480 + 100 \text{ mm} = 380 - 580 \text{ mm}$$

- V.R. *Volobuev* (1960)

$$N = k \cdot \log (Si/So) \cdot a$$

where, N : Leaching water (cu.m/ha)

Si : Soil salinity in 0 to 100 cm layer (20 mmhos/cm = 1.2%)

So : Tolerated residual soil salinity (4 mmhos/cm = 0.24%)

k : Coefficient of proportionality, reckoning cu.m/ha as equal to 10,000 (10,000)

a : Parameter depending on Soil Salinity and on the proportion of chlorides in its salt (1.5)

$$N = 10{,}000 \times \log \frac{1.2}{0.24} \times 1.5$$
$$= 8{,}750 \text{ cu.m/ha}$$
$$= 875 \text{ mm}$$

As calculated by the above-mentioned empirical formulae, the leaching requirement for the reclamation area is estimated in a range from 380 mm to 875 mm. The requirement fluctuates depending on the degree of soil drainability, salt accumulation and quality of leaching water etc.

(2) Field Leaching Test

During the first field work in February and March, 1984, the field leaching tests were carried out in North Wahby and Com Osheem areas by providing a nylon sheet frame about 2.0 meters long, 1.0 - 1.2 meters wide, and 40 to 50 centimeters deep. When the frame was provided, certain soil samples at 5, 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 or four days depending on the filtration of supplied water, the second soil samples at the same depth with the first time sampling 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 samplings. 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. Schedule of the field leaching test is shown in Table F2-12. The results of the leaching test on the movement of EC and PH are described in Table F2-13.

According to the analysis of leaching test, the leaching curves for North Wahby and Com Osheem areas are provided as shown in Fig. F2-3 and the said leaching curves will give us an idea of leaching water requirement in the top soils at the initial stage of the reclamation.

Taking into consideration the result of the field leaching test as well as calculation of the leaching water requirement by the empirical formulae, water requirement for the initial leaching is decided at 300 mm depth in the reclamation area.

(3) Leaching Water Requirement during Maintenance Stage of Crops

As 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. Amount of leaching water for this purpose was calculated as shown in Table F2-14.

(4) Study on irrigation Effect in Movement of EC and PH

During the second field work in July - september, 1984, a field investigation of the movement of EC and PH at the cultivated land was carried out for study on irrigation effect. As shown in Fig. F2-4 "Location of Sampling for EC and PH Analysis, Study on Irrigation Effect", two places were selected and sampling were made for the purpose. Number S-1 - S-10 were sampled at a corn field located along Bahr Fanaus in the Wahby Downstream area while number S-21 - S-37 were investigated at a plantation of olive and grape irrigated by drip method in the North Wahby area reclaimed and cultivated by a farmer. Results of EC and PH analysis are shown in Table F2-15.

Among the results, growth of corn at the numbers S-1 and S-2 is more poor than that at the numbers S-3 - S-5. This fact coincides with the extent of the salt contents which are EC of above 10 mmhos/cm for the sample numbers S-1 and S-2 and EC of below 10 mmhos/cm for the sample numbers S-3 - S-5.

Concerning the sample numbers S-6 - S-10, plant growth of corn is rather good though salt contents in EC indicate more than 10 mmhos/cm. It means that the extent of plant growth is restricted by plenty of factors and not only by the extent of salt contents.

In the olive and grape plantation, sample numbers S-21 - S-37 are analyzed in EC and PH as shown in Table F2-15. Among these samples, numbers S-21 - S-24 and S-25 - S-30 were sampled in the olive and grape plantation, respectively, being cultivated by drip irrigation while numbers S-31 - S-37 were taken at the reclaimed area with the initial leaching and being cultivated by furrow or basin irrigation. In addition, as is described in the said Table F2-15, numbers S-21, S-23, S-25, S-27 and S-29 were sampled at the place of no plant with no irrigation between the rows of plant growth with drip irrigation which show the result of analysis at above 20 mmhos/cm or above 100 mmhos/cm in EC. However, numbers S-22, S-24, S-26, S-28 and S-30 were sampled at near root zone of plants irrigated by drip method which show the results of analysis at below 10 mmhos/cm except S-30. According to the results of EC analysis on S-21 - S-30, good irrigation effect by drip irrigation method can be confirmed. The drip irrigation of the plantation was started in March, 1984 by a private farmer.

In the reclaimed area with the initial leaching located next to the above plantation as shown in Fig. F-2-4, numbers S-31 - S-37 were sampled and also analyzed EC and PH as shown in Table F2-15. According to the results of analysis, the sample S-31 at a field of corn with no good growth has much salt contents while other samples, S-32, S-33, S-34, S-35 and S-37 at the field of corn, sunflower and watermelon with good growth irrigated by furrow or basin method which presented EC ranged between four and nine mmhos/cm. Sample S-36 was taken from the field with no irrigation between rows of planting watermelon shows very high salt contents of about 37 mmhos/cm in EC.

From these fact as same with the result in the olive and grape plantation, good result of irrigation effect can be confirmed.

(5) Soil Dressing Materials

For reclamation of North Wahby and Com Osheem areas, soil dressing would be needed for successful development of the area. For selection of the said materials, physical and chemical analysis including EC and PH analysis were carried out. Among these analysis as shown in Table F2-16, S-11 - S-14 were sampled at Wastany Drain with high salt contents in EC which are not suitable for materials of soil dressing.

Other samples especially materials sampled at the Bahr Wahby show quite low salt contents and are suitable in terms of soil contents for materials of soil dressing.

According to the results of physical and chemical analysis on the soil dressing materials as shown in Table F2-17, contents of C and N in the Samples M1-M10 would effectively affect to the improvement of Soil in the reclamation area. It means that the said materials which will be dredged from Bahr Wahby would be useful and no any obstruction.

Table F2-1 BASIC INTAKE RATE

in North Wahby and Com Osheem Areas

Area and No.	Equation of Intake Rate	Basic Intake Rate (mm/hr)
North Wahby Area		
1 - 1	$I = 300T^{-0.959}$	0.7
1 - 2	$I = 371T^{-0.531}$	17.4
2 - 1	$I = 312T^{-0.344}$	50.0
2 - 2	$I = 343T^{-0.262}$	91.2
3 - 1	$I = 543T^{-0.552}$	22.0
3 - 2	$I = 290T^{-0.522}$	14.4
4 - 1	$I = 384T^{-0.619}$	9.9
4 - 2	$I = 352T^{-0.581}$	11.7
5 - 1	$I = 235T^{-0.556}$	9.3
5 - 2	$I = 323T^{-0.564}$	12.1
6 - 1	$I = 253T^{-0.809}$	1.7
6 - 2	$I = 306T^{-0.907}$	1.0
7 - 1	$I = 266T^{-0.171}$	120.5
7 - 2	$I = 326T^{-0.257}$	89.3
Com Osheem Area		
8 - 1	$I = 304T^{-0.295}$	66.0
8 - 2	$I = 217T^{-0.260}$	58.4
9 - 1	$I = 735T^{-0.801}$	5.2
9 - 2	$I = 371T^{-0.449}$	30.1
10 - 1	$I = 929T^{-0.941}$	2.4
10 - 2	$I = 577T^{-0.923}$	1.7

TABLE F2-2 Auger-hole Tests for Permeability in North Wahby and Com Osheem Areas

No. of Observation	Radius of Hole(r) (m)	Height of Water from Bottom(h) (m)	Discharge (Q) (m^3/s)	$K_{20} = \frac{[\sinh^{-1}(\frac{h}{r})-1]\frac{Q}{2\pi}}{h^2}$ (cm/s)	in/hr
No. 5	0.05	0.499	0.000236	3×10^{-5}	0.04
No. 8	0.05	0.060	0.001964	1.4×10^{-4}	0.20
No. 9	0.05	0.086	0.000785	5.3×10^{-4}	0.75
No.10	0.05	0.121	0.000314	2.1×10^{-4}	0.30

Table F2-3 ETo Calculated by Braney-Criddle

Month	P	Tmax	Tmis	Mean of Day (t) 1/2(Tmax + Tmis)	f = P(0.46t + 8.13)	Block/line	ETo
	%	°C	°C	°C			mm/day
Jan	0.24	19.2	6.3	12.8	3.36	V / 2	2.3
Feb	0.25	21.0	7.6	14.3	3.68	"	2.7
Mar	0.27	24.3	10.8	17.6	4.38	"	4.0
Apr	0.29	28.6	14.5	21.6	5.24	IV, V I, II / 2	6.1
May	0.31	32.5	18.8	25.7	6.19	"	7.5
Jun	0.32	34.7	21.4	28.1	6.74	II / 2	8.0
Jul	0.31	36.6	22.7	29.7	7.07	"	8.7
Aug	0.30	36.7	23.2	30.0	6.58	II / 1-2	7.6
Sept	0.28	33.4	21.6	27.5	5.82	"	6.1
Oct	0.26	30.4	18.9	24.7	5.07	V / 1-2	4.4
Nov	0.24	25.6	14.3	20.0	4.16	"	3.3
Dec	0.23	20.4	8.9	14.7	3.43	"	2.4

Table F2-4 ETo calculated by Radiation Method

Month	Extra terrestrial radiation Ra mm/day	Mean Daily Maximum Duration of Bright Sunshine Hours N	Solan Radiation Rs = (0.25 + 0.50 n/N) Ra n/N	Rs mm/day	Weightry Factor T °C	W	W.Rs	a=-0.30 b	ETo = a+b.W.Rs
Jan	8.8	10.4	1.11	7.1	6.3	0.49	3.48	0.96	3.0
Feb	10.7	11.1	1.04	8.2	7.6	0.52	4.26	1.10	4.4
Mar	13.1	12.0	0.96	9.6	10.8	0.56	5.38	1.10	5.6
Apr	15.2	12.9	0.89	10.6	14.5	0.61	6.47	1.10	6.8
May	16.5	13.6	0.85	11.1	18.8	0.67	7.44	1.10	7.9
Jun	17.0	14.0	0.82	11.2	21.4	0.70	7.84	1.10	8.3
Jul	16.8	13.9	0.83	11.2	22.7	0.72	8.06	1.10	8.6
Aug	15.7	13.2	0.87	10.8	23.2	0.72	7.78	1.10	8.3
Sent	13.9	12.4	0.93	9.9	21.6	0.71	7.03	1.10	7.4
Oct	11.6	11.5	1.00	8.7	18.9	0.67	5.83	1.10	6.1
Nov	9.5	10.6	1.08	7.5	14.3	0.61	4.58	1.10	4.7
Dec	8.3	10.2	1.13	6.8	8.9	0.53	3.60	0.96	3.2

Table F2-5 ETo Calculated by Modified Penman

Month	Tmean	ea	RHmean	ed	(ed -ed)	Wind Function f(u): Wmean	U2 1/	$0.27(1+\frac{U2}{100})$	Weighting Factor: W	I - W	Solar Radiation Rs = (0.25 + 0.50 n/N) Ra: Ra	N	n/N	RS
	°C		%			Knot/hr	Km/day							mm/day
Jan	12.8	14.8	67.6	10.0	4.8	5.5	183.4	0.77	0.59	0.41	8.8	10.4	1.11	7.1
Feb	14.3	16.3	67.8	11.1	5.2	6.4	213.5	0.85	0.61	0.39	10.7	11.1	1.04	8.2
Mar	17.6	20.0	62.4	12.5	7.5	8.1	270.2	1.00	0.65	0.35	13.1	12.0	0.96	9.6
Apr	21.6	25.8	61.1	15.8	10.0	9.6	320.2	1.13	0.71	0.29	15.2	12.9	0.89	10.6
May	25.7	33.0	56.4	18.6	14.4	9.7	323.5	1.14	0.75	0.25	16.5	13.6	0.85	11.1
Jun	28.1	38.0	54.6	20.7	17.3	9.6	320.2	1.13	0.77	0.23	17.0	14.0	0.82	11.2
Jul	29.7	41.7	57.7	24.1	17.6	8.6	286.8	1.04	0.78	0.22	16.8	13.9	0.83	11.2
Aug	30.0	42.4	59.4	25.2	17.2	8.1	270.2	1.00	0.78	0.22	15.7	13.2	0.87	10.8
Sept	27.5	36.8	61.6	22.7	14.1	9.1	303.5	1.09	0.77	0.23	13.9	12.4	0.93	9.9
Oct	24.7	31.1	60.1	18.7	12.4	8.7	290.2	1.05	0.74	0.26	11.6	11.5	1.00	8.7
Nov	20.0	23.4	65.2	15.3	8.1	8.3	276.8	1.02	0.68	0.32	9.5	10.6	1.08	7.5
Dec	14.7	16.7	67.4	11.3	5.4	6.5	216.8	0.86	0.62	0.38	8.3	10.2	1.13	6.8

	(1 - 0.25) Rs	f(t)	f(ed)	f(n/N)	Rnl = f(t) f(ed) f(n/N)	Rn = Rns.Rnl	ETo 2/
	mm/day						
Jan	5.3	13.3	0.20	1.00	2.7	2.6	3.0
Feb	6.2	13.5	0.20	1.00	2.7	3.5	3.9
Mar	7.2	14.1	0.19	1.00	2.7	4.5	5.6
Apr	8.0	14.9	0.16	0.96	2.3	5.7	7.3
May	8.3	15.8	0.15	0.91	2.2	6.1	8.7
Jun	8.4	16.3	0.14	0.88	2.0	6.4	9.4
Jul	8.4	16.7	0.12	0.89	1.8	6.6	9.2
Aug	8.1	16.7	0.12	0.92	1.8	6.5	8.9
Sep	7.4	16.2	0.13	0.98	2.1	5.3	7.6
Oct	6.5	15.6	0.15	1.00	2.3	4.2	6.5
Nov	5.6	14.6	0.17	1.00	2.5	3.1	4.8
Dec	5.1	13.6	0.20	1.00	2.7	2.4	3.3

Notw : 1/ at 2m height Km/day = 0.75 × 1.853 km/hr › Knot/hr × 24 hr

2/ ETo = W.Rn + (1 - W). f(u)(ea - ed)

Table F2-6 ETo Calculated by Pan Evaporation

Month	Epan	Kp	ETo = Kp.Epan
Jan	3.26	0.8	2.6
Feb	4.64	0.8	3.7
Mar	6.17	0.7	4.3
Apr	8.89	0.7	6.2
May	9.99	0.7	7.0
Jun	11.80	0.7	8.3
Jul	11.92	0.7	8.3
Aug	11.68	0.7	8.2
Sept	10.60	0.7	7.4
Oct	8.24	0.7	5.8
Nov	5.78	0.7	4.0
Dec	3.90	0.8	3.1

Table F2-7 Determination of ETo

Month	Braney-Criddle	Radiation	Modified Penman	Pan Evaporation	ETo mean 1/
	(1)	(2)	(3)	(4)	{(2)+(3)+(4)}1/3
Jan	2.3	3.0	3.0	2.6	2.9
Feb	2.7	4.4	3.9	3.7	4.0
Mar	4.0	5.6	5.6	4.3	5.2
Apr	6.1	6.8	7.3	6.2	6.8
May	7.5	7.9	8.7	7.0	7.9
Jun	8.0	8.3	9.4	8.3	8.7
Jul	8.1	8.6	9.2	8.3	8.7
Aug	7.6	8.3	8.9	8.2	8.5
Sept	6.1	7.4	7.6	7.4	7.5
Oct	4.4	6.1	6.5	5.8	6.1
Nov	3.3	4.7	4.8	4.0	4.5
Dec	2.4	3.2	3.3	3.1	3.2

1/ Mean value of methods (2), (3) and (4), because value calculated by Brany-Criddle Method generally shows low accuracy.

Table F 2-8 Reference Crop Evapotranspiration (ETo) & Crop Evapotranspiration (ETcrop)

MONTH		JAN	FEB	MAR	APR.	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Reference Crop Evapotranspiration (ET_0)		2.9	4.0	5.2	6.8	7.9	8.7	8.7	8.5	7.5	6.1	4.5	3.2
Berseem	Cropping Pattern												
	Crop F. Kc	0.80	0.75	0.80	0.07						0.06	0.44	0.90
	ETcrop	2.32	3.00	4.16	0.48						0.37	1.98	2.88
Berseem (S)	Cropping Pattern												
	Crop F. Kc	0.80	0.75								0.06	0.44	0.90
	ETcrop	2.32	3.00								0.37	1.98	2.88
Sorghum	Cropping Pattern												
	Crop F. Kc						0.21	0.97	0.97	0.34			
	ETcrop						1.83	8.44	8.25	2.55			
Wheat	Cropping Pattern												
	Crop F. Kc	1.10	1.10	1.10	0.47	0.08						0.17	1.12
	ETcrop	3.19	4.40	5.72	3.20	0.63						0.77	3.58
Groundnuts	Cropping Pattern												
	Crop F. Kc					0.23	0.65	0.65	0.28				
	ETcrop					1.82	5.66	5.66	2.38				
Tomato	Cropping Pattern								Nursery				
	Crop F. Kc	1.02	0.95	0.40					1.00	0.22	0.51	0.80	1.02
	ETcrop	2.96	3.80	2.08					8.50	1.65	3.11	3.60	3.26
Watermelon	Cropping Pattern												
	Crop F. Kc			0.50	0.73	0.80	0.72						
	ETcrop			2.60	4.97	6.32	6.27						
Fruits	Cropping Pattern												
	Crop F. Kc	0.50	0.50	0.55	0.55	0.55	0.60	0.60	0.60	0.60	0.60	0.55	0.55
	ETcrop	1.45	2.00	2.86	3.74	4.35	5.22	5.22	5.10	4.50	3.66	2.48	1.76
Inter Crop Berseem (S)	Cropping Pattern												
	Crop F. Kc	0.80	0.75								0.06	0.44	0.90
	ETcrop	2.32	3.00								0.37	1.98	2.88
Inter Crop Watermelon	Cropping Pattern												
	Crop F. Kc			0.50	0.73	0.80	0.72						
	ETcrop			2.60	4.97	6.32	6.27						

Table F 2-9 Water Requirement of Proposed Crops

Unit : '000 m^3 Acreage; feddan
( ) : Net leaching water '000 m^3

Crops	Irrg. Meth.	Acreage	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Berseem	Spr.	NW. 1,050	415	484	743	83						(377) 66	342	515
		CO. 1,500	597	692	1,062	119						(539) 94	489	735
Berseem (S)	Spr.	NW. 1,050	415	484								(377) 66	342	515
		CO. 500	197	231								(180) 31	165	245
Groundnuts	Spr.	NW. 1,050				(368)	325	979	1,011	425				
		CO. 500				(175)	155	466	482	203				
Sorghum	Spr.	NW 1,050					(509)	316	1,508	1,474	441			
		CO. 1,500					(728)	452	2,155	2,106	630			
Watermelon	Drip	NW. 1,050		(533)	439	812	1,067	1,024						
		CO. 500		(254)	209	387	508	488						
Tomato	Drip	NW. 525	250	290	176					(176) 17	135	262	294	275
		CO. 250	119	138	84					(84) 8	64	125	140	131
Wheat	Spr.	NW. 525	285	355	511	277	56						(155) 67	320
		CO. 250	136	169	243	132	27						(74) 32	152
Fruits	Drip	NW. 1,050	245	305	483	611	734	853	881	861	(184) 735	(154) 618	405	297
		CO. 500	117	145	230	291	350	406	420	410	(88) 350	(88) 294	193	141
Inter Berseem (S)	Spr.	NW. 525	207	242								(188) 33	171	257
		CO. 250	99	115								(90) 16	82	123
Inter Watermelon	Spr.	NW. 525		(267)	232	430	565	542						
		CO. 250		(127)	111	205	269	258						
Total Leaching (X 1/0.675)		North Wahby		1,185		545	754			261	273	1,668	230	
		Com Osheem		564		259	1,079			124	130	1,329	110	
Miscellaneous (X 0.02)		North Wahby	36	43	52	44	55	74	68	56	26	21	32	44
		Com Osheem	25	30	39	23	26	41	61	55	21	11	22	31
TOTAL	North Wahby	1,000m^3	1,853	3,388	2,636	2,802	3,556	3,788	3,468	3,094	1,610	2,734	1,883	2,223
		m^3/s	0.69	1.40	0.98	1.08	1.33	1.46	1.30	1.16	0.62	1.02	0.73	0.83
	Com Osheem	1,000m^3	1,285	2,084	1,978	1,416	2,414	2,111	3,118	2,906	1,195	1,900	1,231	1,558
		m^3/s	0.48	0.86	0.74	0.55	0.90	0.82	1.16	1.08	0.46	0.71	0.47	0.58
	Grand Total	1,000m^3	3,138	5,472	4,614	4,218	5,970	5,899	6,586	6,000	2,805	4,634	3,114	3,781
		m^3/s	1.17	2.26	1.72	1.63	2.23	2.28	2.46	2.24	1.05	1.73	1.20	1.41

Note : Irrigation Efficiency
- Sprinkler Irrigation : 0.90 × 0.85 = 0.765
- Drip Irrigation : 0.90 × 0.90 = 0.81
- Nursery of Tomato : 0.90 × 0.75 = 0.675

Acreage : NW : North Wahby Area
CO : Com Osheem Area

Irrigation Method : Spr : Sprinkler Irrigation
Drip : Drip Irrigation

Annual total volume (Unit : 1000m^3)

	Total	North Wahby	Com Osheem
Irrigation water for proposed crops :	42,829	24,889	17,940
Irrigation water for inter crops :	3,951	2,679	1,278
Leaching water :	8,511	4,916	3,595
Miscellaneous water :	937	552	385
Grand Total	56,234	33,036	23,198

	Total	North Wahby	Com Osheem
Annual irrigation water for proposed crops per feddan	4,870	4,880	4,850

TABLE F2-10 TOTAL WATER REQUIREMENT BY CROPPING PATTERN

UNIT : '000 m^3
(m^3/sec)

ALTER-NATIVE	CROPPING ACREAGE (Fed.) WINTER	SUMMER	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
CROPPING PATTERN-1	Berseem 3,600 Wheat 3,600 Fruits	Sesame 3,600 Sorghum 3,600 1,800	4,415 (1.65)	5,341 (2.21)	5,620 (2.10)	4,510 (1.74)	3,389 (1.27)	7,031 (2.71)	11,441 (4.27)	8,946 (3.34)	2,984 (1.15)	1,380 (0.52)	3,976 (1.53)	5,239 (1.96)	64,272 (2.04)
CROPPING PATTERN-2	Berseem 3,600 Tomato 1,800 Wheat 1,800 Fruits	Sesame 3,600 Sorghum 3,600 1,800	4,287 (1.60)	5,111 (2.11)	5,470 (2.04)	4,346 (1.68)	3,389 (1.27)	7,031 (2.71)	11,441 (4.27)	8,988 (3.36)	3,214 (1.24)	2,120 (0.79)	4,180 (1.61)	5,079 (1.90)	64,656 (2.05)
CROPPING PATTERN-3	Berseem 3,600 Tomato 1,800 Fruits	Sorghum 3,600 Sesame 1,800 Sorghum 1,800 1,800	4,159 (1.55)	4,880 (2.02)	5,321 (1.99)	4,182 (1.61)	3,329 (1.24)	6,772 (2.61)	11,170 (4.17)	8,917 (3.33)	3,445 (1.33)	2,860 (1.07)	4,383 (1.69)	4,919 (1.84)	64,337 (2.04)
CROPPING PATTERN-4	Berseem 3,600 Beans 1,800 Wheat 1,800 Fruits	Maize 3,600 Sorghum 3,600 1,800	4,435 (1.66)	5,280 (2.18)	6,278 (2.34)	5,560 (2.15)	6,154 (2.30)	9,260 (3.57)	13,745 (5.13)	9,976 (3.72)	2,984 (1.15)	1,872 (0.70)	4,058 (1.57)	5,041 (1.88)	74,643 (2.37)
CROPPING PATTERN-5	Berseem 2,400 Berseem (S) 2,400 Tomato 1,200 Wheat 1,200 Fruits	Groundnuts 2,400 Watermelon 2,400 Sorghum 2,400 1,800	4,214 (1.57)	5,004 (2.07)	5,055 (1.89)	5,330 (2.06)	5,342 (2.00)	6,644 (2.56)	7,771 (2.90)	6,314 (2.36)	2,564 (0.99)	1,767 (0.66)	4,022 (1.55)	5,068 (1.89)	59,095 (1.87)

Note : The total water requirement was estimated for the alternative study on the cropping pattern based on a reclamation area of 9,000 feddan in North Wahby and Com Osheem area.

TABLE F2-11 CALCULATION OF WATER REQUREMENT PLANTED IN FAYOUM IN 1984

Source : Ministry of Irrigation, Fayoum

CROPS	WATER REQUREMENT per FEDDAN in M^3 per MONTH												ACREAGE to be planted	TOTAL AMOUNT OF WATER
	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL	fed.	MCM
Summer Maize				1270	850	1085	530					3,735	50,000	188.750
Summer Millet				1230	825	1045	515					3,615	63,000	227.745
Rice Nursery			840	840								1,680	2,500	4,200
Rice				410	2550	2005	2975	2200				10,140	18,000	182.520
Rice directory seeded			205	1680	2550	2005	2975	2200				11,615	2,000	23.230
Rush (Samar)			410	1680	2550	2005	2975	2200				11,820	5,000	59.100
Sesame				640	860	1000	510					3,010	4,000	12.040
Groundnuts				940	1260	1600	800					4,600	600	2.760
Sunflower				635	850	1085	530					3,100	7,000	21.700
Potato							1450	1820	1730			5,000	100	0.500
Tomato Nursery											1650	1,650	(40)	0.066
Tomato	1100	1100	1170	1340	1130							5,840	2,000	11.680
Cucumber		550	1100	1170	1340							4,160	1,500	6.240
Water Melon (Shaman)		550	1170	1340	1130							4,190	10,000	41.900
Melon for seeds			1170	1340	1130	210						3,850	5,000	19.250
Vegetables			1170	1340	1130	210						3,850	4,000	15.400
Geranume (Ettr)			1170	1340	1130	1450	1820	1730	600			9,240	700	6.468
Mint (Rehaina)			1170	1340	1130	1450	1820	1730	600			9,240	2,800	25.872
Nili Maize					780	750	710	810	440			3,490	59,500	207.655
Nili Millet					430	820	770	880	485			3,385	7,900	26.742
Egyptian Grasses							1045	1310	1245			3,600	2,300	8.280
Tomato Nursery						1450						1,450	(500)	0.725
Nili Tomato							2900	1820	1730			6,450	23,000	148.350
Nili Cabbage & Califlower							1450	1820	1730			5,000	5,000	25.000
Nili Rice							205	2550	2005	2975	2200	9,935	1,500	14.903
Wheat	395	397	374							410	459	2,035	65,000	132.275
Berseen	800	795	870	240					65	350	450	3,570	117,150	418.226
Broad Beans (Fool)	323	487	103								1094	2,007	22,000	44.154
Fenu - greek (Helbe)	313	94							125	285	313	1,130	7,000	7,910
Barley	360	300								413	417	1,490	21,800	32.482
Lupine (Termis)	404	45							160	336	365	1,310	100	0.131
Onion	415	425	390							780	440	2,450	4,500	11.025
Flax	250	255	245							140	300	1,190	250	0.298
Garlic	350	365	330							330	400	1,775	100	0.178
Tomato Nursery								600				600	(500)	0.300
Tomato	665	95							1200	800	900	3,660	23,000	84.180
Cabbage & Califlower	665	95							600	800	900	3,050	9,000	27.540
For Medicine or Perfume: Camonile	550	1100								800	900	3,350	2,500	8.375
For Medicine or Perfume: Geranume	550	1100								800	900	3,350	800	2.680
For Medicine or Perfume: Other Plant	550	1100								800	900	3,350	1,700	5.695
Cotton		960	430	600	950	1070	530					4,540	35,000	158.900
Sugar Cane	530	520	660	740	760	1000	1210	1300	1070	1000	930	9,740	478	4,656
Orchards							905	830	825			2,560	21,948	56,187
TOTAL WATER REQUIREMENT													609,726 (540)	2,274,288
Plus 10 % of losses														2,501,701

Note : *Water dury was doubled due to much SHARAKI in land.

TABLE F2-12 SCHEDULE OF LEACHING TEST

TEST LOCATION & NO.		PREPARATION		FIRST LEACHING			SECOND LEACHING			THIRD LEACHING		
		SIZE OF FRAME LXWXH / DATE	SAMPLE (A) NO./DEPTH cm	LEACHING WATER	PERIOD	SAMPLE (B) NO./DEPTH cm	LEACHING WATER	PERIOD	SAMBLE (C) NO./DEPTH cm	LEACHING WATER	PERIOD	SAMPLE (D) NO./DEPTH cm
NORTH WAHBY AREA	NO. 1	2.00X1.20X0.40 Feb. 20	2 / 5	200 mm 280ppm	1 day	2 / 5 2 /20						
	NO. 2	2.00X1.00X0.50 Feb. 21	2 / 5 2 /40	250 mm 200ppm	2 hrs	2 / 5 2 /40	125 mm 200ppm	1 day	2 / 5 2 /40			
	NO. 3	2.00X1.20X0.50 Feb. 22	4 / 5 4 /40	250 mm 230ppm	1 day	4 / 5 4 /40	125 mm 310ppm	2 days	4 / 5 4 /30			
	NO. 4	2.20X1.20X0.30 Feb. 23	4 / 5 4 /25	250 mm 310ppm	2 days	4 / 5 4 /25	170 mm 290ppm	2 days	4 / 5 4 /25	170 mm 280ppm	3 days	4 / 5 4 /25
	NO. 5	1.90X1.10X0.40 Feb.25	4 / 5	250 mm 290ppm	2 days	4 / 5 4 /25	250 mm 290ppm	2 days	4 / 5 4 /25	250 mm 280ppm	4 days	4 / 5 4 /25
	NO. 6	2.00X1.10X0.35 Feb. 26	4 / 5 4 /30	250 mm 280ppm	4 days	4 / 5 4 /30	250 mm 270ppm	6 days	4 / 5 4 /30			
	NO. 7	1.60X1.00X0.50 Eeb. 27	4 / 5 4 /40	250 mm 280ppm	1 day	4 / 5 4 /30	250 mm 330ppm	3 days	4 / 5 4 /25			
COM OSHEEN	NO. 8	2.10X1.10X0.40 Feb. 28	4 / 5 4 /30	250 mm 270 mm	2 days	4 / 5 4 /25	250 mm 330 mm	2 days	4 / 5 4 /25	250 mm 280ppm	4 days	4 / 5 4 /25
	NO. 9	2.00X1.10X0.50 Feb. 29	4 / 5 4 /30	250 mm 270 mm	3 days	4 / 5 4 /25	250 mm 280ppm	4 days	4 / 5 4 /25			
	NO.10	2.00X1.20X0.40 Feb. 29	4 / 5 4 /30	250 mm 300ppm	3 days	4 / 5 4 /25	250 mm 290ppm	4 days	4 / 5 4 /25			

TABLE F2-13 RESULTS OF LEACHING TEST

Note: Unit of EC: mmho/cm

TEST NO	EC A	EC B	EC C	EC D	PH A	PH B	PH C	PH D
NO 1-1	127.54	15.46			8.05	8.45		
1-2	95.66	15.62			8.05	8.50		
1-3		137.11				8.10		
1-4		146.67				7.55		
NO 2-1	8.45	1.37	0.43		7.95	8.85	8.00	
2-2	9.57	1.42	1.70		8.10	8.40	8.70	
2-3	1.91	2.34	0.64		8.80	8.85	8.80	
2-4	1.48	1.07	0.73		8.35	8.85	8.00	
NO 3-1	170.06	4.15	6.06		8.10	8.35	7.90	
3-2	127.54	4.36	4.30		7.90	7.85	7.60	
3-3	148.27	3.88	4.84		7.60	7.70	7.75	
3-4	138.17	4.09	5.42		8.20	8.00	8.10	
3-5	175.37	19.13	9.33		8.05	8.10	7.75	
3-6	185.00	186.00	15.62		8.10	8.10	7.95	
3-7	276.34	19.66	9.09		7.65	8.15	8.30	
3-8	148.80	286.97	140.30		8.05	7.40	8.95	
NO 4-1	115.60	4.15	3.99	4.15	7.65	8.35	8.35	8.15
4-2	113.19	4.04	4.20	4.15	7.10	7.85	8.20	8.10
4-3	217.88	4.25	3.77	3.93	7.30	8.15	8.25	8.40
4-4	154.11	5.26	4.15	3.93	7.10	7.90	8.10	8.35
4-5	153.05	7.97	10.52	7.65	7.15	8.05	7.75	8.20
4-6	159.43	8.77	8.61	8.61	7.30	7.95	7.85	8.40
4-7	138.17	6.06	2.98	6.38	7.25	7.60	7.75	7.65
4-8	148.80	7.81	8.93	6.06	7.20	8.00	7.60	8.30
NO 5-1	24.45	6.70	3.19	1.31	7.45	8.20	8.45	8.15
5-2	13.07	3.61	1.70	0.99	7.75	8.20	8.40	8.55
5-3	17.01	3.61	3.19	1.59	7.45	7.90	8.45	8.40
5-4	20.19	2.44	1.02	3.19	7.85	7.80	8.10	8.35
5-5		4.94	1.91	1.56		8.50	8.35	8.85
5-6		12.75	4.78	1.70		8.15	7.50	8.15
5-7		9.25	3.07	2.66		7.85	7.35	7.95
5-8		9.88	1.91	2.29		8.10	8.00	8.35

TEST NO	EC A	EC B	EC C	EC D	PH A	PH B	PH C	PH D
NO 6-1	1.38	7.33	7.33		7.50	8.00	8.75	
6-2	191.31	8.93	9.88		7.85	7.70	8.20	
6-3	201.94	13.07	8.93		7.70	7.70	7.70	
6-4	186.00	13.39	7.65		7.90	7.75	8.15	
6-5	70.15	14.35	68.55		7.70	7.75	7.40	
6-6	829.02	79.71	31.89		7.30	7.55	7.60	
6-7	65.37	170.06	62.18		7.80	7.10	7.95	
6-8	66.96	130.73	20.19		7.40	7.95	7.35	
NO 7-1	7.17	3.51	6.70		7.85	7.80	7.90	
7-2	7.33	3.35	3.72		7.75	7.35	8.00	
7-3	7.01	3.61	5.58		7.50	8.05	7.20	
7-4	9.25	3.51	3.72		7.45	8.30	7.70	
7-5	6.86	3.72	3.77		7.45	7.25	7.70	
7-6	6.06	4.57	4.20		7.80	7.70	7.75	
7-7	7.81	5.10	4.78		8.35	7.85	7.95	
7-8	6.22	3.93	3.88		7.50	7.65	7.55	
NO 8-1	14.99	4.78	3.51	5.42	7.65	7.80	7.45	7.85
8-2	11.16	5.42	31.89	4.15	7.80	7.95	8.00	8.30
8-3	14.03	1.38	4.20	3.83	7.80	7.90	7.50	7.70
8-4	9.25	7.01	8.45	4.04	8.20	8.40	8.20	8.15
8-5	228.51	5.74	68.55	9.25	8.25	8.35	7.85	7.95
8-6	191.31	4.78	4.15	3.61	8.60	7.50	7.90	7.70
8-7	829.02	201.94	110.00	4.46	7.75	8.70	8.60	8.00
8-8	244.46	4.84	46.23	4.52	8.15	8.05	8.05	8.15
NO 9-1	38.26	31.89	6.22		7.75	8.35	8.05	
9-2	44.64	100.44	65.37		7.70	7.55	7.55	
9-3	10.52	137.11	35.07		7.75	7.30	8.50	
9-4	15.94	47.83	6.38		8.05	7.40	8.65	
9-5	302.91	297.60	127.54		7.40	7.95	8.05	
9-6	876.85	308.23	79.71		7.70	7.85	7.75	
9-7	297.60	297.60	12.44		8.15	7.90	7.75	
9-8	286.97	297.60	113.19		8.70	7.80	8.00	
NO 10-1	57.39	32.42	5.00		7.30	7.55	8.35	
10-2	62.18	27.10	14.88		7.85	7.80	7.70	
10-3	86.09	55.80	7.65		7.45	7.45	8.55	
10-4	146.67	10.84	10.52		7.15	8.50	7.50	
10-5	244.46	106.82	82.90		7.70	8.10	8.10	
10-6	180.68	124.35	17.54		7.75	7.35	7.95	
10-7	223.20	27.63	31.89		7.95	8.00	8.15	
10-8	255.08	308.23	32.42		7.35	7.50	7.80	

TABLE F2-14 Leaching Requirement

Crops	Leaching Requirement Ration (LR)					Leaching Requirement (Ln)	
	Diw = Dew	ECiw	Drw	ECdw	$\frac{Diw \cdot ECiw}{(Drw + Diw) ECdw}$	$\frac{Dcw}{1 - LR}$	$\frac{Dcw}{1 - LR} - Dew$
	m^3/fed	mmhos/cm		mmhos/cm			m^3/fed
Berseen	2,636	1.2 1/	0	10.0	0.120	2,995	359
Wheat	1,672	"	"	8.0	0.150	1,967	295
Tomato	1,900	"	"	8.0	0.150	2,235	335
Sesame	2,289	"	"	8.0	0.150	2,693	404
Sorghum	2,749	"	"	8.0	0.150	3,234	485
Watermelon	2,876	"	"	8.0	0.150	3,384	508
Groundnut's	1,986	"	"	8.0	0.150	2,336	350

Note : 1/ ECiw : Electrical conductivity of the irrigation water in millimhos per centimeter for average mixed salinity of Batts Drain and Bahr Wahby which is 785 ppm in eqririvalent to 1.2 mmhos/cm (785/640).

TABLE F2-15 Results of Ec and Ph Analysis for Study on Irrigation Effect of Reclamation Area in a Part of North Wahby Area

No.	Location of Sample	EC (mmhos/cm) A (Depth:m)	EC (mmhos/cm) B (Depth:m)	PH A	PH B
S- 1	Corn field along Bahr Fanus with poor plants	14.50(0.10)	10.59(0.60)	8.40	8.10
S- 2	-do-	10.94(0.10)	9.67(0.60)	8.40	8.15
S- 3	-do-	9.29(0.10)	7.38(0.60)	8.25	8.30
S- 4	-do-	7.83(0.10)	20.78(0.60)	7.90	4.80
S- 5	-do-	3.77(0.10)	6.24(0.60)	7.95	8.15
S- 6	Corn field along Bahr Fanus with good plants	12.08(0.10)	10.05(0.60)	8.45	7.85
S- 7	-do-	15.04(0.10)	17.40(0.60)	8.35	8.10
S- 8	-do-	13.22(0.10)	10.12(0.60)	8.25	8.15
S- 9	-do-	16.43(0.10)	11.60(0.60)	8.10	8.35
S-10	-do-	9.30(0.10)	11.21(0.60)	8.25	8.05
S-21	In Olive Plantation (6m × 4m interval) No irrigation	47.86(0.10)	145.90(0.20)	7.95	7.85
S-22	" Irrigated by Drip	5.74(0.10)	4.56(0.30)	7.65	7.80
S-23	" No irrigation	132.18(0.10)	232.40(0.20)	7.95	7.50
S-24	" Irrigated by Drip planted with corn.	9.98(0.10)	4.35(0.40)	7.85	7.55
S-25	In Grape Plantation (3m × 2m interval) No irrigation	21.88(0.10)	136.70(0.15)	7.75	7.80
S-26	" irrigated by Drip Planted with corn	9.98(0.10)	6.38(0.40)	7.65	8.95
S-27	" No irrigation	120.30(0.05)	191.43(0.15)	7.70	7.65
S-28	" Irrigated by Drip Planted with Corn	1.69(0.10)	3.19(0.40)	8.20	8.35
S-29	" No irrigation	109.40(0.10)	154.97(0.40)	7.25	7.45
S-30	" irrigated by Drip Planted with corn	20.05(0.10)	3.87(0.40)	8.00	7.60
S-31	Reclaimed area with the initial leaching. no good growth of corn	51.96(0.10)	11.76(0.40)	7.45	5.35
S-32	" rather good growth of corn	5.20(0.10)	12.58(0.50)	7.85	7.45
S-33	" Watermelon, Sunflower and grape irrigated by furrow	6.29(0.10)	4.92(0.50)	8.15	7.55
S-34	" Grape (3 × 1.5m interval) irrigated by furrow	8.20(0.10)	5.47(0.50)	7.40	7.90
S-35	" Corn (green fodder) irrigated by bassin	3.97(0.10)	4.28(0.40)	7.55	7.85
S-36	" Between the row of watermelon and corn	37.37	17.78	7.80	7.55
S-37	" on the row of watermelon and corn	8.27	8.75	8.00	8.20

TABLE F2-16 Results of Ec and Ph Analysis for Soil Dressing Materials

No.	Location of Sample	EC (mmhos/cm)	PH
S-11	Dredged material of Wastany Drain at near K-13	51.96	7.95
S-12	-do-	13.67	7.45
S-13	Dredged material of Wastany Drain at upstream reach	9.14	8.15
S-14	-do-	14.50	8.30
S-15	Dredged material of Bahr Fanus at downstream	13.53	8.05
S-16	-do-	8.41	7.95
S-17	Dredged material of Bahr Fanus at middlestream	3.77	7.55
S-18	-do-	1.55	7.55
S-19	Dredged material of Bahr Fanus at upstream	1.74	7.80
S-20	-do-	7.11	7.05
M- 1	Dredged material of Gomhouria Canal at 1.5 K	8.69	7.85
M- 2	-do-	7.61	8.05
M- 3	Dredged material of Bahr Wahby at 55 K	0.63	7.90
M- 4	-do-	2.45	7.35
M- 5	Dredged material of Bahr Wahby at 52 K	1.64	7.55
M- 6	-do-	3.43	7.85
M- 7	Dredged material of Bahr Wahby at 50 K	1.26	7.50
M- 8	-do-	2.39	7.55
M- 9	Dredged material of Bahr Wahby at 46 K	1.47	8.25
M-10	-do-	6.52	7.75

Table F2-17 Chemical and Physical Analysis of Soil Dressing Materials

Items of Analysis		Samples of Soil Dressing Materials									
		M-1	M-2	M-3	M-4	M-5	M-6	M-7	M-8	M-9	M-10
Soluble Cation (meq/ℓ)	Ca^{2+}	19.04	26.92	2.19	14.90	6.92	7.11	5.69	11.11	5.19	15.15
	Mg^{2+}	13.37	19.93	2.51	7.11	3.08	5.73	3.90	4.59	3.69	8.14
	Na^{+}	52.10	29.83	1.48	4.78	4.09	19.22	4.96	8.04	6.74	39.04
	K^{+}	2.58	3.03	0.46	0.93	0.42	0.52	0.51	0.71	0.42	1.22
Soluble Anion (meq/ℓ)	CO_3^{-2}	-	-	-	-	-	-	-	-	-	-
	HCO_3^{-1}	0.97	1.02	0.93	1.03	0.85	1.46	1.22	1.07	2.24	1.08
	SO_4^{-2}	24.54	43.04	3.08	24.41	10.15	15.35	9.98	16.10	7.24	17.38
	Cl^{-1}	61.58	35.65	2.63	2.28	3.51	15.79	3.86	7.28	5.96	45.09
ECe mmohos/cm at 25C		8.69	7.61	0.63	2.45	1.64	3.43	1.26	2.39	1.47	6.52
Soluble Cation (meq/100g)	Ca^{2+}	2.39	1.86	0.13	0.72	0.47	0.57	0.42	0.66	0.34	1.07
	Mg^{2+}	1.68	1.38	0.15	0.34	0.21	0.46	0.29	0.27	0.25	0.58
	Na^{+}	6.56	2.06	0.09	0.23	0.28	1.54	0.36	0.48	0.45	2.76
	K^{+}	0.32	0.21	0.03	0.04	0.03	0.04	0.04	0.04	0.03	0.09
Soluble Anion (meq/100g)	CO_3^{-2}	-	-	-	-	-	-	-	-	-	-
	HCO_3^{-1}	0.12	0.07	0.05	0.05	0.06	0.12	0.09	0.06	0.15	0.08
	SO_4^{-2}	3.09	2.98	0.18	1.18	0.69	1.23	0.73	0.95	0.52	1.23
	Cl^{-1}	7.76	2.47	0.15	0.11	0.24	1.27	0.28	0.43	0.39	3.19
CEC meq/100g	Soil	40.88	39.91	26.57	17.42	33.33	35.64	55.22	35.53	33.07	36.51
Exchangeable Cation (meq/100g)	Ca^{+2}	17.77	24.09	18.15	10.13	20.44	16.65	34.82	24.94	18.01	19.12
	Mg^{++}	14.29	10.49	8.19	6.56	9.78	13.16	16.11	8.52	10.68	9.40
	Na^{+}	7.16	3.36	1.50	1.02	2.30	4.15	2.53	1.11	2.52	6.27
	K^{+}	1.66	1.97	0.73	0.71	0.81	1.68	1.76	0.96	1.81	1.72
Particle Size Distribution											
Gravel %		1.92	1.95	2.04	1.24	2.52	1.98	0.48	5.03	1.05	0.31
Coarse Sand %		25.49	25.23	37.95	36.00	20.92	15.53	2.53	12.59	3.13	2.88
Fine Sand %		23.00	22.39	20.39	34.29	26.15	26.36	22.80	32.80	41.80	34.63
Silt %		7.51	7.40	12.05	10.75	17.48	20.48	12.74	12.84	14.89	16.57
Clay %		44.00	44.98	29.61	18.96	35.45	37.63	61.93	41.77	40.18	45.92
Texture Class		Sandy Clay	Sandy Clay	Sand Clay Loam	Sandy Loam	Sandy Clay	Clay Loam	Clayey	Sandy Clay	Clayey	Clayey
$CaCO_3$ %		2.90	3.18	3.63	6.81	3.99	5.08	6.36	13.62	15.25	19.61
$CaSO_4 \cdot 2H_2O$ Gypsum %		1.203	0.990	0.036	0.105	0.033	0.033	0.066	0.157	0.088	0.088
Ph		7.85	8.05	7.90	7.35	7.55	7.85	7.50	7.55	8.25	7.75
Organic Matter C %		0.20	0.40	0.75	1.24	1.41	1.25	0.48	0.38	1.65	0.86
Organic N %		0.042	0.047	0.037	0.070	0.560	0.070	0.070	0.042	0.135	0.075
Available P %		0.003	0.007	0.015	0.008	0.011	0.004	0.010	0.006	0.012	0.007

Note : 1. Sampling was made on July 22, 1984 by the Study Team

Chemical and physical analysis were carried out by Department of Soil and Water Science,

Fayoum faculty of Agriculture, Cairo University in Fayoum, Egypt.

2. Sampling were made from the dredged materials at the following stations of Bahr Wahby;

M - 1 & 2 : Appr. 46.70 km

M - 3 & 4 : Appr. 51.20 km

M - 5 & 6 : Appr. 54.90 km

M - 7 & 8 : Appr. 1.0 km of Com Osheem Canal

M - 9 & 10 : Appr. 0.8 km of Gomhouria Canal

Fig. F2-1 Location of Field Observation for Intake Rate, Permeability & Leaching

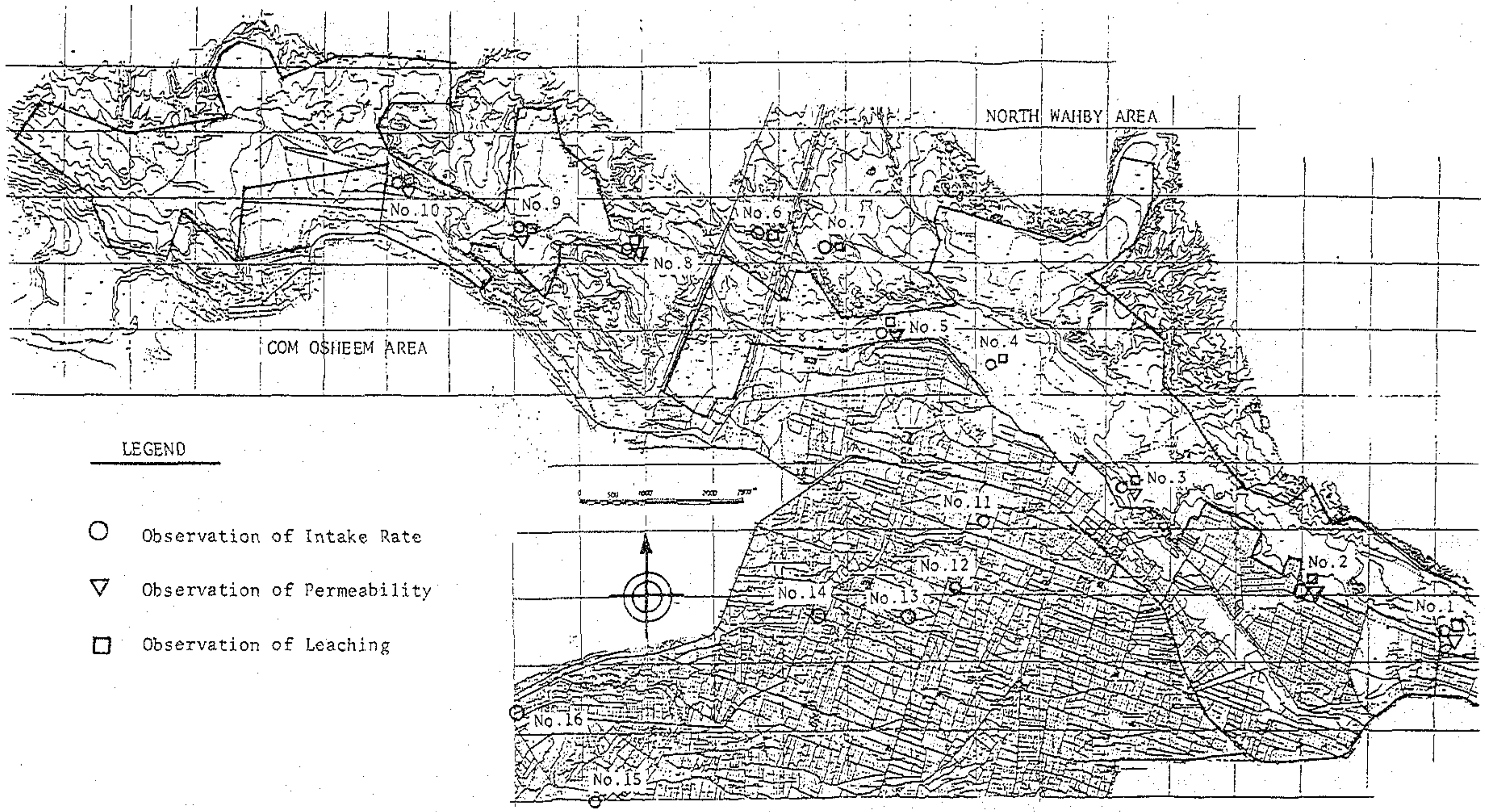


Fig. F2-2 Relation between Soil Salinity and Total Depth of Leaching Water

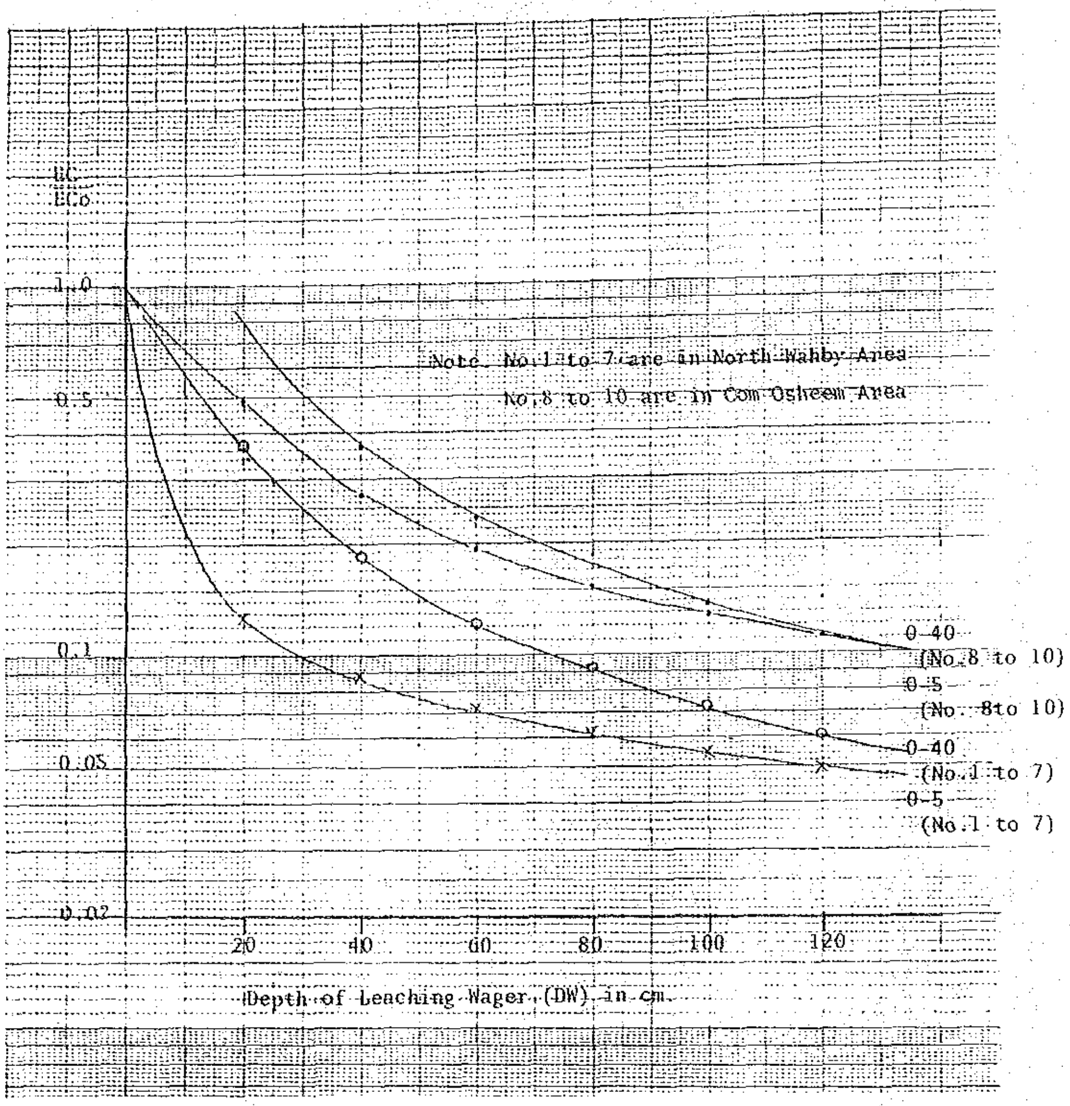


Fig. F2-3 Leaching Curve

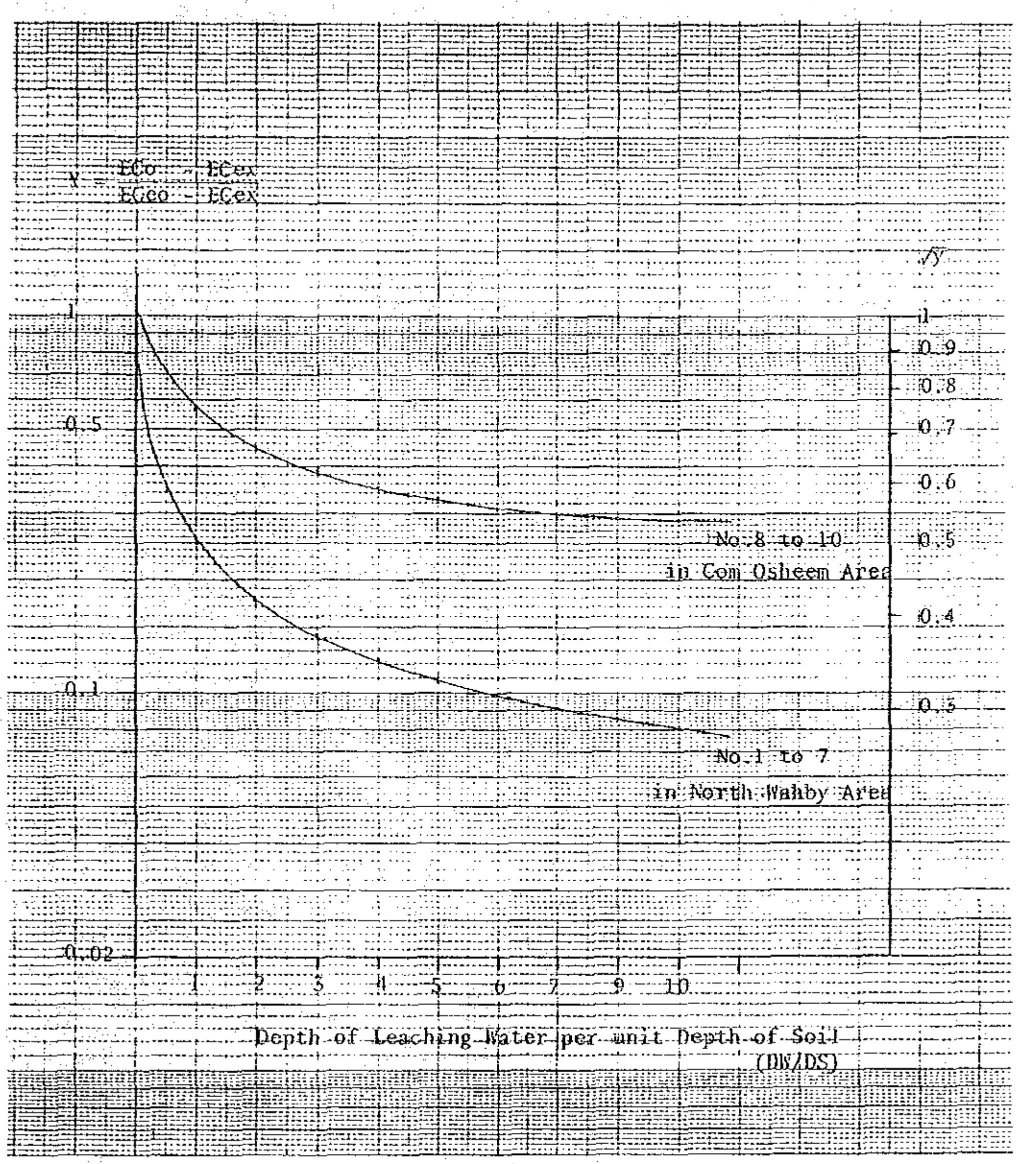
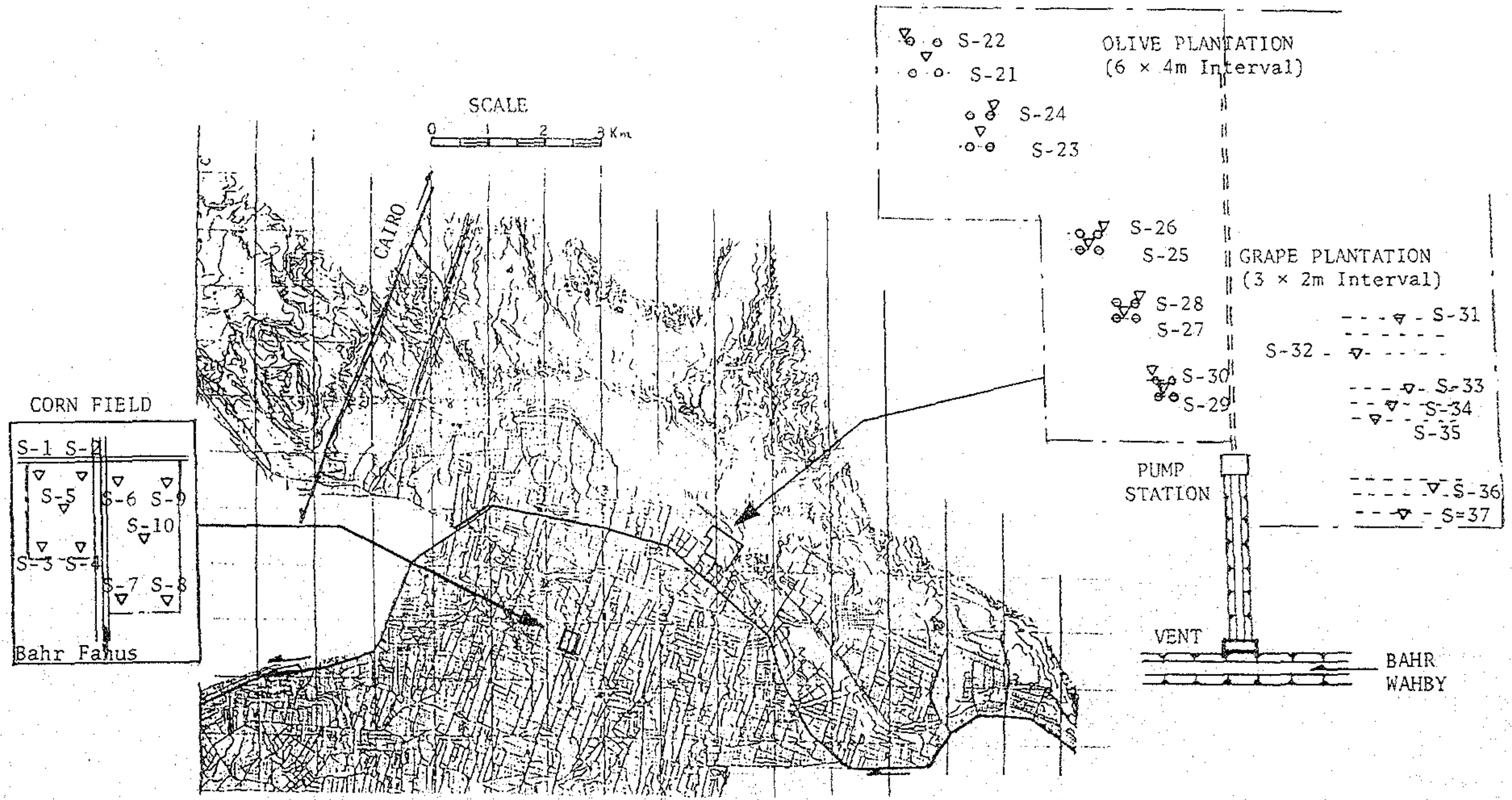


Fig. F2-4 Location of Sampling for Ec and Ph Analysis Study on Irrigation Effect



F-3. Drainage Plan in Reclamation Area

F-3.1. Drainage Plan

Drainage is generally planned for the purpose of eliminating surface runoff and removing excessive moisture in the soils. 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 are 0.23 cubic meters per second and 0.16 cubic meters per second in North Wahby and Com Osheem, respectively.

Reclamation area of North Wahby and Com Osheem areas are topographically expanding the elevation between 15 meters and 28 meters and average width of about 1.4 kilometers. Since the groundwater is absent in this area, unused water out of the total irrigation water will infiltrate into the top soil layer. After saturation of the top soil layer, the said water will infiltrate into the sub-layer. Repeating this movement of water, when all top layer and sub-layer of the area above certain elevation of the area will be saturated, drainage water will come out to the lower places. Taking into the such phenomenon and volume of water, a duration of saturation in the area is estimated at about 10 years.

Reclamation of the area will gradually be developed and the said duration will be taken longer time than ten years estimated. In this regards, notwithstanding the provision of drainage facilities is not required in the reclamation area during a period of about ten to 15 years after completion of reclamation and commencement of irrigated agriculture, construction of open drainage canal is proposed 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 or 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.

F-3.2. Drainage Facilities

As for drainage facilities in the reclamation area, drainage canal should be excavated at the southern verge of the reclamation area as shown in Fig. F3-1. The typical section of the drainage canal is designed as the minimum section in terms of applicability for construction works. Depth of the canal is restricted by the height of groundwater table. For prevention of the top soil from accumulation of salt by irrigated agriculture in the future, the groundwater table should be kept more than 1.5 meters below the ground surface. The typical section of the drainage canal is designed as shown in Fig. F3-1.

Drainage water gathered into the drainage canal will be discharged to the existing drains such as Nazzaz Saweres Drain, Azzam Drain and El Wastany Drain and the depressed area located at the west-southern part of Com Osheem area. Nazzaz Saweres Drain of 4.5 kilometers long, Azzam Drain of 5.8 kilometers long and El Wastany Drain of 7.0 kilometers long should be rehabilitated and/or improved for the purpose.

For the observation of groundwater table, the observation well with perforated PVC casing of 50 millimeters in diameter will be installed by boring six meters in depth and 65 millimeters in diameter. The said well are planned to set 15 places in North Wahby area and ten places in Com Osheem area.

For the observation, two sets of water level indicators will be prepared by the Project.

TABLE F3-1 Discharge of Drainage in Reclamation Area

Description		Annual Mean	Monthly Max.in July	Monthly Min.in Sept.
1. Irrigation Water Supplied				
North Wahby	(1,000 m^3)	33,035	3,468	1,610
Com Osheem	(1,000 m^3)	23,196	3,118	1,195
Total	(1,000 m^3)	56,231	6,586	2,805
2. Expection Discharge of Drainage *				
North Wahby	(1,000 m^3)	7,268	763	354
	(m^3/sec)	0.23	0.28	0.14
Com Osheem	(1,000 m^3)	5,103	686	263
	(m^3/sec)	0.16	0.26	0.10
Total	(1,000 m^3)	12,371	1,449	617
	(m^3/sec)	0.39	0.54	0.24

Note : * ; Weighted irrigation efficiency is used at 78 % according to the irrigation efficiency of 76.5 % for sprinkler irrigation and 81 % for drip irrigation.

FIG F3-1 GENERAL PLAN OF DRAINAGE SYSTEM

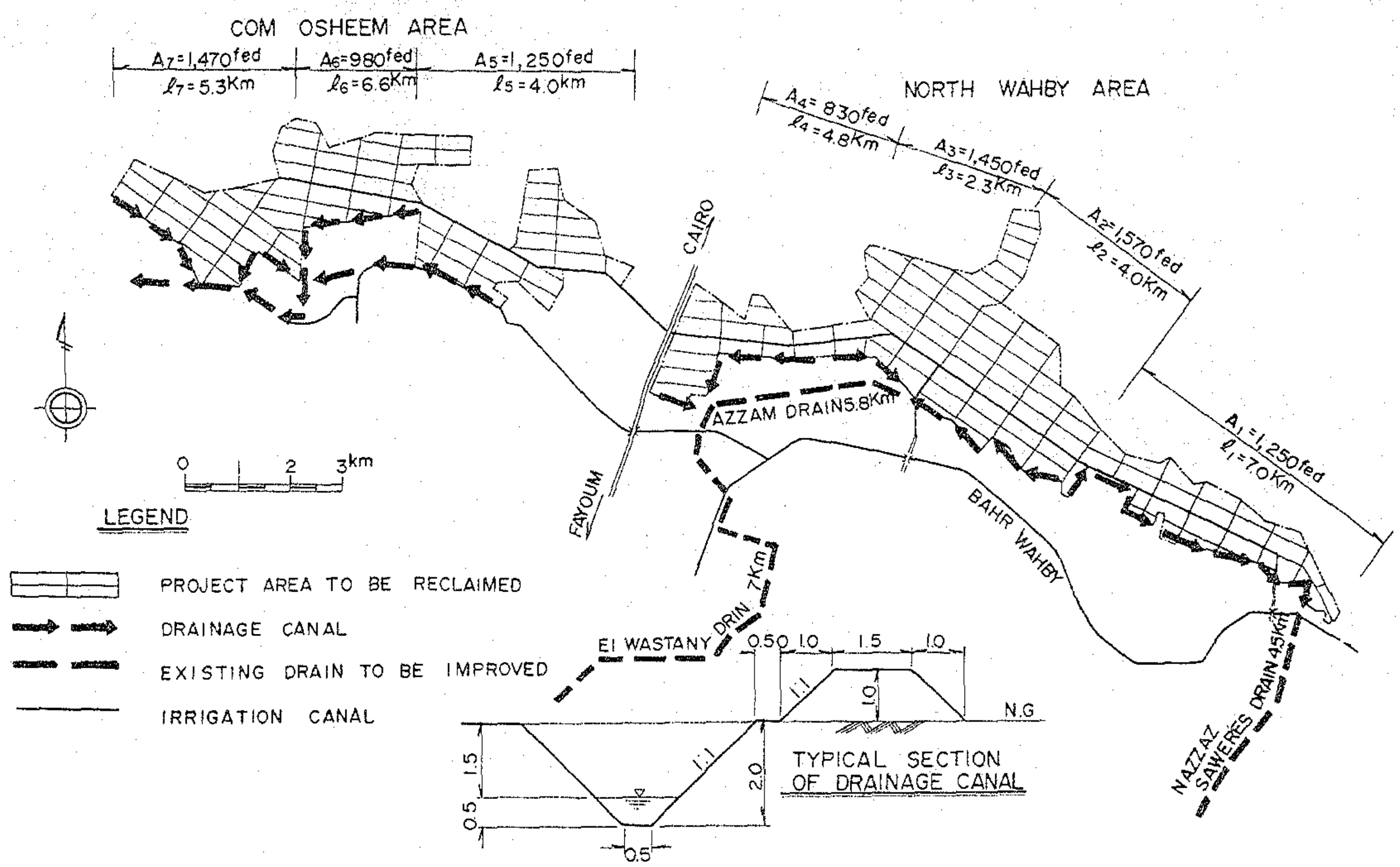
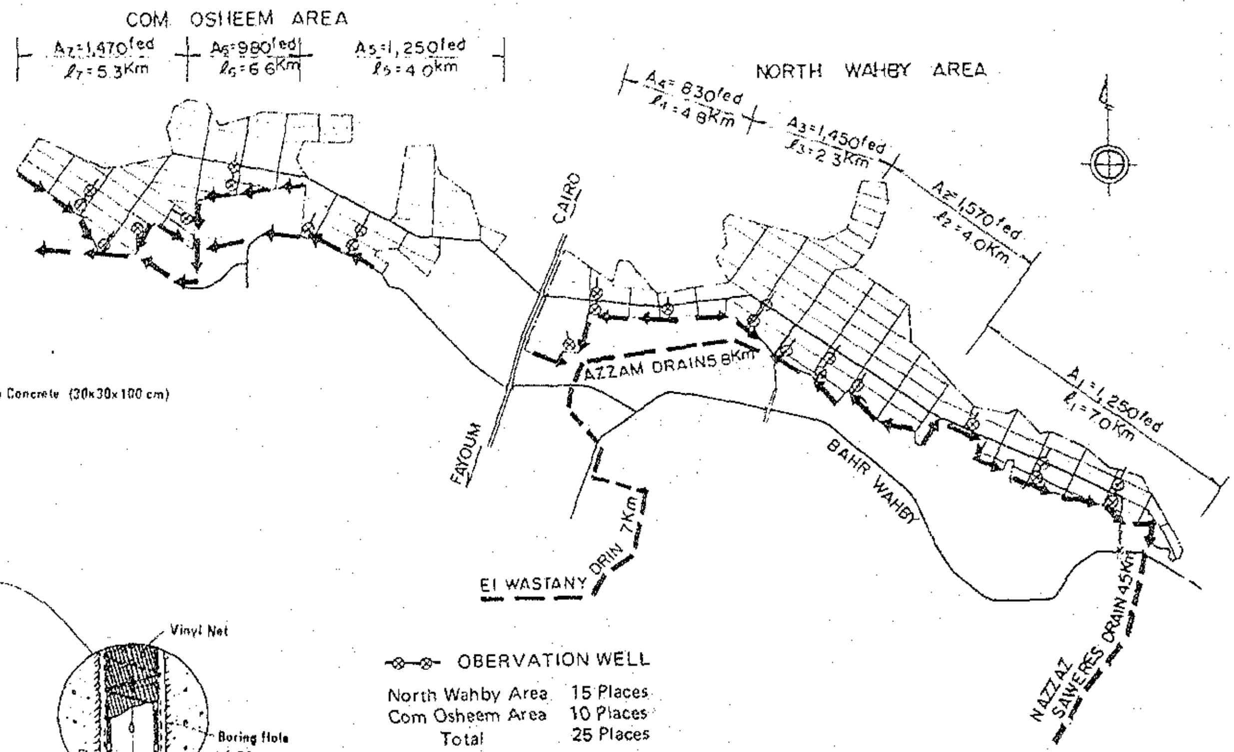
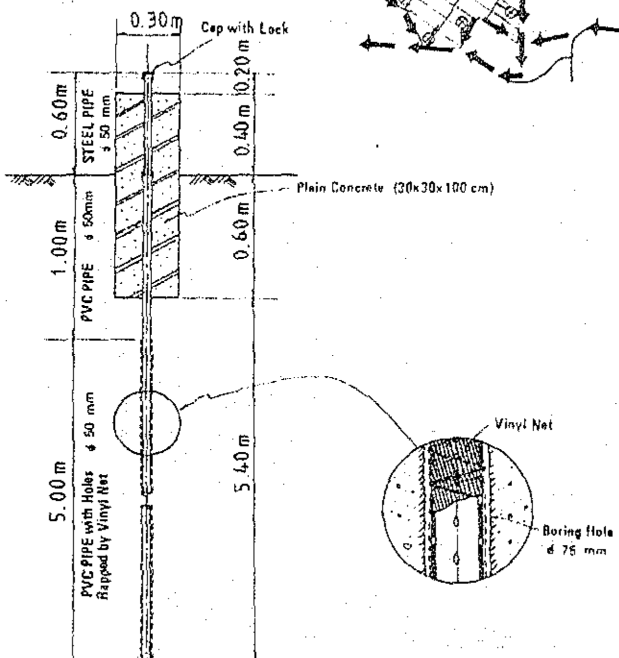


FIG F 3-2 LAYOUT OF PIEZOMETRIC SYSTEM IN THE RECLAMATION AREA





OBERVATION WELL

F-4. Irrigation Plan in Wahby Downstream Area

F-4.1. Present Irrigation System

Wahby downstream area dealt with in this study in defined as an area served by downstream Bahr Wahby Stationed between Bahr Unsi and the end of the Wahby. The area is irrigated through several branch canals laterals and sub-lateral canals as shown in Table F4-1, and Figure F4-2.

The present irrigation system in Fayoum is shown in Fig. F4-1 "Skeleton of Irrigation System in Fayoum". The existing typical canal structures are shown in Figures F4-4 and F4-5.

In the Wahby Downstream area, because of the location of the area at the downstream Bahr Wahby, many farmers complain about the insufficient supply of irrigation water. According to the observation conducted by the study team in August, 1984 as shown in Fig.B2-5. (Refer to Appendix B), the Bahr Wahby at the reach of the diversion point of the Bahr Green had a discharge of 13.9 cubic meters per day per feddan while the discharge to the entire Fayoum Governorate was recorded the monthly maximum discharge of 23.6 cubic meters per day per feddan in July, 1979, the average monthly maximum discharge of 22.5 cubic meters per day per feddan in July and August and the average annual mean discharge of 18.7 cubic meters per day per feddan. It is obvious from this fact that the irrigation water supply to this area has not been enough to maintain growth of crops.

Concerning the irrigation facilities in this area, the total length of canals such as main canal, branch canals, lateral canals and sub-lateral canals, is 53.11 kilometers or 3.34 meters per feddan (7.95 m/ha) as computed from the Table F4-1. In generally speaking, an intensity of canal length of the irrigation system on the gravity irrigation would be considered at four to six meters per feddan (10 to 15 m/ha). The present irrigation system in the area has a little bit small intensity of the canal length. As for the service area by a vent, the direct irrigated area of the main canal, Bahr Wahby, is 82 feddan (34 ha), while that of the branch canals and lateral/sub-lateral canals are 108 feddan (46 ha) and 152 feddan (64 ha), respectively. Service area covered by the lateral/sub-lateral canal seems to be wide for carrying out the proper water management.

Aside from the above-mentioned existing irrigation facilities, one of significant aspects for making the shortage of the irrigation water is uncooperative operation of the system. Some farmer makes a vent larger or lower than the original size by breaking the crest of the vent while some one provides an additional pipe below the crest of the vent to receive much water. To prevent such illegal distribution of the irrigation water the Ministry of Irrigation (MOI) in Fayoum is trying to lower the water level by installing pipes at the check weir and to control the distribution of water. These handling of the irrigation system made much troubles and provided unbalanced water distribution. Repeating this way can not be reached to the successful goal in water management. Provision of adequate irrigation facilities by improving the present system and also organization of the farmers group for cooperative operation of the system would be considered as the essential procedures for satisfaction of unified distribution of irrigation water in the area.

During the field work in July and August, 1984 in addition to the soil survey, the auger-hole tests for permeability and EC and PH analysis were carried out as shown in Fig. F4-3 and Tables F4-3 and F4-4. Permeability of K-13 and K-14 are analyzed at 0.035 inches per hour (2.5×10^{-5} cm/s) and 4.08 inches per hour (2.9×10^{-3} cm/s), respectively. EC at K-12 shows a little bit high value while EC of the top soil at K-13 and K-14 are good values for growth of crops.