CHAPTER 4

THE PROPOSED PROJECT

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4-1 Project Description

To accomplish the objectives of the development of El Sir & El Kawareer Zone with the total land area of 135,000 feddans, it has been proposed to implement the integrated agricultural development project that consists of the following main components:

- **Water Conveyance and Water Management:**
  construction of the water conveyance system to connect the Shikh Gaber El Sabah canal with the Project area with the design capacity of 52.66 m^3/sec, including the canals with the length of 44.1 km, main pumping station No.7 and the water management facilities to control water quantity and quality;

- **Land Reclamation and Irrigation and Drainage Systems:**
  construction of the irrigation and drainage systems in the Project area by which the area of 111,000 feddans (gross 135,000 feddans) will be reclaimed for irrigated agriculture development;

- **On-farm Irrigation and Drainage Facilities:**
  construction of the on-farm irrigation and drainage facilities that are operated by the settlers themselves at the expense of them;

- **Agricultural Development Supporting Services:**
  provision of supporting services to the settlers with an emphasis on small farmers and graduate farmers by the establishment of the North Sinai Agriculture Development Center and organization of agricultural cooperatives and farmer associations;

- **Settlement and Social Infrastructure:**
  settlement of about 23,200 households (total population of 116,100) in 15 villages with provision of basic social infrastructure to develop new rural communities;

- **Agro-industrial Development:**
  provision of agro-industrial factories that will be managed by the private sector, generating the value added and creating employment opportunities.

4-2 Water Conveyance and Water Management Project

4-2-1 Water Conveyance System

As discussed in Chapter 3-3, the plan that takes the route B, C-2 with the delivery water level of 110 m at the western edge of the Study area has been selected as the most advantageous plan.

Topographic surveys of this proposed route was carried out during the second field survey period, based on which the planning of the water conveyance system was made. Outlines of the proposed water conveyance system are given as follows:

(1) Water Conveyance Canal

The proposed water conveyance canal departs from the end point of the Shish Gabber El Sabbath canal, 84.9 km from the Suez Canal, and ends at the western edge of the Project area with a total length of 44.1 km.

- Conduit types

Section	Type of Conduit	Length (km)
BP - 8.7 KM	Open canal	8.7
8.7 KM - 16.5 KM	Box culvert canal	7.8
16.5 KM - 23.0 KM	Open canal	6.5
23.0 KM	Pumping station No.7	-
23.0 KM - 35.6 KM	Steel pipeline	12.6
35.6 KM - 44.1 KM	Open canal	8.5
Total		44.1

- Design discharge : 52.66 m^3/sec
- Design water level : 15.62 m MSL at BP
  : 110.00 m MSL at end point
- Open canals
  - bottom width : 12 m
  - side slope : 2/1
  - bed slope : 8 cm/km, or 1/12,500
  - water depth : 3.305 m
  - velocity : 0.86 m/sec
  - structure : concrete lining
- Box culvert canals
  - section : 3.8 m x 3,8 m x 4
  - bed slope : 19.1 cm/km, or 1/5,240
  - water depth : 3.30 m
  - velocity : 1.05 m/sec
  - structure : reinforced concrete
- Steel pipelines
  - diameter : 3,000 mm
  - nos. of pipelines : 4 lines
  - velocity : 1.862 m/sec
  - hydraulic gradient : 73.2 cm/km
- Spillway
  - location : 102.0 KM
  - capacity : 52.66 m^3/sec
  - canal length : 2.0 km
  - water depth : 2.30 m
  - bottom width : 15.0 m
  - side slope : 3/1
  - bed slope : 1/2,000
  - structure : unlined earth canal

(2) Pumping Station No.7

(a) General Description

Given the design discharge of 52.66 m^3/sec, a suction water level of 9.90 m MSL, a discharge water level of 114.18 m MSL, and an actual head of 104.33 m, the main features of the pumping station No.7 were planned as follows:

- Pump type : vertical shaft single suction diffuser and volute type
- Nos. of pump units : 7 units and 1 standby unit, total 8 units
- Pump discharge : 7.52 m^3/sec/unit = 451 m^3/min/unit
- Nominal bore : ϕ 1,200 mm
- Pump efficiency : 90%
- Motor output : 10,400 kW (14 poles) x 8 units, total of 73 MW
- Total head : 115.47 m
- Pump house : 18.5 m x 106.5 m
- Regulating reservoirs
  - Nos. of reservoirs : 2 ; No.1 at the suction and No.2 at the discharge
  - Capacity : 32,000 m^3 per reservoir

(b) Water Hammer

For the long pipeline heading by pumping with high head, countermeasure facilities are generally required to withstand the water hammer pressure. Water hammer phenomena are mainly caused by the stoppage of pumps, for example an interruption of power supplies. Having the total length of 12.6 km, the proposed pipeline may require water hammer protection measures; the following studies were carried out to provide an appropriate countermeasure:

Case 1 : No provision of countermeasure
Case 2 : Provision of two (2) one-way surge-tanks at 2 locations on the pipeline
Case 3 : Provision of three (3) one-way surge-tank at 3 locations on the pipeline
Case 4 : Two (2) one-way surge-tanks and one (1) air chamber at 3 locations on the pipeline

Based on the results of the studies given below, provision of three (3) one-way surge-tanks is proposed to protect the pipeline from the expected water hammer pressure.

Case 1: Negative pressure of (-) 60 m shall act on the pipeline.

Case 2: Two (2) tanks are installed at the stations of 2.2 KM and 9.4 Km. Negative pressure of (-) 6.5 m shall act on the pipeline which is likely to cause the detrimental water column separation. Therefore, this case is not recommendable.

Case 3: Three (3) tanks are installed at the stations of 2.2 KM, 6.6 KM and 10.2 KM. Negative pressure of (-) 1.5 m shall act on the pipeline; no water column separation shall take place.

Case 4: Two (2) tanks at the stations of 2.2 KM and 10.2 Km are installed as well as one (1) air chamber at the station 8.3 KM. The estimated negative pressure is (-) 2.0 m, a little higher than the case 3. Furthermore, the air chamber needs an air compressor and a high pressure tank, requiring frequent maintenance, thus this case is not recommended.

The three (3) one-way surge tanks will be constructed on the pipeline at the following locations:

No.1 surge tank : Station 2.2 KM from pumping station No.7, 32.2 m^2 x 5.0 m depth
No.2 surge tank : Station 6.6 KM from pumping station No.7, 1.3 m^2 x 5.0 m depth
No.3 surge tank : Station 10.2 KM from pumping station No.7

(3) Cathodic Protection

The proposed steel pipelines need the corrosion protection for mitigation of the pipe corrosion. One of the following methods is generally used:

Coating: Coatings normally intend to form a continuous film of an electrically insulating material over the metallic surface to be protected.

Insulated Joints: Insulated joints are used to break the metallic electrical connection between the anode and cathode, which are caused by the electrical potential between soil and steel, and thereby prevent the flow of current between the two.

Cathodic Protection: Cathodic protection is the use of direct current electricity from an external source to oppose the discharge of corrosion current from anodic area. In anodic area where the pipeline corrodes, current is flowing from the outer surface of the pipe steel into surrounding electrolyte (soil or water). Likewise, where current is flowing from the electrolyte into the pipe surface is cathodic and does not corrode.

To control the pipeline corrosion, the proposed pipeline should be coated to isolate the metal from direct contact with the surrounding electrolyte, and to interpose such a high electrical resistance in the anode-cathode circuit that there will be no significant corrosion current flowing from the anode to the cathode.

For all that corrosion current will be greatly reduced with the pipe coating, current can enter to or leave from the pipe only through breaks or pinholes in the coating. With concentration of current at these coating defects in anodic area on the coated pipe, the degree of attack, i.e., the rate of penetration, will be greater than the case with bare pipe under similar condition. Such concentrated anodic current flowing out from the coating defect makes sharp pitting corrosion and penetration of the pipe wall within a short period and may cause serious accidents due to high hydraulic pressure in the pipeline.

The cathodic protection system may be the only effective method to avoid such accidents. Generally accepted as an effective practice in modern pipelines, corrosion control work comprises the use of good coatings in combination with cathodic protection. Following two (2) kinds of cathodic protection are well known systems:

- Impressed current cathodic protection, mainly be applied to a long pipeline,
- Galvanic anode cathodic protection, mainly be applied to a structure in low resistance circumstances.

The impressed current system is usually preferred because of control flexibility and ample current capacity. The proposed schematic diagram of the typical cathodic protection system is shown on Figure 4-1 and the cathodic protection system will include:

- Transformer recurrent unit	: 2 units of 50V x 50A, at the BP and EP of the pipeline
- Deep-well ground-bed	: 30 m x 3 pcs x 2 sites, at the BP and EP of the pipeline
- Anode	: High silicon cast iron anode, 22.5 kg/pc, 12 pcs x 2 sets
- Bonding	: Pipe bonding with wire at both edge and midway
- Test box	: At ach 1 km interval, on 1 pipeline out of 4 pipelines

(4) Spillway

The construction of a spillway at the station 102 KM is proposed to discharge water into the dipressions. Major dimensions of the spillway are as follows:

- Location	: Station 102 KM
- Design discharge	: 52.66 m^3/sec
- Canal length	: 2.0 km

- Water depth : 2.30 m
- Bottom width : 15.0 m
- Velocity : 1.05 m/sec
- Canal structure : Unlined earth canal

4-2-2 Water Management

For the control of quality and quantity of the irrigation water, the implementation of water management project has been proposed, covering the El Salam canal system, Shikh Gaber El Sabah canal system and the proposed water conveyance system, in conformity with the objective of the current irrigation water management undertaken by the Irrigation Department. The proposed project will establish two (2) sub-master stations, 11 zonal offices and 16 remote terminal units (RTU) with provision of necessary equipment as given as follows:

Sub-master station
- Mansura office : to cover 6 projects related to El Salam canal
- Kantara office : to cover 5 projects related to Shikh Gaber El Sabah and the water conveyance canals

Zonal office
- West bank : 1 office for each project, total 6 offices
- East bank : 1 office for each project, total 5 offices including El Sir & El Kawareer zonal office

The remote terminal units (RTU) will be established at 10 important hydraulic structure sites to monitor water levels (WL), water discharge (WD), or water quality (WQ).

List of RTU

RTU No.	Structures to be Controlled	Observation		
1	Damietta intake	WD	WQ	-
2	Serw drain mixing	-	WQ	-
3	Pumping station No.1	WD	-	-
4	Pumping station NO.2	WD	-	-
5	Pumping station No.3	WD	-	-
6	Spillway	-	-	WL
7	Pumping station No.4	WD	-	-
8	Tal Clooly cross regulator	-	-	WL
9	Pumping station No.5	WD	-	-
10	Romana cross regulator	-	-	WL
11	Pumping station No.6	WD	-	-
12	Nigala cross regulator	-	-	WL
13	Bir El Abd cross regulator	-	-	WL
14	Cross regulator at station 84.8 KM	-	-	WL
15	Spillway at station 102 KM	-	-	WL
16	Pumping station No.7	WD	-	-

Data transmission will be available by VHS radio system. Voice communication services include the provision of the following equipment:

Fixed station
- Sub-master stations : 2 units for each station : 4 units
- Zonal offices : 1 unit for each office : 11 units

Mobile station		
- Sub-master stations	: 4 cars for each station	: 8 cars
- Zonal offices	: 1 car for each office	: 11 cars
Portable station	: 25 sets	

4-3 Irrigation Project

4-3-1 Main Irrigation System

(1) Alignment of the Main Irrigation System

As mentioned in Chapter 4-2 "Shikh Gaber El Sabah Water Conveyance Project", the water is lifted up by pumping station No.7 and discharged at the western side of the Project area at an elevation of 110.00 MSL which is the highest elevation within the area. The irrigation system in the Project area, therefore, distributes the water by gravity without requiring any additional booster pump.

Taking into account the topographic condition, the main canal runs from its high starting point along the southern boundary of the Project area towards the east, and then crosses Wadi El Arish by means of siphon. After crossing the wadi, the canal turns towards the north-west, and leads to the lowest location. Branch canals, feeding water from the main canal, are mostly aligned along contours in order to give the canals a gentle slope but at the same time to keep the water level high enough so that the water can be taken by distribution canals. The distribution canals are mostly aligned perpendicular to the branch canal.

The irrigation blocks (service unit) take water either from a branch canal, as is mostly the case for large scale investors, or from a distribution canal, and no block is allowed to take water from the main canal directly. The alignment of the main irrigation system is shown on Appendix J.

(2) Canal Design Discharge

Canals are so designed that they can deliver the required water for the designated command area. The required demands are shown below according to farmer category:

Small Scale Farmers/Graduates:	36.0 m^3/net-feddan/day
Small Scale Investors:	35.6 m^3/net-feddan/day
Large Scale Investors:	35.5 m^3/net-feddan/day

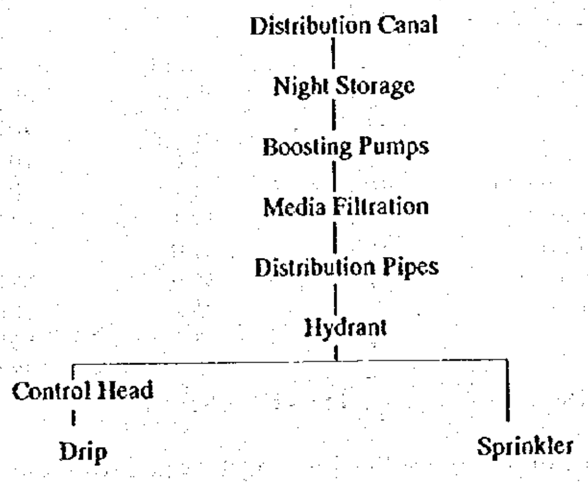
The required demand above is about 36 m^3/net-feddan/day, while the net required water demand, based on 30 m^3/gross-feddan/day, which is the design for base El Salam canal related projects, can be calculated as 36.5 m^3/net-feddan/day (30 X 135000/111000). Therefore, the amount of 36.5 m^3/net-feddan/day is adopted to design all canals except the main canal. The main canal is designed to deliver not only the irrigation water, based on 36.5 m^3/net-feddan/day, but also future industrial water of 500000 m^3/day. The representative designs of the canals are shown on Appendix J.

(3) Canal Facilities

The canals are concrete lined and require such facilities as intakes, tail-end-spillways and check gates. Tail-end-spillway is constructed at the end of each canal, and spills excessive water either to a drainage canal located nearby or to natural drainage course like a wadi. A check gate will be constructed at those place(s) in the canals which have relatively steep slopes making difficult to keep enough water in the channel for taking or distribution. The main canal requires a siphon to cross Wadi El Arish. The siphon will be of the concrete culvert type, and constructed at the most upstream end of the wadi within the Project area. Those facilities are shown on Appendix J.

4-3-2 On-farm Irrigation System

The system of on-farm irrigation is generally composed of night storage, boosting pumping station, media filtration facility, distribution pipe network, hydrant, control head, and terminal devices such as sprinkler and drip. The general layout of the system is described below and the layouts of the small scale, graduate, and investor's service units are shown on Appendix J:



(1) Night Storage

Canals will be operated to deliver the required water 24 hours per day, while on-farm irrigation will be limited to a period less than 24 hours a day. In Egypt, farmers irrigate their land between eight (8) and 16 hours a day with its maximum during the peak period.

Although the difference between the 24-hour-delivery and 8 to 16 hour-irrigation has in the past been regulated by providing supplementary storage of water in the main and distribution canals in Egypt, this however gives difficulties in the continuous management for the whole canal system and also raises the project cost as mentioned in the Land Master Plan prepared in 1985.

Therefore, storing facilities are to be introduced in this Project. The proposed storage will consist of a concrete-lined reservoir to be placed at each service unit with a capacity of eight (8) hours storage, assuming a maximum working day of 16 hours.

With automated sprinkler systems, operating hours can be extended to even 22 hours a day with two (2) hours allowed for maintenance. However, the same 16 hour working day has been adopted for the automated irrigation in order to release the sprinkler attendance from continuous working.

The storage capacity is calculated as follows in both cases for non-automated and automated irrigation:

$$V = ETcrop / (Ed \times Ea) \times 10 \times A / 0.42 \times 8/24$$

where:

V	=	Capacity of storage reservoir, m^3
ETcrop	=	Crop water requirement, mm/day
Ed	=	Field distribution efficiency, 0.95
Ea	=	Field irrigation efficiency, 0.75 & 0.80 & 0.90
A	=	Command area of storage reservoir, feddan
0.42	=	Conversion of feddan to hectare
8/24	=	Eight (8) hours storage a day

ETcrop depends on the crops to be planted in each farm category's. With reference to the calculated crop water requirements, following night storage capacities were calculated:

Night Storage Volume for Each Irrigation Unit

Irrigation Unit	Command Area	Unit Daily Requirement	8 hours Volume
Small Scale Farms	100 feddans	32.7 m^3	1090 m^3
Graduate (Veg+Fruit)	100	32.8	1093
Graduate (Veg+Livestock)	100	31.1	1037
SSI (Vegetable+Beef)	100	37.1	1237
SSI (Vegetable+Fruit)	100	27.0	900
LSI (Land Use Crop)	720	35.6	8544
LSI (Dairy Cattle)	720	35.9	8616
LSI (Beef Cattle)	720	35.9	8616
LSI (Fruits)	720	20.3	4872

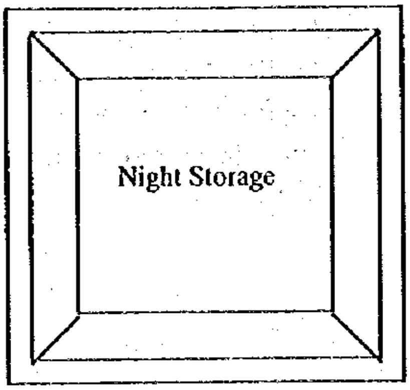
Note: SSI is Small Scale Investor, LSI is Large Scale Investor.

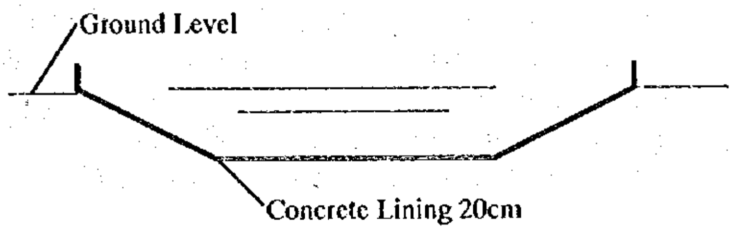
The night storage will consist of a concrete lined rectangular open reservoir. The free board is 20 cm in the case of a 100 feddans irrigation block and 30 cm in the case of a 720 feddans irrigation block respectively. A wall of 50 cm in height will surround the reservoir in order to prevent sedimentation by drifting sand. The wall is made of concrete and will provide additional free board. Based on the required volume calculated above, following dimensions are proposed:

Dimensions of Night Storage for Each Irrigation Unit

Irrigation Unit	Bottom Dimension (m)	Top Dimension (m)	Net Depth (m)	Free Board (cm)
Small Scale Farms	19x19	28x28	2	20(70)
Graduate (Veg+Fruit)	20x20	29x29	2	20(70)
Graduate (Veg+Livestock)	20x20	29x29	2	20(70)
SSI (Vegetable+Beef)	21x21	30x30	2	20(70)
SSI (Vegetable+Fruit)	17x17	26x61	2	20(70)
LSI (Land Use Crop)	48x48	61x61	3	30(80)
LSI (Dairy Cattle)	48x48	61x61	3	30(80)
LSI (Beef Cattle)	48x48	61x61	3	30(80)
LSI (Fruits)	34x34	47x47	3	30(80)

Note: SSI is Small Scale Investor, LSI is Large Scale Investor.
Free board in bracket includes 50 cm height wall.





(2) Boosting Pump

The booster pumps will be driven by electric motors. Power will be supplied from the medium voltage distribution network via a transformer. The design of the boosting pumps is based on the required discharge and the specified pressure. A horizontal centrifugal pump including motor mounted on a steel frame is recommended since this system is generally the lowest in cost and more convenient in terms of maintenance.

It is recommended that two (2) duty pumps with one (1) stand-by are installed for the case of the 100 feddans irrigation unit and four (4) duty pumps with one (1) stand-by for the case of the large scale investors unit. The main characteristics of the pumps are described below:

Main Characteristics of Booster Pumps

Irrigation Unit	Number of Pumps	Discharge (l/s) Total	/Pump	Total Head (m)	Motor (kw)	Trsfmr (KVA)
Small Scale Farms	2+1	57	29	45	22	110
Graduate (Veg+Fruit)	2+1	57	29	45	22	110
Graduate (Veg+Livestock)	2+1	54	27	45	22	110
SSI (Vegetable+Beef)	2+1	64	32	45	22	110
SSI (Vegetable+Fruit)	2+1	47	24	45	18.5	95
LSI (Land Use Crop)	4+1	445	111	55	90	650
LSI (Dairy Cattle)	4+1	449	112	55(45)	90(75)	650(550)
LSI (Beef Cattle)	4+1	449	112	55(45)	90(75)	650(550)
LSI (Fruits)	4+1	254	64	55	55	400

Note: SSI is Small Scale Investor, LSI is Large Scale Investor.
Figures in ( ) apply to center pivot sprinkler.
Total head is based on preliminary calculation.

(3) Media Filter

In line with common practice in Egypt, media filter will be provided to drip irrigation system. However, a media filter is not usually used in case of sprinkler irrigation. The irrigation water in this Project will contain some suspended solids since the irrigation water is to be mixed with drainage water.

In order to remove debris, algae, sand and silt from the irrigation water, a media filter coupled with a pressure regulating valve and an air valve must be provided just after the booster pump. This applies to both cases, sprinkler and drip systems. The filter prevents clogging of distribution pipelines, nozzles and emitters, and reduces the wear to sprinkler.

Media filter systems available in Egypt normally consist of a sand media filter equipped with a simple backwash actuation system. The backwash actuation is usually done manually by opening a valve. An automatic actuation system, using hydraulic power is recommended for investors' farms. The design capacity of the media filter has to be the same as the required water demand in the irrigation block since it is designed to filtrate all the water to be supplied to the block.

Required Capacity for Media Filter

Irrigation Unit	Capacity (m^3/hour)
Small Scale Farms	210
Graduate (Veg+Fruit)	210
Graduate (Veg+Livestock)	200
SSI (Vegetable+Beef)	240
SSI (Vegetable+Fruit)	170
LSI (Land Use Crop)	1710
LSI (Dairy Cattle)	1620
LSI (Beef Cattle)	1620
LSI (Fruits)	920

(4) Distribution Pipes and Hydrants

Main distribution pipelines will be laid along farm roads. The pipes are buried and will have at least 80 cm of soil cover. For pipes with diameters greater than 400 mm the material will be asbestos while PVC will be used for diameters smaller than or equal to 400 mm, taking into consideration local availability. The required pressure shall be 6 bar.

Hydrant valves will be located in a place that supply areas in which the same type of crops are grown so that a control head equipped with fertilizer tank can be installed. Terminal points of buried distribution pipes will also have hydrants to which a main pipe can be connected for an on-farm sprinkler or drip system.

(5) Control Head

A control head is necessary when using drip irrigation. Usually a control head is installed at a hydrant supplying those areas in which the same type crops are grown. The hydrant connects the water distribution pipe to the head and is fitted with a valve. A control head usually consists of a metering valve, non-return valve, fertilizer tank, pressure gauge, pressure breaker reducing valve, and screen filter.

For the investors' farms, control heads will be equipped as mentioned above, and in some cases it may be preferred to operate the head automatically. However, control heads applied on small scale and graduate farms should be more simple, and consist of a fertilizer tank, pressure reducing valve and screen filter since low cost system is required and one head usually only commands 2.5 feddan.

A fertilizer tank installed in the control head are capable of accurately supplying the required amount of soluble fertilizers, which is a clear advantage for drip irrigation since the fertilizer can be applied directly to the root zone of the plant. There are many ways of introducing soluble fertilizer into the irrigation pipes, among which pressure differential systems and pump injection systems are the most common in use.

In this Project, pressure differential systems are recommended because this system is already used to a large extent in existing projects in Egypt and does not require an additional pump. The pressure in the fertilizer tank and in the distribution pipeline is the same, but the pressure at the outlet of the fertilizer tank is slightly reduced by the pressure reducing valve or venturi tube, thus allowing the fertilizer to enter the distribution pipeline.

(6) Sprinkler

Aluminum pipes of 3 inches in diameter and unit length of 6 m are used for the lateral of the fixed type sprinkler and the hand-moved sprinkler, onto which a riser pipe is mounted at intervals of 12 m. The lateral is placed or moved (in case of hand-moved type) at intervals of 18 m. Therefore, the sprinkler space is 12 x 18 m, and the sprinkler's required pressure is about 3 kg/cm^2. The distribution pipe, to which several laterals at 18 meter intervals are connected, consists of 3 or 4 inch diameter aluminum pipe with a unit length of 9 m. The 4 inches pipe will be used on the large investors' farm. The distribution line will be placed so that the line supplies the plot to be irrigated from the center in order to achieve uniform distribution as much as possible.

In case of a hand-moved sprinkler, the 2.5 feddan plot is sub-divided into four (4) parts. The three (3) inches diameter aluminum pipes are connected to the hydrant and the sprinkler is set in the 1st position for 8 hours. After this, the sprinkler is moved to the 2nd position to undertake the next irrigation for 8 hours, totaling 16-hour-per-day assuming irrigation during peak periods. On the second day, the sprinkler is moved to the 2nd part of the plot and the same sequence is repeated. Thus, four (4) day rotational irrigation will be practiced in this case.

A center pivot sprinkler is especially suitable for large scale investors farms, raising beef and dairy cattle. Four (4) number of center pivot sprinklers can be allocated on a farm plot. The arm length is 438 m and the working pressure is usually 2.5 kg/cm^2 which is lower than conventional sprinklers. The net irrigation area using a center pivot sprinkler is 578 feddan which is about 77 % of the gross area of 748 feddan.

(7) Drip Irrigation

Pipes in common use for drip irrigation systems are polyethylene (PE) and PVC. Because of the allowable higher hydrostatic design pressure of PVC, PVC is more economical for the large sizes whereas PE is used mainly for small diameter pipes where flexibility is desired such as for laterals and sometimes distribution pipes.

In this Study, 16 mm diameter PE hoses are used for laterals and 50 or 75 mm diameter PVC pipes are used for distribution pipes. The distribution pipe is placed along the center of the plot to be irrigated, to both sides of which laterals are connected.

4-3-3 Rotational Irrigation Practice

Rotational irrigation is employed for conventional sprinkler systems in order to economize the size of the irrigation facilities. In Egypt, an interval between four (4) to seven (7) days has mostly been used depending upon season, crops and available workforce.

(1) Estimation of TRAM

The design irrigation interval is calculated based on the total readily available moisture, so-called TRAM. TRAM is obtained by dividing the available moisture in the important soil layer by the value of the soil moisture extraction pattern (SMEP) in that layer, and is given as follows:

$$TRAM = (fe - MI)\ D / Cp$$

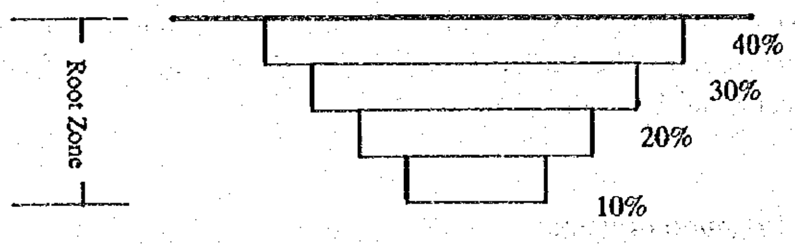
Where: fe = field water holding capacity in volume ratio, %
MI = wilting point in volume ratio, %
D = thickness of important soil layer, mm
Cp = SMEP in the important soil layer, %

The field water holding capacity represents the water content at which the moisture level in the soil begins to remain relatively constant. The capacity is therefore defined as the water which remains in the soil after the soil has drained to a deep water table.

In the past the wilting point was defined as the moisture content at which plants permanently started wilting. It was usually defined as the water content at a capillary pressure of pF 4.2. However, the wilting point is now often regarded as the point at which the depletion of moisture is starting to affect optimum growth rather than that of starting permanent wilting in order to achieve not only optimum crop yield but also good crop quality. The pF value that will affect the yield as well as quality is said to start at 3.5 to 3.8. Therefore, pF 3.5 is applied to estimate the wilting point MI shown in above equation.

The important soil layer is included in the effective soil layer, and dominates moisture consumption of crops. In other words, the moisture condition in this layer directly influence the growth of crops, yield and quality. Therefore, it is the layer with the smallest TRAM which can be calculated from the available moisture and the SMEP. If the soil is formed out of layers, the important layer can be found by observation. However, since the soil within the root-zone is mostly homogeneous, the important layer in most cases is located 20 cm from the surface.

A moisture reduction in the effective soil layer is not uniform with depth, and generally decreases logarithmic when going deeper. SMEP is the ratio of moisture reduction in each layer of the whole effective soil layers. Although SMEP varies with crops, soils and growing stages, Shockley suggested a conventional pattern of 40, 30, 20, 10 % respectively in descending order from the surface layer. Applying this pattern Cp can now be determined as 40 %.



Using the results of the "pF-moisture" relationship tests, available water for crops can be calculated from the difference between fe and MI. The available water for crops varies widely from 2.54 to 34.32 % with an average of 14 %. The data show that the area can be divided into three (3) zones; namely, the first zone with an available water of 2.54 to 10 %, the second with 10 to 20 % and the third with more than 20 %. Therefore, available crop water of 5, 15 and 20 % in addition to the average of 14 % will be applied in calculating the TRAMs. For the thickness of important layer, two (2) root depths are adopted being 40 and 80 cm, resulting in a 10 and 20 cm thickness of the important layer. The calculation is summarized below:

Calculation of TRAM

Available Water, %	SMEP, %	D, mm	TRAM	Remarks
5	40	100, 200	12.5 - 25.0	Coarse Texture
15	40	100, 200	37.5 - 75.0	Medium Texture
20	40	100, 200	50.0 - 100.0	Fine Texture
14	40	100, 200	35.0 - 70.0	Average

(2) Design Irrigation Interval

The design irrigation interval is calculated by dividing the TRAM by the maximum daily consumption of irrigation water. The maximum daily consumption occurs in July and is about 9 mm/day. Therefore, the irrigation interval is calculated in the following:

Calculation of Irrigation Interval

TRAM	M.Cons.,mm	Interval, days	Remarks
12.5 - 25.0	9	1.4 - 2.8	Coarse Texture
37.5 - 75.0	9	4.2 - 8.3	Medium Texture
50.0 - 100.0	9	5.6 - 11.1	Fine Texture
35.0 - 70.0	9	3.8 - 7.8	Average

Since coarse texture areas will mostly be managed by investors using drip or automated sprinkler systems, short term irrigation intervals or even daily irrigations can be carried out. Therefore, rotational irrigation will be adopted in the medium and fine texture areas. With reference to the results shown above, this Study proposes four (4) to seven (7) days rotational irrigation, which is almost similar to practices currently in use in Egypt.

4-4 Drainage Project

4-4-1 Main Drainage System

(1) Alignment of Main Drainage System

In order to avoid water logging problems associated with excessive seepage water as a result of irrigation, drainage systems must be introduced in this Project. The drainage systems will consist of both open drainage and on-farm buried drainage. The open drainage system will be constructed during the same stage as the irrigation canals, while on-farm drainage system will be constructed at a later stage.

The main drainage system, including open drainage, will be aligned along and in parallel with irrigation canals in case the canals are aligned along contour lines. The drainage only serves command areas on one side of the drain. In case that the irrigation canal is aligned perpendicular to the contour line , the open drainage will be aligned in between two (2) irrigation canals. The alignment of open drainage systems is shown on Appendix J, and the drainage water will ultimately be discharged to three (3) places; namely, Wadi El Arish with net drainage area of 98600 feddans and two (2) depression areas located in the west of the Project area. The two depression areas will serve smaller drainage areas of 11000 feddans and 1400 feddans respectively.

(2) Drainage Design Discharge

The drainage design discharge has already been defined in Chapter 3-5 "Irrigation and Drainage", and is 2 mm/day. Therefore, the capacity of the open drainage is designed in such a way to drain the discharge from the entire allocated drainage area. Also, open drains to which excessive irrigation water is discharged, will be designed having a capacity of 20 % of the irrigation canal in addition to the on-farm drainage discharge capacity based on the 2 mm/day. The typical sections of the drains are shown on Appendix J.

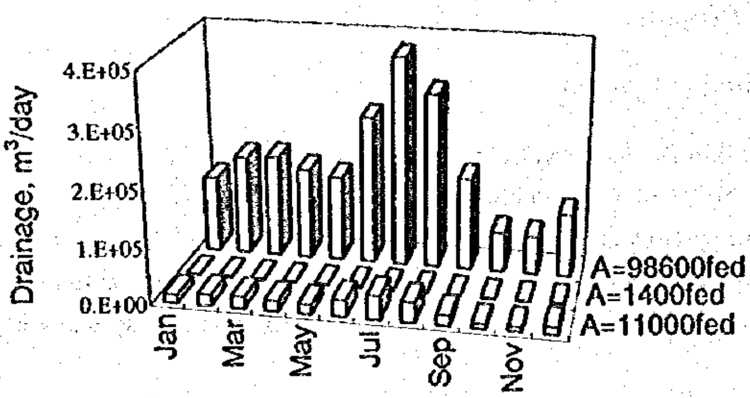
(3) Expected Drainage Amount

The drainage amount to be expected will depend on the seepage incurred by irrigation losses. With reference to the seepage discussed in Chapter 3-5 "Irrigation and Drainage", the seepage amount ranges between 10 and 15 % of the irrigation water depending on the irrigation method applied. The overall averaged drainage amount will be about 12 % of the irrigation water taking into consideration the area of each irrigation method.

With 12 % as the drainage amount of the Mesqa-based irrigation water, the monthly based drainage amount for each drainage area is estimated as shown in the following figure, and the annual drainage amount, peak drainage amount in July and averaged drainage amount throughout year are as follows:

Drainage Amount in Each Drainage Area

Drainage Area	Annual (m^3)	Maximum (m^3/sec)	Average (m^3/sec)	Remarks
No.1, 11000fed	7365455	0.48	0.23	north-western end of the Project area
No.2, 1400fed	937422	0.06	0.03	eastern-neighbored to No.1 area
No.3, 98600fed	66021258	4.32	2.09	drain to Wadi El Arish



The annual amounts drained from areas of No.1 and No.2 are not large; namely 7.4 MCM and 0.9 MCM, because of their small catchments. The drainage water of No.1 and No.2 area will be collected in a form of pond and utilized for irrigation of windbreak nearby.

The drainage amount into Wadi El Arish is relatively large, about 66 MCM and the average throughout the year is 2.09 m^3/sec. The amount may partly penetrate into deeper ground, thus less drainage water will show up in the on-farm drains, or may partly evaporate and penetrate during the courses of the open drains and Wadi El Arish. Therefore the calculated amount may be regarded as a probable maximum, and the creation of surface run-off generated by the drainage could be delayed until a certain period has passed and the groundwater level has reached nearly to ground level. Taking into consideration these uncertainties, this Study proposes that regular monitoring of the drainage water in Wadi El Arish should be undertaken and run-way to discharge the drainage water into Mediterranean sea should only be constructed if necessary.

4-4-2 On-farm Drainage System

(1) Drainage Areas

Ten (10) number of hydraulic field tests (infiltration test) have been carried out as part of this Study. The hydraulic conductivity, described as final infiltration rate (Kostiakov equation), varies widely between 0.15 m/day and 13 m/day with the average of 4.2 m/day.

The Study area is divided into three (3) categories in terms of drainage classification (FAO Soil Survey Manual) based on the infiltration tests and physical soil survey results such as density, porosity and particle size distribution. The categories are as follows:

Class I:	Coarse texture Drainage Class 5 (well drained)
Class IIa & IIb:	Medium texture Drainage Class 3 (moderately well drained)
Class IIIa & IIIb:	Fine texture Drainage Class 2 (imperfectly drained)

In this Study, Class I is not provided with buried drainage (pipe drainage) but only with open drainage. Class II is partly provided with buried drainage depending on the topographic condition. Class II, located at a lower elevation with almost flat topographical conditions, will have a buried drainage system. Class III will be mostly provided with buried drainage, except for those areas that are represented by relatively steep slopes and higher elevations. The areas provided with buried drainage are shown on Figure 4-2.

(2) Lateral Drain

The steady state flow equation, based on the following parameters, is employed to calculate the lateral drain spacing:

$$q = (8 \cdot K \cdot d \cdot h)/S/S + (4 \cdot K \cdot h \cdot h)/S/S$$

where: q = discharge rate per unit surface area (0.002m/day)
h = hydraulic head above drain level midway between the drains (0.5 m)
K = hydraulic conductivity (0.30 & 1.07 m/day)
S = drain spacing
d = thickness of the so-called Hooghoudt's equivalent layer

In practical application, a limitation has been imposed on maximum and minimum drain spacings in Egypt despite the theoretical spacing. A minimum spacing of 30 m was economically justified, and a maximum of 60 m was claimed to be a practical upper limit. However, these criteria for the spacing were changed in 1986 to adopt the spacing as obtained from the theory but with a minimum of 20 m. Therefore, the spacing calculated with the above equation is used in this Study with a minimum spacing of 20 m.

Regarding the infiltration test results, the hydraulic conductivity of Class II may be represented by Site No.20 with conductivity of 1.07 m/day, while the conductivity of Class III may be taken as 0.30 m/day, which is the average of Site No. 33, 72, 80, and 94. Since the number of infiltration tests is very limited, hydraulic conductivity should be further investigated prior to the Project implementation.

Substituting the hydraulic conductivity of 1.07 m/day and 0.30 m/day in the equation above, lateral drain spacings of 100 m and 50 m respectively. Therefore the following lateral spacings are applied in this Study.

Class II: Lateral Spacing 100 m (Medium texture)
Class III: Lateral Spacing 50 m (Fine texture)

Corrugated perforated PVC pipe enveloped with synthetic filter is locally available, having an 80 mm outside diameter and 72 mm inner diameter. This PVC pipe has been used for field lateral drains in Egypt, and the ones that will be installed in the Project area are of the same kind.

(3) Drain Depth

Based on the experimental practices carried out in the Nile Delta, DRI pointed out that drain depths deeper than 1.40 m were not justified and an optimum choice of the drain depth seemed to be around 1.30 m (Land Drainage in Egypt, 1989).

The groundwater table should in principal be kept below a certain depth in order to provide aeration to the root zone. FAO Irrigation and Drainage paper No.38 suggests the following water table depth in meter below ground surface:

Field Crops:	1.0 m
Vegetables:	1.0 m
Tree Crops:	1.2 m

Drain depth is usually calculated by summing: the design water table above, half the water table rise by the maximum individual recharge, and a residual hydraulic head of 0.1 m. Assuming that the water table rise is 0.50 m as employed in the equation above, the following drainage depths have been worked out:

Field Crops:	1.0 + 0.25 + 0.1 = 1.35 m
Vegetables:	1.0 + 0.25 + 0.1 = 1.35 m
Tree Crops:	1.2 + 0.25 + 0.1 = 1.55 m

The depths above are very close to the optimum depth suggested by DRI, thus a drainage depth of 1.35 m used for field crops and vegetables in the area represented with relatively steep topographic conditions. In case of tree crops, 1.55 m depth, calculated above, is to be applied in a steep topographic condition since the limit of 1.40 m suggested by DRI was based on crops other than trees. Whereas, in such areas with relatively flat topographic conditions, a 1.0 m depth will be applied at the beginning of the laterals in order to avoid having unreasonable deep drainage.

(4) Alignment of Collector Drains

Lateral drains are connected to a collector which commands a part or a whole area of one irrigation unit (service unit). The commanding area of a collector drain is usually between 50 and 300 feddans. Taking into consideration the area of each irrigation unit, following alignments of collector drains are proposed:

For Small Scale and Graduate Farms:	1 Nr. along center line (Command Area ≈ 100 feddans)
For Small Scale Investors Farms:	1 Nr. along center line (Command Area = 100 feddans)
For Large Scale Investors Farms:	3 Nr. in parallel with side (Command Area = 240 feddans each)

Collector drains are constructed of plain concrete pipes with inside diameters varying between 15 cm and 40 cm, and of reinforced concrete pipes with diameters of 45 cm to 60 cm. In deciding the drainable area in accordance with the pipe diameter and slope, Wesseling worked out the following equation taking into consideration 25 % reduction in area in order to allow for light sedimentation in the pipe (FAO Irrigation and Drainage paper No. 9):

$$A = (1.91/q \times d)^{2.714} \times S^{0.57}$$

Where:
- A = drainable area under effective transport (ha)
- q = discharge rate per unit surface area (2 mm/day)
- d = pipe inner diameter (cm)
- S = slope (0.125% based on the field condition)

Based on the above equation, each farm will have the following collector pipes with the diameter varying from 150 to 250 mm and of plain concrete:

For Small Scale and Graduate Farms:	150 & 200 mm inner diameter
For Small Scale Investors Farms:	150 & 200 mm inner diameter
For Large Scale Investors Farms:	150 & 200 & 250 mm inner diameter

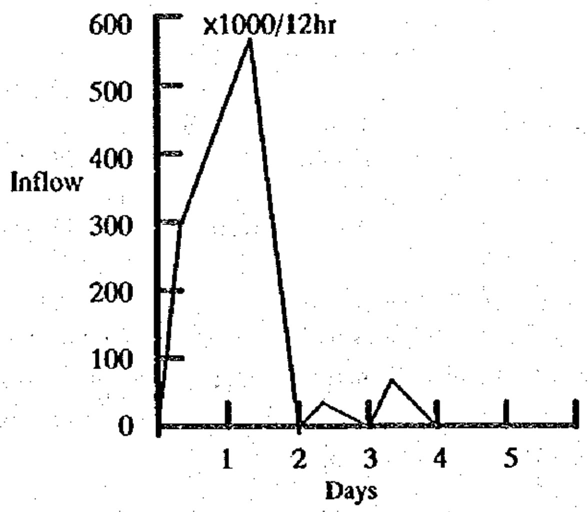
The layouts of lateral and collector drains are shown on Appendix J.

4-4-3 Wadi El Arish Drainage Project

As mentioned in Chapter 2-4 "Climate and Hydrology", the maximum flood in Wadi El Arish in the past may have had a magnitude of about 20 MCM or just above, and no noticeable flooding is to be expected with the raised Rawafaa dam storing floods in the reservoir. However, floods of certain magnitudes may still result in some damage to the reclaimed area located near the wadi. Therefore, an attempt is made in calculating peak floods downstream of Rawafaa dam in order to determine the wadi cross-section that can drain the flood and to design structures crossing the wadi such as a siphon.

Sinai Water Resources Study (1993) presents a flood volume occurring at Rawafaa dam with a 50-year-return period. The flood volume was estimated on the basis of an annual precipitation falling over the wadi with 50-year-return period. The flood volume presented in the study is 20.62 MCM and is almost equal to the previously recorded maximum volume.

Since it is extremely difficult to estimate peak floods occurring in a large scale wadi without a suitable number of actual field observations, a simplified hydrograph is assumed to estimate the peak flood associated with the total flood volume of 20.62 MCM. The flood occurred in 1994 and resulted in 1.5 MCM being stored in Rawafaa dam. Its water levels were recorded at the reservoir, and this flood is the only one that can be used to develop a hydrograph. The following graph shows the calculated hydrograph showing the water levels recorded every 12 hours:



The above hydrograph suggests that the duration of the flood was between 24 and 32 hours. It is generally known that the bigger the flood, the longer the duration of the flood becomes. Therefore, the duration of a 50-year-return-period flood may be longer than shown on the graph above. However in estimating the peak flood with a 50-year-return-period, a 24 hour flood duration is assumed with a simplified triangular hydrograph.

The flood volume, which spills over Rawafaa dam, is estimated by subtracting the dam reservoir volume from the 50-year-return-period flood from 20.62 MCM. The peak volume of the flood running through the wadi is calculated below:

Spilled Volume: 20.62 - 5.3 = 15.32 MCM (50 years probability)
Peak Volume: 15320000 / 86400 x 2 = 360 m^3/sec

Although it is noteworthy that the peak volume calculated above is only a guide because of scarcity of the data, a minimum cross section of the wadi which can drain the peak flood can be estimated with the Manning formula using a roughness coefficient of 0.04 and the wadi longitudinal slope. The typical cross section and the design of the siphon crossing the wadi are shown on Appendix J.

4-5 Land Reclamation and Agricultural Infrastructure

4-5-1 Land Reclamation

The total area inside the Project boundary is approximately 153,900 feddans (64,600 ha). The Project area becomes about 135,000 feddans (56,700 ha) when sand dune zones not suitable for the agriculture, specific exclusion areas and the high elevation land are deducted. The irrigation area reduces to 111,000 feddans (46,600 ha) by removing the areas for canals, roads, villages and social utility land from the above area (see Appendix D).

Because the Project area has a mainly flat topography with some undulations, major grading and leveling of land is not expected. Only simple land smoothing by heavy equipment is anticipated in all farm lands. Windbreak will be arranged on the periphery of each service unit consisting of rows of trees at intervals of 2m. Shelterbelts (green ring) which have a 50 m width and will consist of many kinds of trees, which will be established along the 150 km long project boundary. Movement of sand dunes into the crop land should be avoided by this shelterbelts, and the invasion of vermin will also be prevented (see Appendix D).

The service units arrangement in the Project area is shown on the general plan. To reduce water head loss, the route of the main irrigation canal is planned in the high land along the Project boundary, and in the same way, the route of the branch irrigation canals is selected in such away that they run parallel with the contours as much as possible. Each service unit will border on at least one irrigation canal and a drainage canal. This will result in a concentrated network of canals and roads throughout the Project area. Shelterbelts will have a function to the prevention of wind and water erosion in the Project area.

4-5-2 Agricultural Infrastructure

(1) Irrigation and Drainage Canals

The total length of the irrigation and drainage canals are as follows:

Main irrigation canal	71 km	
Branch/distribution irrigation canals	472 km	
Main/branch drainage canals	475 km	Total 1,018 km

O&M roads paved with asphalt or gravel shall be constructed on one side or both sides of the canals. In general irrigation canals will have a concrete lining with a side slope 1:2.0, and will be constructed partially by excavation and partially by creating an embankment so that the water elevation in the canal is equal to the natural ground level. The canal embankments have a positive effect which is preventing the invasion of movable sand into the canal. Riprap lining will be installed on the side slopes of banks, and will prevent collapse. The minimum bottom width of the irrigation canal is 1.0m taking into consideration the canal maintenance. The height of the lining should be adjusted corresponding with the design discharge of the canal and corresponding water levels. The drainage canal will be unlined, and riprap lining should only be installed in the top section where the ground condition is unstable (see Appendix J).

(2) Other Facilities

The following types of facilities are part of the agricultural infrastructure which is planned in the Project area:

Bridges: These structures are made from reinforced concrete. Bridges are constructed on the routes of the trunk road which connect villages and main farm roads.

Division work: These facilities are installed at the confluence of each main and branch irrigation canals. The structures are made of a box culverts of one row or two rows corresponding to the design discharge, and have slide gate(s) for the adjustment of the intake volume.

Intakes: These structures are installed at each service unit to take water to the night storage in the service unit from the branch/distribution irrigation canal.

Check gates: They are installed to maintain water levels inside the irrigation canals, to allow even water distribution, in areas with a comparatively steep slope.

Tail-end spillways: At these facilities the remaining water is discharged to the drainage canal, and they are installed at the end of each irrigation canal. Tail-end spillways have as function to maintain appropriate water levels.

Siphon: This structure carries water to the northeastern irrigation area by crossing Wadi El Arish. The difference of the water levels is about 10m and the length of the siphon, formed from box culverts, is 600m. A spillway will be constructed in the upper reach of the siphon.

(3) Farm Roads

Trunk roads paved with asphalt exist on three routes in the Project area, and it has been decided to used these roads in their present condition for this project. Again, O&M roads are planned along the canals as mentioned above, farm roads planned in the Project area will mostly consist of these roads, however some additional farm roads are required. However, the main route which connects the villages is planned as an asphalt paved road of 13m width (with road shoulder).

4-6 Settlement and Social Infrastructure

4-6-1 Farm Land Allocation and Village Distribution

(1) Farm land Allocation

The settlers will consist of three categories, namely (a) large investors, (b) small investors and (c) graduates, small farmers and Bedouins. The required area and number of lots for each category are as follows:

Farm Land Allocation

Category	Standard unit of lot	Number of farm lot	Total farm area (fed.)
Large Scale Investor	720 fed.	90	66,600
Small Scale Investor	100 fed.	170	16,650
Graduate & S.farmer	10 fed.	2,215	22,150
Bedouin	10 fed.	560	5,550
Total		3,040	111,000

Based on the soil survey, silty clay sand or silty sand soil area (classified as category III of the land management categories) are allocated to graduates, small farmers, Bedouins and small investors. Large investors will be allocated the sandy soil area (classified as category III and IV).

(2) Village Distribution

The villages proposed for this Project include three (3) central villages with four (4) satellite villages to each central village, totaling fifteen (15) villages. The village distribution is based on the following criteria:

- distance from village to farm lot should be around 3 to 4 km, but not further than 5 km.
- villages should be located beside the existing (national) roads or planned along main/secondary canals or as near as possible to allow the use of the inspection roads.
- existing villages should be included in the proposal.
- areas unsuitable for cultivation should be utilized for the villages as much as possible.

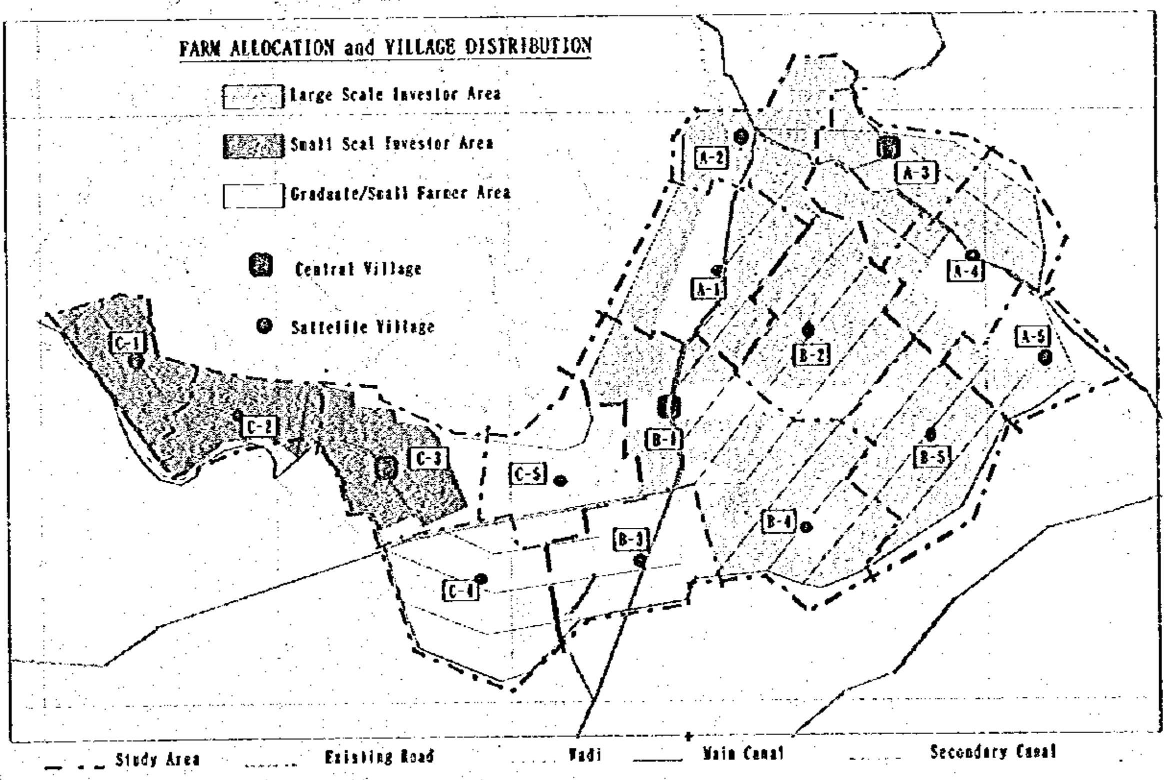
The planned village distribution and indexes are shown in the following Table and Figure.

Village Index

Village	Number of Land Holder				Total of		Remarks
	Large Scale Investor	Small Scale Investor	Small Farmer & Graduate	Bedouin	Farm Area	Population	
A-1	10	-	265	85	10,844	10,219	
A-2	11	-	-	-	7,920	8,341	Lehfen
A-3 ©	8	-	-	-	5,544	6,971	El Koreah
A-4	10	-	138	142	10,216	9,796	
A-5	4	-	82	98	4,608	4,179	Magdaba
B-1©	11	-	-	-	8,100	12,780	El Resan
B-2	13	-	-	-	9,252	9,690	
B-3	-	-	370	50	4,200	2995	
B-4	13	-	-	-	9,360	9,853	
B-5	12	-	-	-	8,856	9,349	
C-1	-	58	-	-	5,800	6,805	
C-2	-	48	-	-	48,00	5,630	
C-3©	-	61	88	12	7,050	8,993	
C-4	-	-	726	99	8,250	5,901	
C-5	-	-	546	74	6,200	4,433	
Total	92	167	2,215	560	111,000	115,934	

Note A-3 ©,B-1 © and C-3 © are Central villages
villages A-2, A-3, A-5 and B-1 will be expanded existing villages

Farm Allocation and Village Distribution



4-6-2 Social Infrastructure

(1) Road Network

The following three types of roads are planned for the road network in the Study Area.

Access roads

The villages are located beside the existing national road or main irrigation canals. The existing roads are used as access roads without any improvement since they are proposed to be paved and should be in good condition. Some inspection roads along irrigation canals will also be used as access roads with some modification to the standard dimensions.

Main street

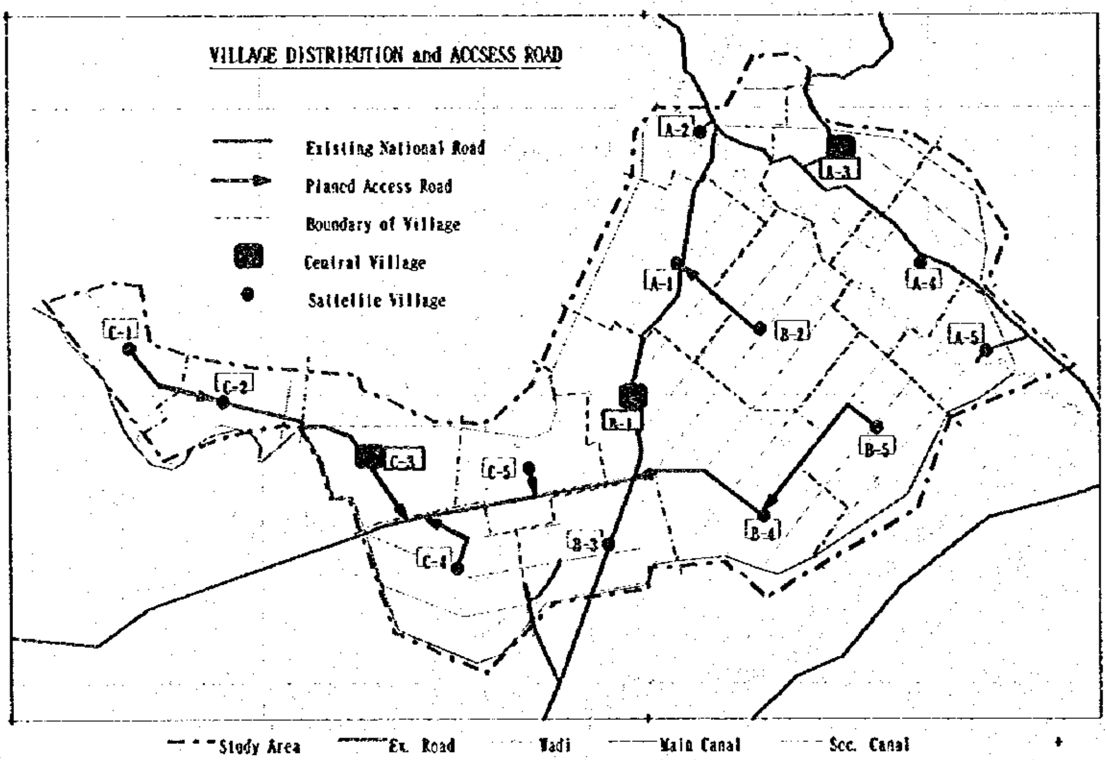
The main street in the village is situated in the village center where public offices and facilities will be located.

Street

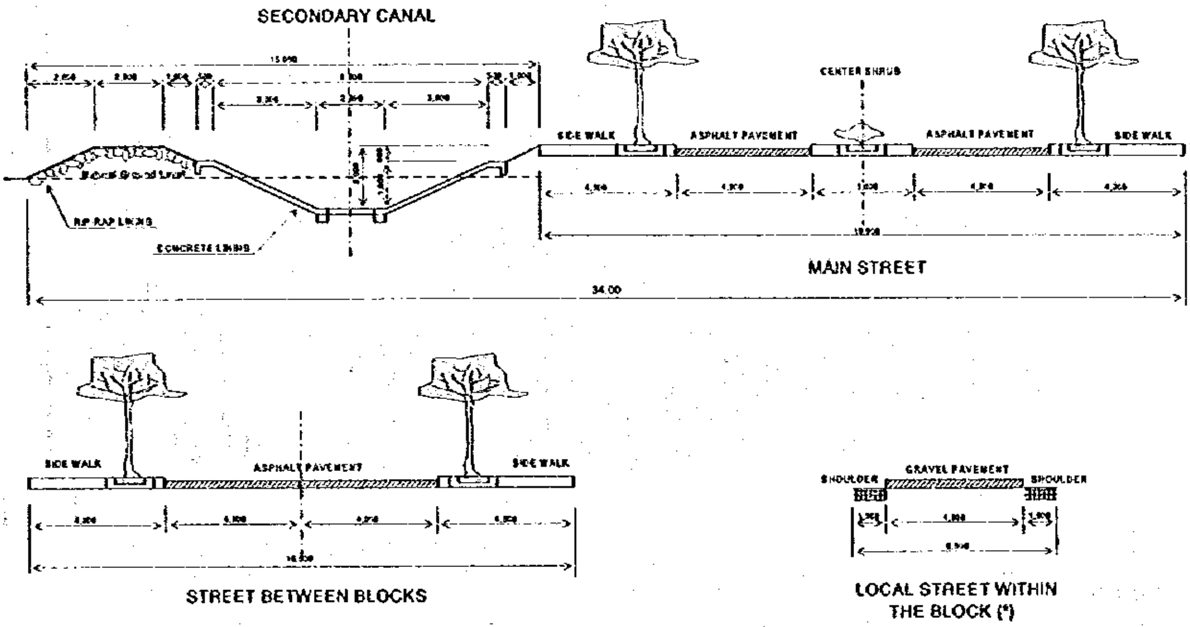
The street in the villages are planned for daily access to the village center.

The village distribution and the planned access road networks and typical cross sections are shown below.

Village Distribution and Access Road Network



Typical Roads Cross Section



(*) The streets within the block can be also of the same type of those between the blocks although with a side walk of only 2 (two) meters. Furthermore, as can be seen in the arrangement of blocks, sometimes there are green areas between the street beds.

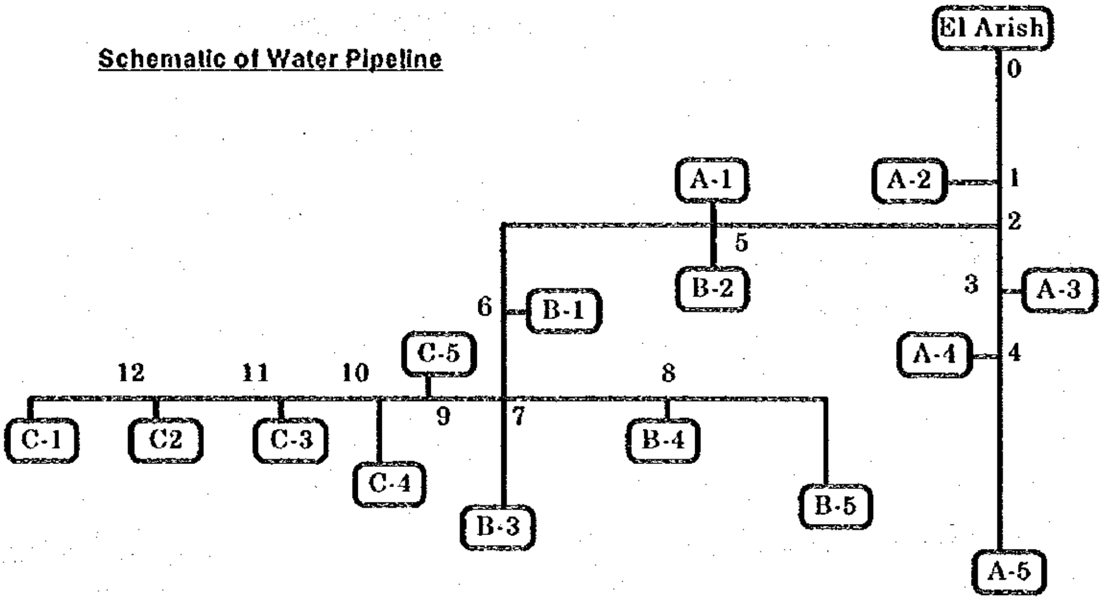
(2) Domestic Water

The domestic water demand is estimated as 200 liters /capita/day which includes public use, cattle use, some industrial usage, etc. The water demand and pipeline network are as follows:

Water Demand and Pipeline

Point Form	to	Popula -tion	Demand (m^3/d)	Discharge (l/s)	Discharge (m/s)	L (km)	Point Form	to	Popula -tion	Demand (m^3/d)	Discharge (l/s)	Discharge (m/s)	L (km)
0	1		23,200	335.7	1.709	16.8	5	B-2	9,690	1,940	28.1	0.893	6.0
1	2		21,530	311.5	1.586	0.8	6	B-1	12,780	2,560	37.0	1.179	0.2
2	3		4,190	60.6	1.235	5.1	7	B-3	2,990	600	8.7	0.707	3.6
3	4		2,800	40.5	1.066	7.6	8	B-4	9,850	1,970	28.5	0.907	0.2
4	A-5	4,180	840	12.2	0.990	8.7	7	9		6,360	92.0	1.302	5.6
1	A-2	8,340	1,670	24.2	0.769	0.5	9	10		5,470	79.1	1.120	6.4
3	A-3	6,970	1,390	20.1	1.138	2.1	10	11		4,290	62.1	1.264	4.1
4	A-4	9,800	1,960	28.4	0.903	0.2	11	12		2,490	36.0	1.147	8.7
2	5		17,340	250.9	1.577	7.1	12	C-1	6,810	1,360	19.7	1.114	5.4
5	6		13,360	193.3	1.215	7.2	9	C-5	4,430	890	12.9	1.050	1.7
6	7		10,800	156.3	1.243	4.1	10	C-4	5,900	1,180	17.1	0.966	4.0
7	8		3,840	55.6	1.132	7.8	11	C-3	8,990	1,800	26.0	0.829	0.2
8	B-5	9,350	1,870	27.1	0.861	8.6	12	C-2	5,630	1,130	16.4	0.925	0.2
5	A-1	10,220	2,040	29.5	0.939	0.2	Total		115,930	23,200	335.7		123.1

Schematic of Water Pipeline



(3) **Electricity**

The electric demand for villages is based on 0.4 kw per capita which include domestic, official and small scale industrial use, and the demand for booster pumps is estimated at 25 kw/lot (100 feddans) for small farm lot and 300 kw/lot (720 feddans) for large farm respectively. The detail is stated in chapter 4-3-2 (2)

The following table shows the total demand of each village.

Electric Demand

Village	Domestic Use		Agricultural Use			Total Demand (kw)
	population	Demand (kw)	No. of Small lot	No of Large lot	Demand (kw)	
A - 1	10,220	4,090	35	10	4,575	8,665
A - 2	8,340	3,340		11	3,300	6,640
A - 3	6,970	2,790		8	2,400	5,190
A - 4	9,800	3,920	28	10	4,260	8,180
A - 5	4,180	1,6801	18	4	2,010	3,690
Sub Total	39,510	15,820	81	43	16,545	32,365
B - 1	12,780	5,120		11	3,300	8,420
B - 2	9,690	3,880		13	3,900	7,780
B - 3	2,990	1,200	42		1,890	3,090
B - 4	9,850	3,940		13	3,900	7,840
B - 5	9,350	3,740		12	3,600	7,340
Sub Total	44,660	17,880	42	49	16,590	34,470
C - 1	6,810	2,730	58		2,610	5,340
C - 2	5,630	2,260	48		2,160	4,420
C - 3	8,990	3,600	71		3,195	6,795
C - 4	5,900	2,360	83		3,735	6,095
C - 5	4,430	1,780	62		2,790	4,570
Sub Total	31,760	12,730	322		14,490	27,220
Total	115,760	46,430	445	92	47,625	94,055

Note : Power demand for domestic use : 0.4 kw/capita,
Booster pumps for small lot (100 feddans) : 22kw x 2 units=45 kw/lot
Booster pumps for large lot (720 feddans) : 75kw X 4 units=300 kw/lot

Figure 4-3 gives electric power network and related information.

(4) **Public Services**

The public service facilities such as government offices, administrative offices, schools, hospitals, and mosques, etc. will be located in the center of the village and the cemetery block is arranged at outskirts of the village.

(5) **Settler's Housing**

The residential area will be arranged by the settler category around the public services area. Five types of model house are planned. The construction works are to be divided into two stages. During the 1st stage, the size of residential rooms will be reduced. The model types 4 and 5 are designed as two stories house.

Settler's House Model

Type Model	Land Area (m^2)	Construction Area 1st Stage	2nd Stage	Livestock /Garden Area
1 : Labor/Bedouin	12.5×20 250	42.50	53.50	6.0×12.5 72
2 : Graduate/Small Farmer	14.0×25 350	65.70	52.50	8.0×14.0 112
3 : Official Staff	16.0×24 400	89.20	42.00	8.0×16.0 128
4 : Small Investor/ Manager	16.0×24 400	87.50	G/F 42.0 1st/F 32.0	8.0×16.0 128
5 : Large Investor	18.0×25 450	111.70	G/F 37.0 1st/F 57.5	8.0×18.0 144

The general layout of the central village is given in Appendix E.

(6) **Sewage and Refuse**

The sewage network systems for the settlement villages are planned as underground pipeline system. The potable sewage discharge is estimated at 90 percent of the domestic water demand of 200 litter per capita per day. Each village is provided with one treatment plant located outside of the village. The treatment method is "Oxidation Pond" method which is simple and most economical.

The refuse treatment plants are planned in central villages. The amount of waste disposal is estimated at 0.5 kg/capita/day. Following table shows estimated discharge and pipeline length of sewage and amount of waste disposal.

Sewage Water Discharge ,Pipeline Length and Waste Disposal

Village	Population	Discharge (m^3/day)	Pipeline (m)	Waste (ton/day)	Village	Population	Discharge (m^3/day)	Pipeline (m)	Waste (ton/day)
A-1	10,200	1,840	45,200		B-4	9,850	1,770	43,400	
A-2	8,340	1,500	36,500		B-5	9,350	1,680	40,800	
A-3	6,970	1,250	30,400	19.8	C-1	6.810	1,230	30,400	
A-4	9.800	1,760	42,600		C-2	5,630	1,010	25,200	
A-5	4,180	750	18,200		C-3	8,990	1,620	39,100	15.9
B-1	12,780	2,300	55,600	22.3	C-4	5,900	1,060	26,100	
B-2	9,690	1,740	42,600		C-5	4,430	800	20,000	
B-3	2,990	540	13,000		Total	115,930	20,850	509,000	58.0

4-7 Agro-processing

For purposes of raising the value added of agricultural products, the establishment of agro-processing industries has been proposed. The proposed facilities include a concentrated feed factory, a tomato paste factory, olive oil extraction factories, a slaughter house and a milk processing factory. Outlines of these factories are given below:

Concentrated Feed Factory : one (1) factory

Annual production of grains for processing of concentrated feed is estimated at 21,400 ton of barley grains and 53,000 ton of maize grain. 70,680 ton of concentrated feed will be produced in one factory having a processing capacity of 260 ton per day. The factory will be equipped with four (4) lines of plants. The processing capacity of one (1) plant is 65 ton per day. The annual working days are 300.

The factory will be operated by a manager and 53 staff; six (6) engineers, four (4) grain reception and weighters, 12 plant line operators, eight (8) packaging staff, 12 forklift operators, and 11 labors. The factory requires a building of 0.23 feddans and a receiving platform of 0.38 feddans.

Tomato Paste Factory: one (1) factory

Tomatoes for processing will be harvested by the investors over 100 days from the end of July to the early November. The estimated annual production is 71,500 ton, which are equivalent to 715 ton per day on the average. The factory will have a processing capacity of 720 ton per day with three (3) processing plants.

The factory will be operated by a manager and 119 staff; 10 engineers, 27 plant line operators, 36 packaging staff, 20 forklift operators, 15 labors and 11 other staff. It needs to provide a single story building of 3.4 feddans and a building with a floor space of 1.9 feddans.

Olive Oil Extraction Factories: 31 factories

Olives will be harvested by the investors over 80 days from the end of September to the early December. Each large investor will provide one factory for his use, totaling 23 factories, while eight (8) factories will be established for processing of olives to be harvested by the small scale investors at a rate of one (1) factory to 10 small investors. The processing capacity is 1.5 ton per hour composed of three (3) plants with a capacity of 500 kg/hour, or four (4) ton per day.

The factory will be operated by a manager and nine (9) staff: three (3) operators for one (1) plant. The estimated size of the factory is: a single story building of 0.14 feddans and drying yards of 0.03 feddans.

Slaughter House: one (1) house

The total number of beef cattle to be treated is 33,000 heads per year, including waste milk cows of 5,300 heads. The estimated capacity of a slaughter house is 150 heads per day with annual working days of 250. The slaughter house will be capable of slaughtering, dressing, packing and storing in a cold storage.

The house will be operated by a manager and 83 staff: 28 dressing staff, 14 cutting staff, nine (9) packing staff, four (4) veterinarians, 19 administrators and nine (9) other staff. The house require a building of 0.97 feddans and a lot of 6.7 feddans.

Milk Processing Factory; one (1) large-scale factory and three (3) small-scale factories
A milk processing factory will be established to process 116,100 ton of raw milk. It is proposed to establish a milk processing factory with a processing capacity of 318 ton per day; eight (8) hours a day and 365 days a year. The raw milk of 318 ton will be processed to produce 127 ton of high treated milk, 31 ton of butter and 2.4 ton of white cheese.

The factory will be operated by a manager and 71 staff: six (6) mechanical engineers, nine (9) staff for milk reception, 16 staff for pasteurization and aseptic packing, 10 staff for laboratory, 10 store keepers, 10 boiler keepers and 10 other staff. The estimated building space is 0.57 feddans and lot area is 2.93 feddans.

Besides the above-mentioned large-scale factory, three (3) small-scale factories may be provided at three satellite villages to meet the demand of small farmers and graduate farmers, each of which will have a processing capacity of 8 ton per day to produce 6 ton of high treated milk.

4-8 Agricultural Development Supporting Services

The proposed project will provide the establishment of the North Sinai Agricultural Development Center and its branch office in the Project area and branch offices of extension services and veterinary services, and the farmer organizations as given below:

North Sinai Agricultural Development Center
The center will be built in Bir El Abd to function as a core for the extension activities related to the irrigated agriculture on the lands of North Sinai reclamation projects (400,000 feddans). This center is proposed to have responsibility for several activities which are presently not covered by the Department of Agriculture. The components of the center are as follows:

Land area	: 50 feddans
Buildings	: offices, workshops, training rooms, dormitories, officers' houses, and garages,
Applied research farm	: crop fields, irrigation fields, farm machinery utilization fields, livestock sheds, and nursery houses,
Farm Machineries	: tractors, rotaries, lime sowers, sprays and others,
Laboratory equipment	: microscopes, incubators and others,
Demonstration equipment	: televisions, video recorders, projectors, walkie talkies, etc.
Vehicles	: 4 wheel driving cars, pick-up trucks, minibus,

A branch office will be established in the Project area. Supporting services to be provided, taking into consideration the desert conditions, are various educational training using the demonstration farms of nine (9) farm leaders. the branch components include:

Buildings : office, exhibition rooms, garage and extension workers' houses
Vehicles : pick-up trucks and motorcycles.

Branch Offices of Extension and Veterinary Services

An agricultural extension branch office will provide agricultural extension services to all the settlers under the control of the agricultural extension office in Bir El Abd. The components of the branch office are as follows:

Buildings : office, officers' houses and garages
Vehicles : pick-up trucks and motorcycles

A veterinary branch office will be established in the Project area under the control of the Department of Livestock in El Arish. This branch office's main task is to control animal diseases through livestock producers' associations. The components are as follows:

Buildings : office, medical rooms, livestock sheds, officers' houses, and garages,
Equipment : refrigerators, medicine racks and others,
Vehicles : pick-up trucks, motorcycles

Farmer Organizations

A multi-purpose agricultural cooperative will be established in the Project area. This organization will mainly support marketing of agricultural products and provide assistance with changing from individual dealings to the cooperatives. For the purpose, the cooperatives should have leadership for crop products, that is, quality and standardizing by keeping connection with the agricultural extension branch office. The cooperatives will also manage six (6) marketing centers to be established in the Project area. The components are as follows:

Buildings : offices, storehouses, meeting rooms, officers' houses, and garages,
Equipment : forklifts, beltconveyors, carrier board. etc.,
Vehicles : pick-up trucks, sedans, motorcycles

Nine (9) producers' associations for vegetables, fruits and livestock will be established by the farmers. The associations will provide buildings for meetings of members.

4-9 Agricultural Marketing System Development Project

In the section 3-9, three plans are presented in relation with marketing system development of the project. Of these three plans, the third plan, which designs to improve marketing activity of vegetables and fruits among small farmers and graduates, is closely concerned with the proposed development area and would benefit directly settlers of the area, has been materialized as a marketing system development project. The project will consists of six (6) marketing centers to be established within the project area.

(1) Objective

The general objectives for establishment of marketing centers is to enhance marketing channel of vegetables and fruits among small farmers and graduates and to contribute to increasing value-added of agricultural commodities of the project; more specifically, the aims to realize strategic shipment of vegetables and fruits and to reduce post-harvest losses.

(2) Responsible Agency for Operation

Multi-purpose agricultural cooperatives to be formed by graduates and small farmers shall be the responsible agency for establishment, operation and management of the marketing centers.

(3) Location to be Established

It is proposed to locate the marketing centers at six (6) villages where will be populated by major proportion of small farmers and graduates.

(4) Services to be Rendered

The marketing centers will function as temporary storage facilities for shipment of perishable horticultural. The services to be rendered by the center shall comprise, but not to limited to, reception, storage and shipment.

It is advisable that the marketing centers will be provided in the future with equipment and installations which enable commodities to be shipped to international market.

(5) Produces to be Marketed

The following produces are candidate produces to be treated at the center.

Produces	Average Marketing Volume (t/year)	Produces	Average Marketing Volume (t/year)
Tomato	12,900	Squash	3,700
Cantaloupe	11,300	Green pepper	8,000
Water melon	6,700	Peach	1,700

(6) Tangible Benefits

The establishment of the HPMC will produce such tangible benefits as:

- Marketing margin between producers and wholesalers/retailers which is actually retained by middlemen.
- Reduction of post-harvest loss attributable to accomplishment of better shipment and storage of perishable commodities.

These tangible benefits shall be regarded as benefits of the project.

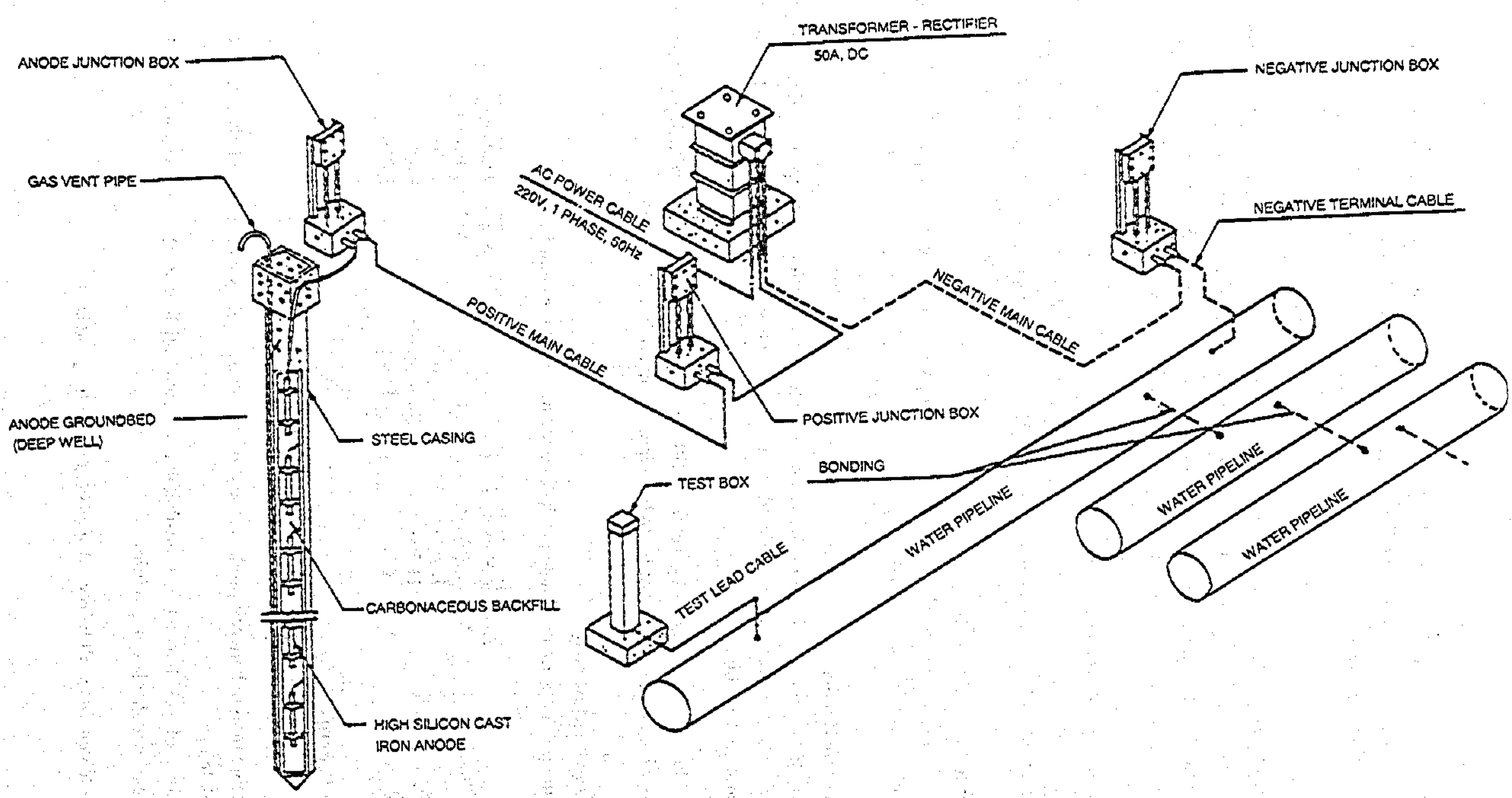


Figure 4-1 Schematic Diagram of Cathodic Protection System

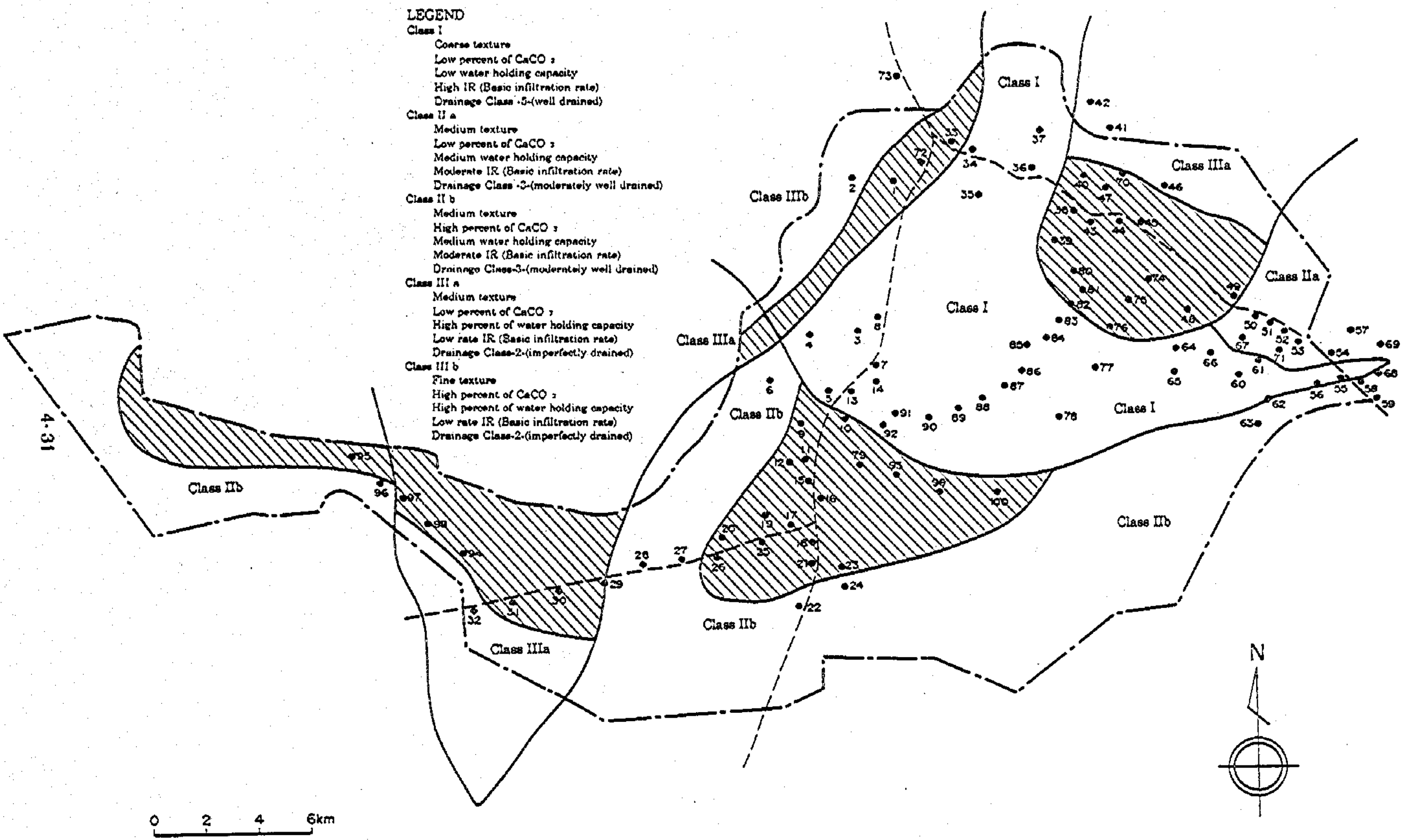


Figure 4-2 Areas to be Provided with On-farm Drainages

Note: Hatched zone is provided with drainage.

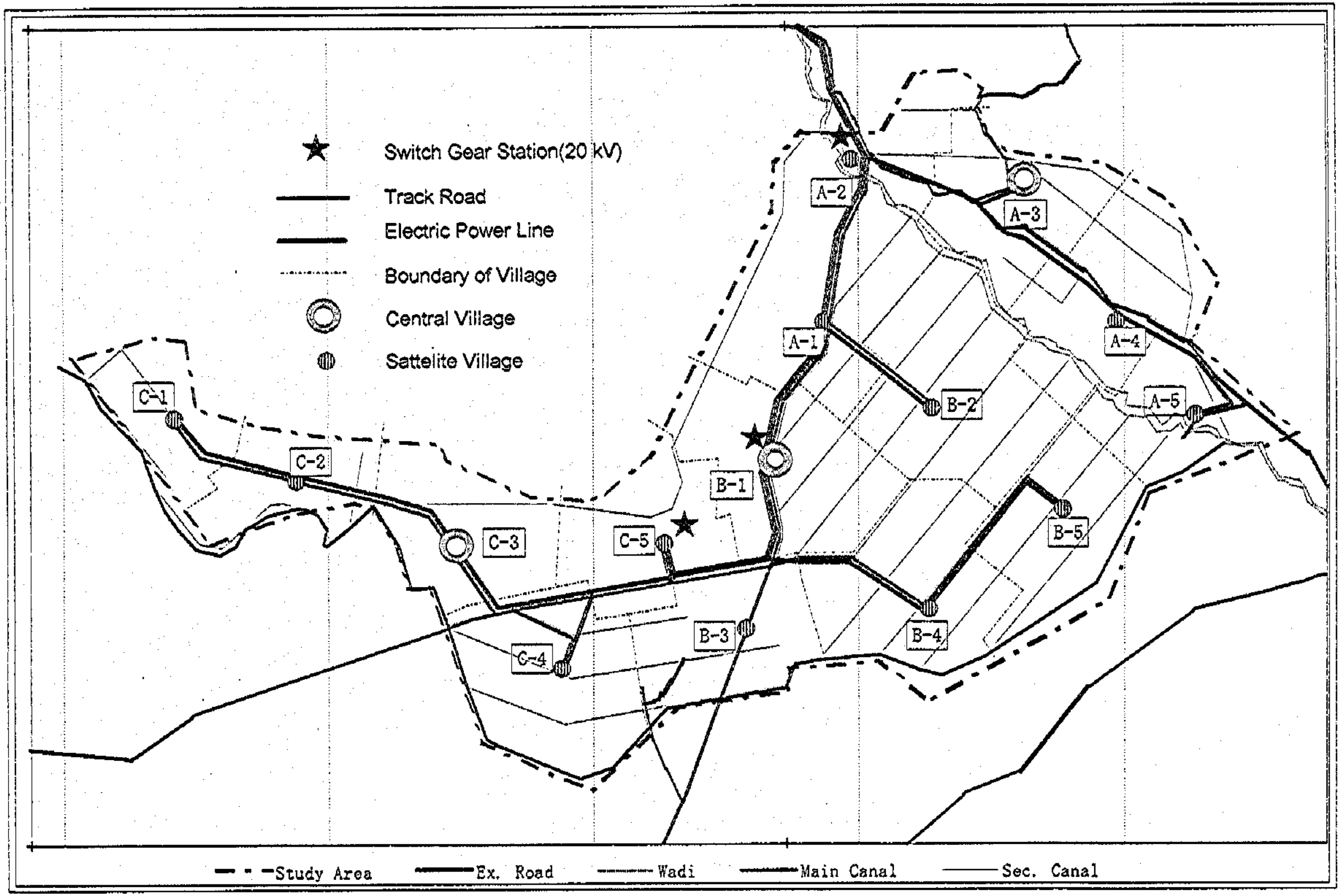


Figure 4-3(1) Electric Power Line Network

Electric Power Demand in Study Area

Village	Domestic Use: Population	Domestic Use: Demand(kw)	Agricultural Use: No. of Small Lot	Agricultural Use: No. of Large Lot	Agricultural Use: Demand(kw)	Total Demand(kw)
A-1	10,220	4,090	35	10	4,575	8,665
A-2	8,340	3,340	0	11	3,300	6,640
A-3	6,970	2,790	0	8	2,400	5,190
A-4	9,800	3,920	29	10	4,260	8,180
A-5	4,180	1,680	18	4	2,010	3,690
Sub Total	39,510	15,820	81	43	16,545	32,365
B-1	12,780	5,120	0	11	3,300	8,420
B-2	9,690	3,880	0	13	3,900	7,780
B-3	2,990	1,200	42	0	1,890	3,090
B-4	9,850	3,940	0	13	3,900	7,840
B-5	9,350	3,740	0	12	3,600	7,340
Sub Total	44,660	17,880	42	49	16,590	34,470
C-1	6,810	2,730	58	0	2,610	5,340
C-2	5,630	2,260	48	0	2,160	4,420
C-3	8,980	3,600	71	0	3,195	6,795
C-4	5,900	2,360	89	0	3,795	6,095
C-5	4,490	1,780	62	0	2,790	4,570
Sub Total	31,760	12,730	322	0	14,490	27,220
Total	115,930	46,430	445	92	47,625	94,055

Note: Domestic Use: 0.4kw/capita
Small Lot (100 feddan) = 45kw/lot : (22 kw X 2 unit)
Large Lot (720 feddan) = 300kw/lot : (75 kw X 4 unit)

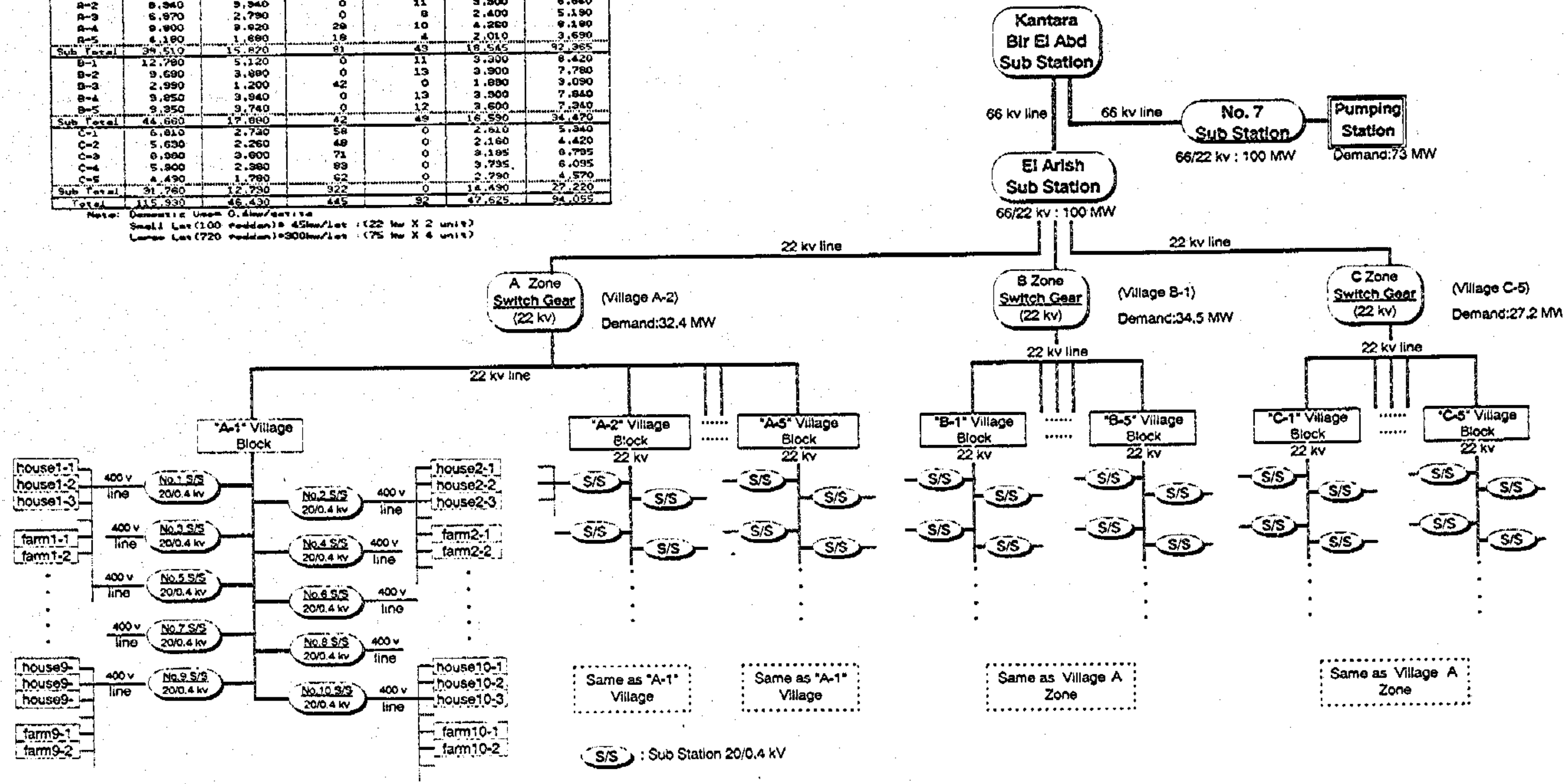


Figure 4-3(2) Schematic of Electric Power Line Network