社会開発協力部報告書

FEASIBILITY STUDY
ON
EL-ARISH SEWERAGE AND
DRAINAGE SYSTEM
IN
THE NORTH SINAI PROVINCE
ARAB REPUBLIC OF EGYPT

FEASIBILITY REPORT

VOLUME TWO

MAIN REPORT

MARCH 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Arab Republic of Egypt, the Japanese Government decided to conduct a feasibility study on the El-Arish Sewerage and Drainage System and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to El-Arish a survey team headed by Mr. Shohei Sata, Nihon Suido Consultants Co., Ltd., from 15th July to 4th November, 1984.

The team had discussions on the project with the officials concerned of the Government of Egypt and conducted a field survey in El-Arish and it's surrounding area. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Arab Republic of Egypt for their close cooperation extended to the team.

March, 1985.

Keisuke Arita

Keisuke Arita
President
Japan International Cooperation Agency

FEASIBILITY STUDY

ON

EL-ARISH SEWERAGE AND DRAINAGE SYSTEM

CONSTITUENT VOLUMES

VOLUME ONE - EXECUTIVE SUMMARY
VOLUME TWO - MAIN REPORT
VOLUME THREE - APPENDICES
VOLUME FOUR - DRAWINGS

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Units and Acronyms

Agencies

GOSSD	General Organization for Sewerage and Sanitary Drainage
NOPWASD	National Organization for Potable Water and Sanitary Drainage
NSG	The North Sinai Governorate
CAPMAS	Central Agency for Public Mobilization and Statistics
JICA	Japan International Cooperation Agency

Technical Terms

BOD	Biochemical Oxygen Demands at 5-day, 20^0C
Cl	Chloride Ion
COD	Chemical Oxygen Demands
DO	Dissolved Oxygen
DWF	Dry Weather Flow
H_2S	Hydrogen Sulfide
MLSS	Mixed Liquor Suspended Solids
MPN	Most Probable Number
pH	The reciprocal of the logarithm of the hydrogen-ion concentration
SRT	Sludge Retention Time
SS	Suspended Solids
TS	Total Solids

Units

cm	Centimetre
gpcd	Grammes per capitaper diem
ha	Hectare
fd	Feddan (0.42 ha)
hr	Hour
km	Kilometre
lpcd	Litres per capita per diem
l/sec	Litres per second
m	Metre

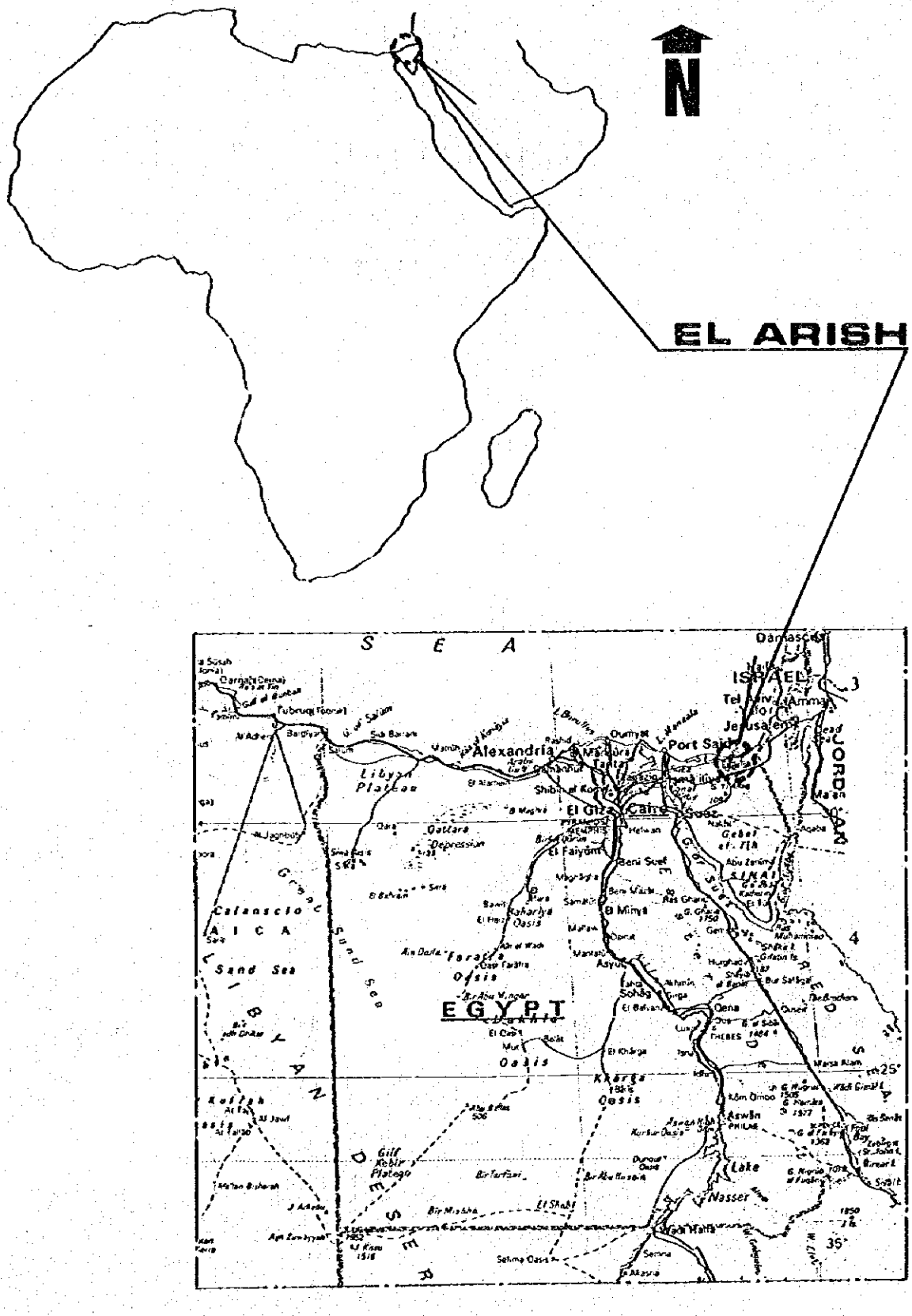
Units and Acronyms

m/s	Metres per second
mm	Millimetre
m2	Square metre
m^3	Cubic metre
mg/l	Milligrammes per litre
m^3/day	Cubic metres per diem
m^3/min	Cubic metres per minute
m^3/m^2/day	Cubic metres per square metre per diem
kl/day	Kilolitres per diem
kW	Kilowatt

Economic and Financial Terms

B/C	Benefit to Cost Ratio
EIRR	Economic Iternal Rate of Return
FIRR	Financial Internal Rate of Return
NPV	Net Present Value
PW	Present Worth
OCC	Opportunity Cost of Capital
p.a.	Per Annum

LOCATION OF STUDY AREA



CHAPTER-ONE

INTRODUCTION

Chapter One

INTRODUCTION

1.1. PROJECT BACKGROUND

El-Arish City, the capital of the North Sinai Province, lies at 33° 50' east longitude and 31° 10' north latitude, facing the Mediterranean Sea as shown in the Plate and Figure 1-1. The present population of the City and its surrounding area of 800 ha is estimated to be approximately 70,000, including those in Masaid and Salem districts.

During the 12 years occupation of this region, no study and construction for the sanitary sewerage system has been made and thereby the deterioration of sanitary conditions have now become a deplorable level, particularly the contamination of the groundwater by the uncontrolled discharge of wastewater through transh.

In order to meet the basic demands of public sanitation in the area and to set up a good link between projects for drinking water and sanitary sewerage, the North Sinai Governorate (hereinafter referred to as NSG) has taken up the sewerage project in the City as one of the top priority programmes.

In 1983, the NSG retained a German consultants for undertaking a feasibility study on sewerage and reuse of treated sewage for the City. The feasibility study completed in July 1983 and a series of feasibility study report (KUP Report) prepared. The KUP Report recommended the sewerage and drainage system development programme up to the year 2020, including sewage treatment plant effluent reuse for irrigation purpose. Analyses were used to prepare a strategic plan for the system and to select the most desirable system to be built in the near future.

Upon completion of the KUP Report, the Government of the Arab Republic of Egypt requested the Japanese Government in 1984 for assistance in establishing the sewerage and water reuse programme for El-Arish area, as the first step towards the implementation of the project.

In response to the request of the Government of the Arab Republic of Egypt, the Government of Japan decided to conduct a feasibility study on El-Arish sewerage and drainage system (hereinafter referred to as "the Study"), within the general frame work of technical cooperation between Japan and Egypt which is set forth in the Agreement on Technical Cooperation between the Government of Japan and the Arab Republic of Egypt entered into force on 31st January, 1984.

The Japan International Cooperation Agency (hereinafter referred to as "JICA"),the official agency responsible for the implementation of the technical cooperation programmes of the Government of Japan, has carried out the Study in close cooperation with the North Sinai Governorate (hereinafter referred to as "NSG") and the authorities concerned of the Government of the Arab Republic of Egypt.

The Study comprises detailed field investigations, surveys and technical analyses of alternative plans for the various elements, and present legal, managerial, economic and financial matters as proposed for the implementation of the First Stage Programme for sewerage,drainage and sewage reuse systems.

1.2. PURPOSE AND SCOPE OF STUDY

The objectives of the Study are:

(a) To examine and assess the technical and economic feasibility of the First Stage Programme (the target year of 2005) on sewerage and drainage system in the City of El-Arish, and

(b) To prepare the basic considerations on the potentiality of the eventual treated sewage reuse project.

The Scope of the Study are as follows:

(a) The Study Area covers the City of El-Arish and its suburban areas of approximately 800 ha, including those existing and under consideration.

(b) The target year for the First Stage Programme is 2005 AD.

(c) The Study comprises the field work in Egypt and analytical and design work in Japan, including;

- Data collection and review.
- Field survey for topography and water quality.
- Preparation of alternative plans.
- Identification of the appropriate plan in the form of items, including facilities planning, implementation planning, and organization, operation, and management planning.
- Basic consideration on the potentiality of the eventual treated sewage reuse project.
- Evaluation of the proposed system.

1.3. UNDERTAKING OF THE STUDY

The Government of Egypt has accorded privilages, immunities and other benefits to the study team, and through the authorities concerned, taken necessary measures to facilitate smooth conduct of the Study.

The Government of Japan, through JICA has taken necessary measures to despatch the study team to Egypt and to perform technology transfer to the Egyptian counterpart personnel in the course of the Study. The project organization is described in Appendix - Eight, 'Project Organization.'

The study team commenced the work on 9th July, 1984, starting the field work in Egypt from 15th July 1984, upon arrival at Cairo. The study team proceeded to the City of El-Arish on 17th July to undertake the initial survey for the Study. The field work lasted until 3rd November 1984 and the study team left Egypt on 4th November 1984 to finalize all the studies in Japan. The

work in Japan finalized in mid-February 1985, and the results of the Study were presented in the form of Draft Final Report. The Draft Final Report was explained by the Advisory Committee and the study team in Egypt and was confirmed by all the agencies concerned in February 1985. Upon receipt of the Government's comments on the Draft Final Report and the necessary revision and addition thereon were made, the Report was finalized in March 1985 as presented here.

1.4. ACKNOWLEDGMENTS

The courtesy and cooperation extended to the Advisory Committee and study team during the course of these studies by the following agencies are gratefully acknowledged:

- North Sinai Governorate
- El-Arish City Council
- National Organization for Potable Water and Sanitary Drainage
- Central Agency for Public Mobilization and Statistics
- Meteorological Authority
- National Research Centre
- Ministry of Planning
- Ministry of Finance
- National Planning Research Centre, ILO
- National Institute of Planning

In addition, the advice and assistance provided by the counterpart staff and other personnel of the North Sinai Governorate and El-Arish City Council are appreciated.

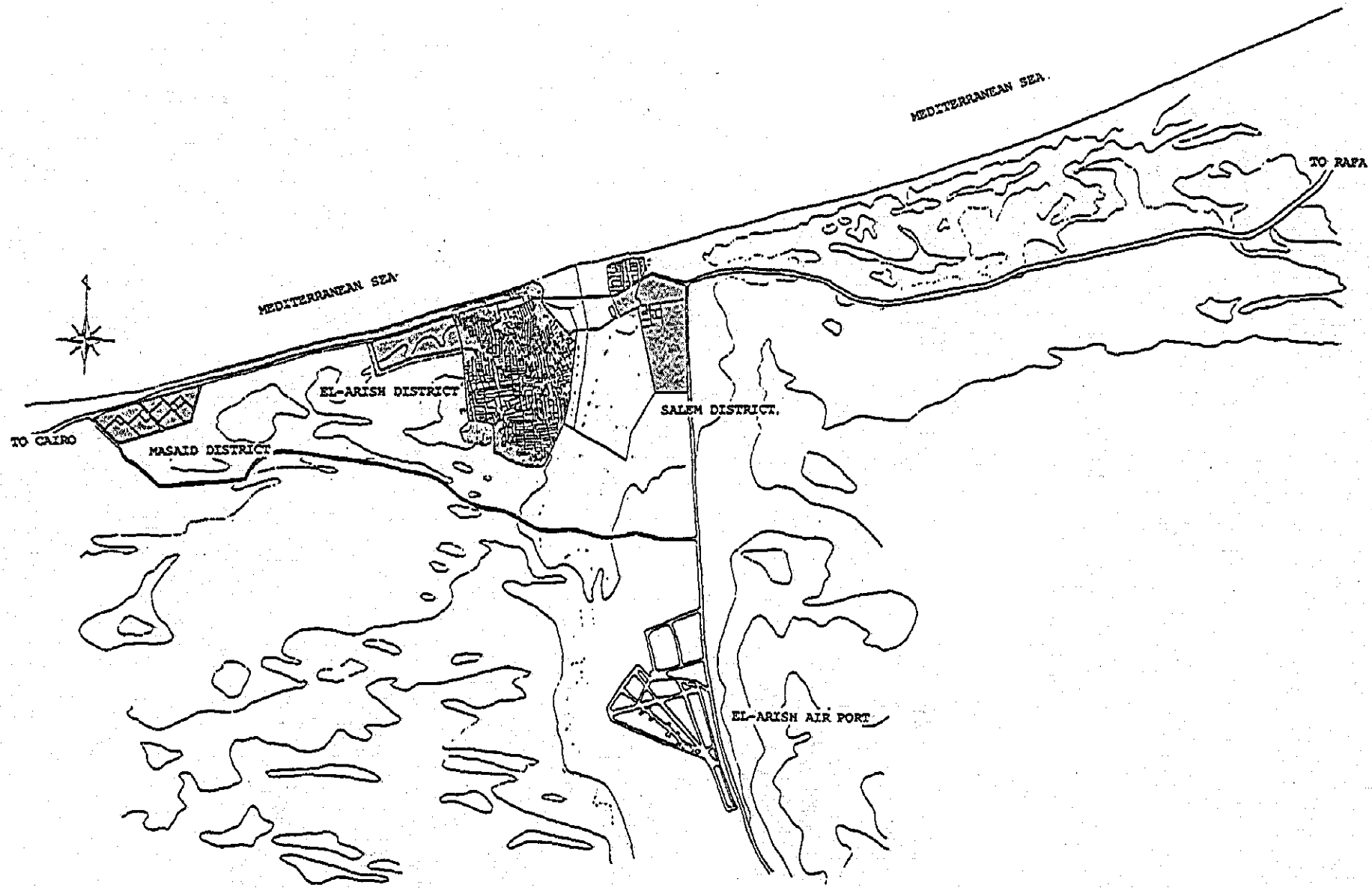


Figure 1.1. Study Area

CHAPTER-TWO

PHYSICAL, SOCIAL AND ECONOMIC ASPECTS OF THE STUDY AREA

Chapter Two

PHYSICAL, SOCIAL AND ECONOMIC ASPECTS OF THE STUDY AREA

2.1. INTRODUCTION

This chapter provides the background information used in Chapter Three to estimate future sewerage and drainage demands, and in Chapter Four to develop the specific proposals for this project covering the period 1985 - 2005.

This chapter therefore discusses conditions in the Study Area, the population in the sewerage districts, and existing water and sanitation service levels and wastewater production patterns. The data are largely based on the investigations and field surveys specifically carried out for this feasibility study from July through November 1984 by the JICA Study Team in the Study Area. All the previous ly prepared studies and information, as listed in "References" of this report, have been reviewed and, where necessary, revised in the light of the latest conditions of the area.

The data presented here are, therefore, more up to date than those in the previous reports and studies. Unless otherwise stated, all cost data in this report are at mid-1984 prices. The planning period adopted for the First Stage Programme is the next 20 years (up to 2005). The strategic plan for this period defines the project which is expected to be implemented during the fiscal year of 1985 to satisfy the urgent needs for the system.

Detailed calculations for engineering and financial studies are separately contained in Volume Three - Appendices. Corresponding reference numbers are indicated as needed for the convenience of readers.

2.2. SOCIO-ECONOMICS

2.2.1. National Economy

Embracing the population of current 45 million and estimated 65 - 70 million up to the year 2000, the Government has promoted the Five-Year Plan for Economic and Social Development 1982/83 - 1986/87, in which GDP is projected to increase 8.1 % per annum and per capita would be expected to be L.E. 573 in 1986/87 at constant price of 1981/82, respectively. Besides, the conceptual quintessence of the Plan consists in the stable improvement of the living standard together with increasing efforts for self-sustaining economy. The Plan aims to upgrade the standard of living by rates at least twice the rate of population growth.

The Plan also emphasizes even as the goal for the Plan to solve the invariable deficit of the balance of payment. The total cost of public debt service, interest plus instalment, has reached L.E.16 billion in 1981/82 that is equivalent, to 24.3 % of the current receipt in the balance of payment. The Plan aims to increase export at the base of 10.5 % of commodity in general, 11.8 % of petroleum and 8 % of agriculture, while yearly import increase 5.2 % for capital goods, 5 % for intermediate goods and 2.5 % for consumer goods are targeted. With projection for surplus in the services balance and in the factor income balance, the Plan expects a gradual decline of the deficit in the balance of payment from L.E. 2 billion in 1981/82 to L.E. 0.5 billion in 1986/87, and yet the absolute term of the debt service cost would reach L.E. 2.0 billion from the level of L.E. 1.6 billion as of 1981/82.

Development efforts by sector can be summarized as indicated in Table 2.2 -1, where structural change is distinct for commodity in its growing and deploying. The Government role, though it is carried out in every sector item in every possible way, would be symbolically recognized in social services. Of the social services, 68.8 % is shared with the Government services, which means 13.2 % for the total GDP in 1986/87 (Details refer to Appendix Table V-41.)

Table 2.2.-1 Increment of GDP up to 1986/87

(constant prices of 1981/82, LE millon)

Sector	Increment	Annual Growth %	GDP Structure	
			1981/82	1986/87
Commodity	5,287.5	8.5	53.7	57.0
Productive Services	2,218.7	7.2	27.4	23.9
Social Services	1,775.0	8.1	18.9	19.1
Total	9,281.2	8.1	100.0	100.0

Source : The Five-Year Plan

Investment and employment are thus steadily projected in the Plan. Development of employment in 1986/87 is assumed to reach 14 million which indicates average 3.3 per cent per annum increase since 1981/82. Indices by sector of it show that productive services take the top-front in growing ratio but the last-bottom in number of employment, for which Table 2.2.-2 shows the outline and Appendix Table V-42 indicates the details. Meanwhile, gross investment projected in the public sector should reach L.E. 48.9 billion in which the total investment during the Plan period shares L.E. 25.8 billion with it. A trait of the investment programme would be recognized in the indomitable challenge to the new projects which are just exceed the level of the replacement and renovation. Table 2.2.-3 shows its summary by type of project (For detail refer to Appendix Table V-43).

2.2.2. Regional Economy, North Sinai Governorate and El-Arish

As the Plan acknowledges in itself, there are widening gaps between prosperous Nile Delta together with Valley areas and secluded local areas. In the latter, there are also gaps between local centres and rural areas. It is to say that the integration of remote areas into the mainstream of Egyptian civilization is invariablly required. In this respect, the total investment of the governorates' level is due to reach L.E. 1,560 million during the Plan period, over a double of it for the past five years from 1978 to 1981/82. Table 2.2.-4 shows its sectorial allocation.

Table 2.2.-2 Development of Employment Over 1981/82 - 1986/87

(1,000)

Sector	1981/82	1986/87
Commodity Sector	6,463.0	7,668.3
Productive Services Sector	1,781.9	2,167.1
Social Services Sector	3,480.0	4,001.4
Total	11,724.9	13,836.8

Source : The Five-Year Plan

Table 2.2.-3 Investment by Type of Project

(LE Million)

Type	Total Cost	Implemented by end June '82	Total Planned Invest.	Residual Invest. Expenditure
Replacement & Renovation	4,816.6	38.8	4,226.4	550.4
Rehabilitation	2,752.7	438.8	1,294.9	1,019.0
Completion & Expansion	31,191.1	9,041.3	15,624.7	6,525.1
New Projects	9,513.8	-	4,337.5	5,176.3
Non-Identified Projects	284.8	47.6	196.3	40.9
Other Projects	324.3	0.2	113.0	211.1
Total	48,882.3	9,556.7	25,792.8	13,522.8

Source : The Five-Year Plan

Sinai, the restored peninsula from Israeli occupation just a few years ago, is set the particular tasks. Namely, establishment of agricultural settlements through land reclamation and better use of groundwater, establishment of industrial activities based on the available natural resources and modernization of fishing activities and better exploitation of touristic potentialities. Drastic attempt to construct the water conveyance system from Nile to Sinai was thus portraied and launched and

is now strenuously developing. Courageous, comprehensive and well-integrated Sinai Development Study was materialized, to which almost every ministry and/or agency was involved.

Table 2.2.-4 Investment by Sector, at the Governorate Headquarters

(LE million)

Sector	Total	Local	Foreign		
			Total	Currency	Facility
Agriculture	183.0	168.7	14.3	9.8	4.5
Industry	129.0	97.1	31.9	6.2	25.7
Electricity	118.5	113.1	5.4	5.4	-
Transport, & Communication	560.0	513.2	46.8	16.3	30.5
Public Utility	450.0	404.6	45.4	7.0	38.4
Services	119.5	113.3	6.2	5.3	0.9
Total	1,560.0	1,410.0	150.0	50.0	100.0

Source : The Five-Year Plan

Table 2.2.-5 Financial Plan by Year and by Sector, North Sinai Governorate 1982/83 - 1986/87

(LE 1,000)

Sector	1982/83	83/84	84/85	85/86	86/87	Total
Agriculture	650	600	428	470	550	2,698
Industry	440	465	502	2,226	1,682	5,315
Electricity	750	795	858	931	1,008	4,342
Transport, & Communication	1,550	2,253	2,915	3,402	4,295	14,415
Public Utility	4,428	4,348	4,658	4,514	5,000	22,948
Services	1,212	1,207	912	486	525	4,342
Total	9,030	9,668	10,273	12,029	13,060	54,060

Source : The Five-Year Plan, Annual Financing of North Sinai Governorate 1982/83 - 1986/87

Expenditures conducted by North Sinai Governorate should be amounted to L.E. 54 million up to 1986/87. Besides, other funds allocated by the Government ministrial and/or agencies sources should be simultaneously input. At the governorate level alone, a trait of the expenditure would be the gradual increasing tendency by year. In 1982/83, some L.E. 9 million should be disbursed and over L.E. 13 million might be spent in 1986/87, for which Table 2.2.-5 would clarify. As for sectional allocation of expenditure, utilities are standing out. Transportation is following it. Industry and services run rather behind them. The biggest portion in the sectoral total is shared to road pavement for both urban and rural, with a little difference for potable water supply (Refer to Table 2.2.7.-A and B).

In the North Sinai, El-Arish is not only the capital and headquarter for the North Sinai Governorate but also the provincial centre of living, commercial and trade, and industrial activities in the area. Affluent groundwater as the conventional assets accompanying white beach on the Mediterranean coast with green date-palm groves invite people from inland and upland together with tourists, domestic and foreign. Establishment of tourists centre in El-Arish is strongly recommended by the Sinai Development Study and Integral Rural Development Project for Sinai Northern Uplands is just completed its study in July 1984. Figure 2.2.-1 roughly shows a potentiality of them. However, because of wars and Israeli occupation for long years, development of this central city in the area is just launched. Table 2.2.-6 shows that the place inhibited some 70,000 is in the very beginning stage of activity and is now starting to progress.

Table 2.2.-6 Summary of Business Activities in El-Arish City

Section	No. of Establishment	Share
Retail	699	67
Wholesale	86	8
Hotel, Cafe & Restaurant	31	3
Construction (incl. wholesale & construction)	199	20
Manufacturing	17	2
Total	1,032	100

Source : Sinai Development Study, Phase I, Vol. III, June 1983

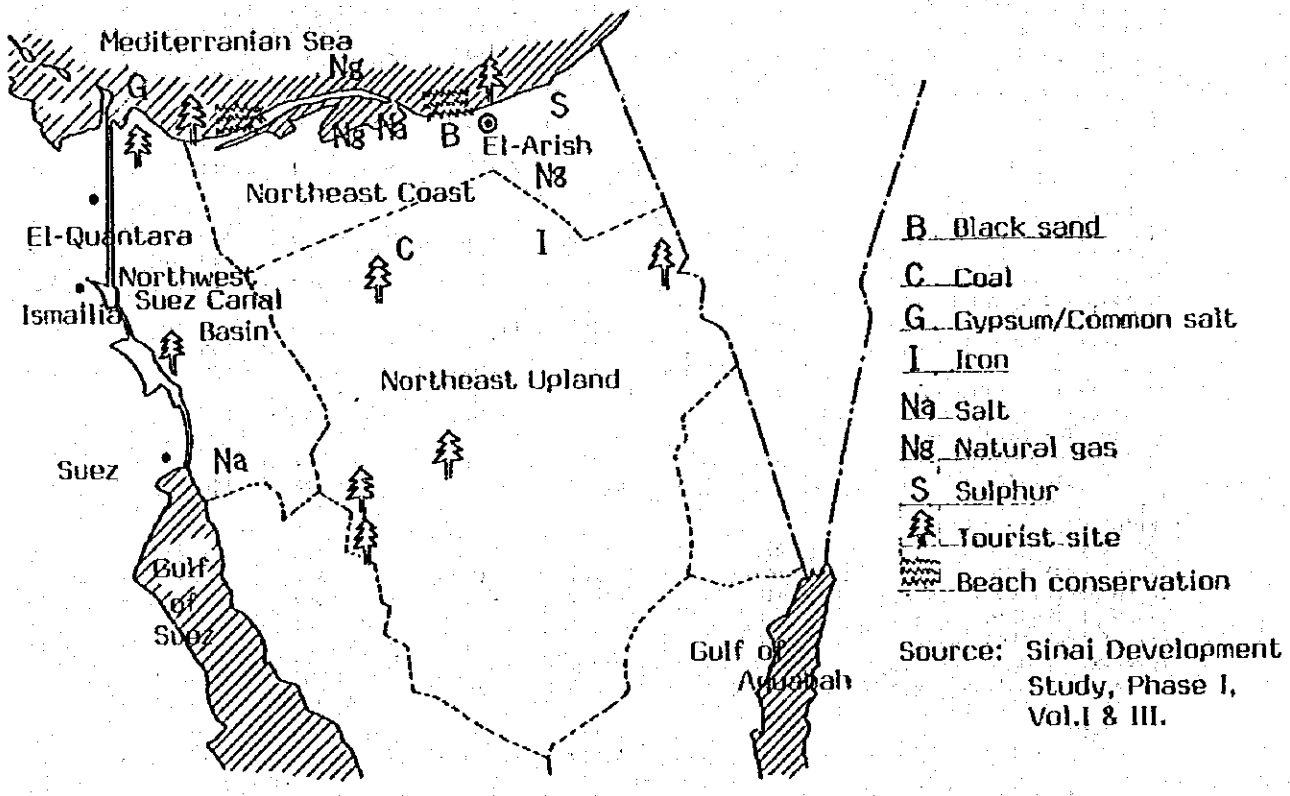


Figure 2.2.-1 Minning and Tourism Potentialities in North Sinai

Table 2.2.7.-A Expenditures of NSG

(L.E. 1,000)

Sector	1982/83			1983/84			1984/85		
	D	F	T	D	F	T	D	F	T
Agriculture									
Cattle Fattening Stations	100	-	100	100	-	100	110	-	110
Milk Production Stations	160	40	200	200	-	200	218	-	218
Egg & Poulty Stations	100	-	100	100	-	100	100	-	100
Fishing Farms	165	35	200	200	-	200	-	-	-
Fruit & vegitable farming	50	-	50	-	-	-	-	-	-
Sub Total	575	75	650	600	-	600	428	-	428
Industry									
Slaughtering Houses	-	-	-	60	-	60	70	-	70
Sand & Stone factory	265	35	300	250	-	250	250	-	250
Ice factory	-	-	-	15	-	15	50	-	50
Furnaces & casting	60	-	60	60	-	60	82	-	82
Olive refining	60	20	80	80	-	80	50	-	50
Sub Total	385	55	440	465	-	465	502	-	502
Electrification									
Elect. network supporting	100	-	100	100	-	100	113	-	113
Elect. network extension	350	-	350	350	-	350	350	-	350
Lighting equipment	249	51	300	175	125	300	220	125	345
Elect. network MO	-	-	-	-	-	-	-	-	-
Lighting for new areas	-	-	-	45	-	45	50	-	50
Sub Total	699	51	750	670	125	795	733	125	858
Transportation									
Paring for urban road	750	-	750	1,000	-	1,000	1,400	-	1,400
Paring for urual road	250	-	250	570	-	570	720	-	720
Equip. replace & repair	257	30	290	310	-	310	350	-	350
Bridges	200	-	200	300	-	300	400	-	400
Road shoulder enforcement	-	-	-	-	-	-	-	-	-
Ferry	-	-	-	-	-	-	-	-	-
Public bus	49	11	60	73	-	73	45	-	45
Sub Total	1,506	44	1,550	2,253	-	2,253	2,915	-	2,915
Utilities									
Cleaning-up towns	345	55	400	425	-	425	430	-	430
Planning	130	-	130	150	-	150	150	-	150
Official cars & trucks	286	77	363	400	-	400	420	-	420
Municipal & Central Establish 1)	1,485	-	1,485	1,173	-	1,173	1,629	-	1,629
Recovering lakes & Sewerage	200	-	200	250	-	250	300	-	300
Potable water 2)	1,500	-	1,500	1,600	-	1,600	1,729	-	1,729
Expenses for liaison transport	-	-	-	350	-	350	-	-	-
Subsidy for hand-operate well	350	-	350	-	-	-	-	-	-
Sub Total	4,296	132	4,428	4,348	-	4,348	4,658	-	4,658
Services									
Security	275	22	297	295	-	295	395	-	395
Urban development	100	-	100	110	-	110	-	-	-
Youth-hostel construction	410	-	410	465	-	465	215	-	215
Bench protection	-	-	-	-	-	-	-	-	-
New project studying	-	-	-	-	-	-	47	-	47
Tourism	230	-	230	312	-	312	230	-	230
Research & Studies	25	-	25	25	-	25	25	-	25
Subsity for liaison transport	150	-	150	-	-	-	-	-	-
Sub Total	1,190	22	1,212	1,207	-	1,207	912	-	912
Grand Total	8,651	379	9,030	9,543	125	9,668	10,148	125	10,273

Remarks: D = Domestic component
F = Foreign component
T = Total

Table 2.2.7.-A (Continued) Expenditures of NSG

(L.E. 1,000)

1985/86			1986/87			Total		
D	F	T	D	F	T	D	F	T
120	-	120	150	-	150	580	-	580
220	-	220	250	-	250	1,048	40	1,088
130	-	130	150	-	150	580	-	580
-	-	-	-	-	-	365	35	400
-	-	-	-	-	-	50	-	50
470	-	470	550	-	550	2,623	75	2,698
100	-	100	190	-	190	420	-	420
1,295	-	1,295	692	-	692	2,752	35	2,787
100	-	100	200	-	200	365	-	365
150	-	150	200	-	200	552	-	552
581	-	581	400	-	400	1,171	20	1,191
2,226	-	2,226	1,682	-	1,682	5,260	55	5,315
126	-	126	126	-	126	565	-	565
370	-	370	370	-	370	1,790	-	1,790
250	125	375	365	10	375	1,259	436	1,695
-	-	-	77	-	77	77	-	77
60	-	60	60	-	60	215	-	215
806	125	931	998	10	1,008	3,906	436	4,342
1,400	-	1,400	1,991	-	1,991	6,541	-	6,541
1,080	-	1,080	1,400	-	1,400	4,020	-	4,020
421	-	421	285	115	400	1,623	148	1,771
238	-	238	200	-	200	1,338	-	1,338
218	-	218	150	-	150	368	-	368
45	-	45	40	-	50	95	-	95
-	-	-	104	-	104	271	11	282
3,402	-	3,402	4,180	115	4,295	14,256	159	14,415
450	-	450	470	-	470	2,120	55	2,175
170	-	170	200	-	200	800	-	800
450	-	450	480	-	480	2,036	77	2,113
1,800	-	1,800	1,500	-	1,500	7,587	-	7,587
350	-	350	400	-	400	1,500	-	1,500
1,294	-	1,294	1,950	-	1,950	8,073	-	8,073
-	-	-	-	-	-	350	-	350
-	-	-	-	-	-	350	-	350
4,514	-	4,514	5,000	-	5,000	22,816	132	22,948
120	-	120	150	-	150	1,235	22	1,257
-	-	-	-	-	-	210	-	210
-	-	-	-	-	-	1,090	-	1,090
141	-	141	200	-	200	341	-	341
50	-	50	-	-	-	97	-	97
150	-	150	150	-	150	1,072	-	1,072
25	-	25	25	-	25	125	-	125
-	-	-	-	-	-	150	-	150
486	-	486	525	-	525	4,320	22	4,342
11,904	125	12,029	12,935	125	13,060	53,181	879	54,060

Table 2.2.7.-B Expenditures of NSG

(L.E.1,000)

	Distribution by Material Item						
	Furni-ture	Trans-port	Tools	Machines	Con-struction	Non-Housing	Hous-ing
Project carried-over							
Electrical network inforcement	77	-	-	-	-	-	-
Paving equippment inforcement	-	-	-	1,771	-	-	-
Potable water	-	-	-	1,000	1,000	-	-
The mechanical Unit construction	-	1,113	-	1,000	-	-	-
Tariffic, security and fire-defense	-	-	-	741	-	-	-
Sub Total	77	1,113	-	4,521	1,000	-	-
Projects needed to complete							
Cattle feeding farms	-	50	-	-	-	300	-
Dairy farms	-	88	-	-	-	500	-
Broilar & eggs farms	-	-	-	-	-	200	-
Bardawill Lake rehabilitation	-	-	-	400	-	-	-
Vegitable & fruit farms	-	-	-	-	-	-	-
Slaoughtering farms	-	-	-	220	-	200	-
Argil quarrying factories	-	-	-	1,207	-	540	-
Ice plants	-	-	-	365	-	-	-
Olive refining	-	-	-	1,091	-	100	-
Electrical network establishment	565	-	-	-	-	-	-
Electrical network extension	1,790	-	-	-	-	-	-
Lighting equipments	-	-	-	1,695	-	-	-
Lighting new areas	215	-	-	-	-	-	-
Paring rural roads	-	-	-	-	6,541	-	-
Paring urban roads	-	-	-	-	4,020	-	-
Public sanitation	-	-	-	2,175	-	-	-
Planning System establishment	-	-	-	-	-	-	-
Official building construction	-	-	-	-	-	2,987	-
Lakes rehabilitation sewage & drainage	300	200	-	300	300	-	-
Potable water	2,000	-	-	2,423	-	-	-
Traffic & security	-	400	400	57	-	-	-
Civil work development	-	-	-	-	-	10	-
Youth hostal construction	-	-	-	-	-	1,090	-
Tourism	72	-	-	-	-	-	-
Studies & resarches	-	-	-	-	-	-	-
Non-central inforcement	-	-	500	-	-	-	-
Sub Total	4,442	738	900	10,013	10,861	5,887	-
New Projects							
Agil quarrying factories	-	-	-	1,000	-	-	-
Automatic Packing Machies	-	-	-	252	-	300	-
Bridges	-	-	-	-	1,338	-	-
Embankment inforcement	-	-	-	-	368	-	-
Ferry	-	95	-	-	-	-	-
Official building construction	-	-	-	-	-	5,000	-
Potable water	-	-	-	1,000	1,000	-	-
Civil work development	-	-	-	-	-	200	-
Environment inprovement	-	-	-	-	-	97	-
Tourism	-	-	-	-	-	1,000	-
Sub Total	-	-	-	2,252	2,706	6,597	-
Grand Total	5,019	2,228	900	16,777	14,567	12,484	-

Table 2.2.7.-B (Continued) Expenditures of NSG

(L.E.1,000)

Outlay by Component						Total sum for Five-Year of 1982-1987	Carrying-out till June 30 1982	Actual Total of Investment
Land	Others	Total fixed	Facility	Cash	Domestic			
-	-	77	-	-	77	77	-	77
-	-	1,771	-	148	1,623	1,771	-	1,771
-	-	2,000	-	-	2,000	2,000	-	2,000
-	-	2,113	-	77	2,036	2,113	-	2,113
-	-	741	-	-	74	741	0	741
-	-	6,702	-	220	6,477	6,702	-	6,702
-	230	580	-	-	580	580	70	650
-	500	1,088	-	40	1,048	1,088	170	1,258
-	380	580	-	-	580	580	70	650
-	-	400	-	35	365	400	20	420
-	50	50	-	-	50	50	10	10
-	-	420	-	-	420	420	20	440
-	-	1,747	-	15	1,772	1,787	15	1,802
-	-	365	-	-	365	365	45	410
-	-	1,191	-	20	1,171	1,191	67	1,258
-	-	565	-	-	565	565	200	765
-	-	1,790	-	-	1,790	1,790	400	2,190
-	-	1,695	-	436	1,259	1,695	400	2,095
-	-	215	-	-	215	215	50	265
-	-	6,541	-	-	6,541	6,541	1,366	7,407
-	-	4,020	-	-	4,020	4,020	635	4,655
-	-	2,175	-	55	2,120	2,175	101	2,276
800	-	800	-	-	800	800	230	1,030
-	-	2,987	-	-	2,987	2,987	2,004	4,991
-	-	1,100	-	-	1,100	1,100	165	1,265
-	-	4,423	-	-	4,423	4,423	1,585	5,008
-	-	857	-	22	835	857	270	1,127
-	-	10	-	-	10	10	62	72
-	-	1,090	-	-	1,090	1,090	533	1,623
-	-	72	-	-	72	72	240	312
-	125	125	-	-	125	125	10	135
-	-	500	-	-	500	500	75	575
800	1,285	35,426	-	643	34,783	35,426	8,993	44,419
-	1,000	-	-	1,000	1,000	-	1,000	
-	-	552	-	-	552	552	-	552
-	-	1,338	-	-	1,338	1,338	-	1,338
-	-	368	-	-	368	368	-	368
-	-	95	-	-	95	95	-	95
-	-	5,000	-	-	5,000	5,000	-	5,000
-	-	2,000	-	-	2,000	2,000	-	2,000
-	-	200	-	-	200	200	-	200
-	-	97	-	-	97	97	0	97
-	-	1,000	-	-	1,000	1,000	-	1,000
-	-	11,932	-	-	11,932	11,932	-	11,932
800	1,285	54,060	-	879	53,181	54,060		63,053

2.3. POPULATION AND LAND USAGE

2.3.1. Present Population and Its Distribution

The Northeast Coast Subregion of Sinai, with 117,000 people or 15 per cent of the Sinai total, has by far the highest population density of Sinai's five Subregions. Eighty per cent of this Subregion's population, over half of Sinai's population, are concentrated in the northeastern corner from El-Arish through Rafah.

Because precise and long period census data are lacking to indicate the population and its distribution in the City of El-Arish and its environs, attempts have been made by the government agencies to obtain the present population. The population data prepared by the Information Centre of NSG indicate the present population and its distribution for over three years from 1982 through 1984, as shown in Table 2.3.1. and Figure 2.3.1. Of these districts, the existing builtup urban zones of 533 ha comprise El-Arish, and Ab Sagal and Salaima Suburb areas. As discussed in Section 3.2., the sewerage planning area comprises the existing builtup urban zones and the development planning area of 434 ha which is to be developed as an urban district by the year 2005, with the total tributary area of 967 ha.

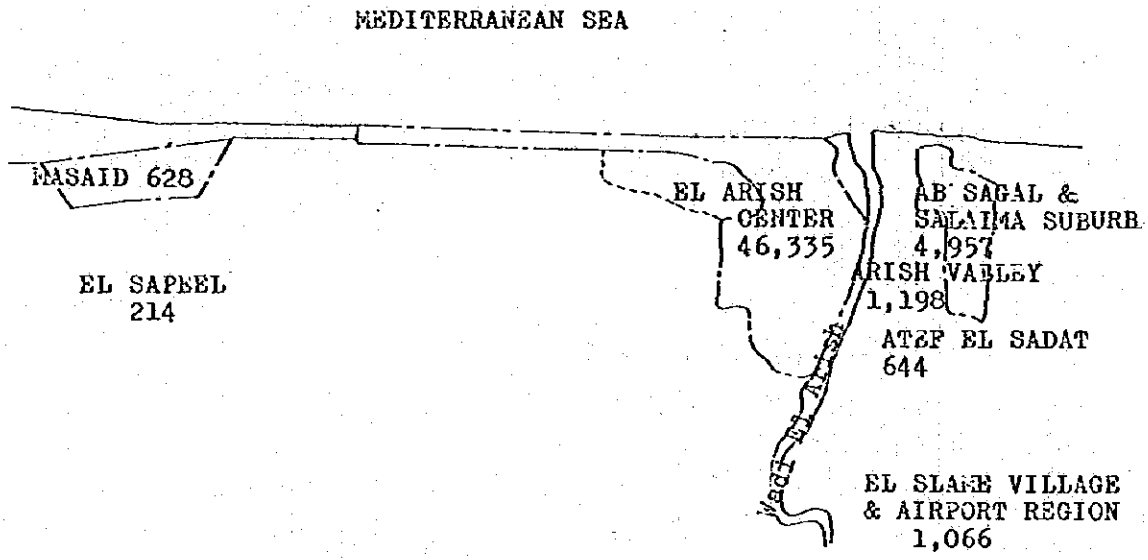
As discussed and agreed in the meeting held on 2nd August, 1984, at the City Council's Project Office, between the NSG and City's personnel and the Study Team, the 1984 population in El-Arish is estimated to be 57,000, of which 51,000 population reside in the sewerage planning area. In addition, a total of 13,000 tourists, workers and transients stay in El-Arish over short period, particularly during summar seasons. These temporary populations are considered as the served population in the sewerage planning, thus making the total present population within the sewerage planning area to be 64,000. The breakdown of the population is as follows:

(a) Sewerage planning area -	Residents	51,000
	Temporary	13,000
	Total	64,000
(b) Outside sewerage planning area	Residents	6,000
Total of El-Arish Area		70,000

Table 2.3.-1 Population of El-Arish by District

	1982			1983			1984		
	Urban	Beduin	Subtotal	Urban	Beduin	Subtotal	Urban	Beduin	Subtotal
EL ARISH CENTER	43,857	-	43,857	46,335	-	46,335	48,953	-	48,953
AB SAGAL & SALAIMA SUBURB	4,692	-	4,692	4,957	-	4,957	5,237	-	5,237
EL MASAID	-	595	595	-	628	628	-	664	664
ATEF EL SADAT	-	609	609	-	644	644	-	680	680
EL SLAME VILLAGE & AIRPORT REGION	-	1,008	1,008	-	1,066	1,066	-	1,125	1,125
ARISH VALLEY	-	1,133	1,133	-	1,198	1,198	-	1,265	1,265
EL SAPEEL	-	203	203	-	214	214	-	227	227
EL MEDEN	-	341	341	-	360	360	-	380	380
ZAREK	-	189	189	-	200	200	-	211	211
JARADA	-	335	335	-	354	354	-	374	374
EL TOUIEL	-	226	226	-	238	238	-	252	252
BEER LEHFEN	-	428	428	-	452	452	-	478	478
TOTAL	48,549	5,067	53,616	51,292	5,354	56,646	54,190	5,656	59,846

Source: Information Centre, North Sinai Governorate



Skirt of El Arish

- El Meden	360	(2 km West)
- Jarada	354	(11 km East)
- Beer Lehfen	452	(10 km South)
- Zarek	200	(15 km East)
- El Touiel	238	(20 km South-east)

Total Population 56,646

Figure 2.3.1. Population Distribution in El-Arish in 1983

2.3.2. Land Use Plan

A land use plan for the City of El-Arish and its environs has been under consideration by the Ministry of Housing and Reconstruction; however, the plan is still tentative one and subject to the final approval by the Government. Because of the present lack of a land usage plan, discussions and hearing on the plan have been made and projections made for six general categories of land use, based on the Ministry's tentative plan, topography, general survey of existing land usage, existing population densities, and development trends and recommendations.

The sketch land use plan thus elaborated is shown in Figure 2.3.2., however, the plan should not be considered a master plan; its purpose is to generally project factors that will determine future sewage quantities, qualities and other factors with respect to the sewerage planning. Each of the land use is defined as follows:

(a) Commercial Area - This area is defined as the area occupied mainly by shops, stores, restaurants, and business offices.

(b) Commercial-Residential Area - Largely composed of buildings for the combined residential and commercial use.

(c) Residential Area - Comprises living quarters including small stores scattered in the area.

(d) Institutional Area - Comprises mainly community and public administrative buildings including government offices, hospitals, schools, universities, mosques, etc.

(e) Tourism Area - Comprises mainly hotels and cottages.

(f) Green Area - Comprises mainly parks and play grounds.

The area and percentage of each land use category in the sewerage planning area of 967 ha are shown in the following table:

Table 2.3.2. Land Use in Sewerage Planning Area

Category	Area (ha)	Percentage (%)
Commercial	27	2.8
Commercial-Residential	38 (3)	3.9 (0.3)
Residential	718 (123)	74.2 (12.7)
Institutional	54 (1)	5.6 (0.1)
Tourism	111	11.5
Green	19	2.0
Total	967 (127)	100.0 (13.1)

Note: Figures in ( ) show the areas of Ayaiba district.

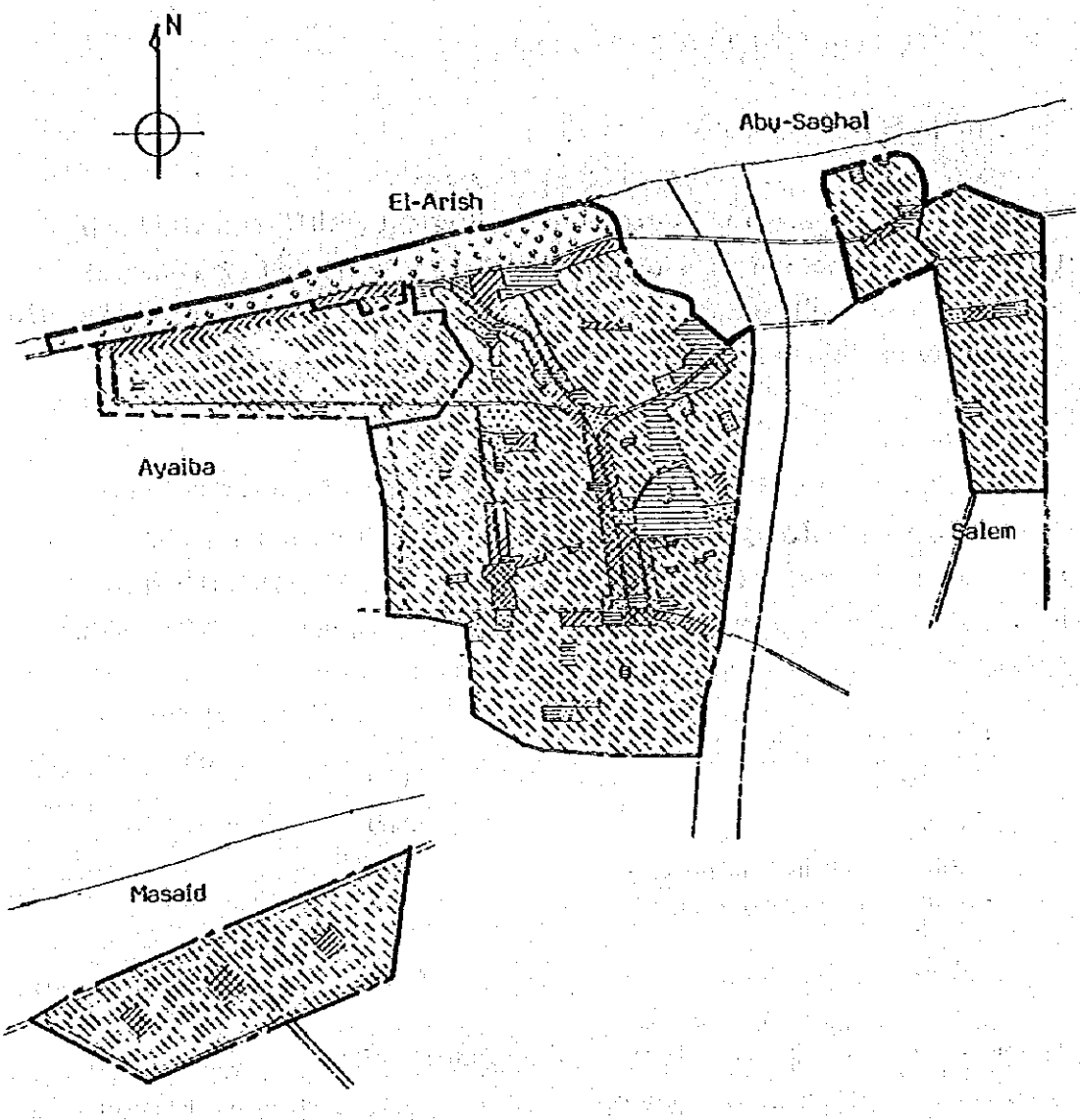


Figure 2.3.2. Land Use Plan of the Study Area

2.4. INDUSTRIES, AGRICULTURE AND FISHERIES

2.4.1. Industries

In El-Arish, there are many licensed establishments both secondary and tertiary activities, but most of these businesses are small in scale and in general use small amount of water. Major industrial activities in the City are briefly explained in the following:

(a) Car Repair

As of 1984, there are approximately 8,500 registered automobiles in the City. The number of the cars has been increasing rapidly at the rate of over 20 per cent per annum. The registered cars comprise the following types:

Heavy duty vehicles (trucks, buses)	3,000
Private cars	2,000
Taxis	2,500
Vehicles for industrial use (incld. agricultural use)	1,000
Total	8,500

Major parts of engines are brought from Cairo, while such simple items as bumpers, mufflers, etc., are produced in the area. This industry is rapidly expanding on account of the ever-increasing number of the vehicles in the City. The average size of the factories is about five in the number of the employees. Their water use is in general small in quantity.

(b) Hardware Stores

Many small scale hardware stores exist in the City with the maximum number of five workers. Steel plates, angles, channels and pipes, as well as other various non-ferrous metals, are processed for a variety of purposes such as building and other structural uses. The amount of water used for the processes is small.

(c) Transportation

The long-distance busses are managed by the Central Government, but about 30 of the city busses are controlled by NSG. Private transportation agents manage their business by one truck. Cars are not frequently washed owing mainly to the high salinity content of the water, thereby the water use in this business is in general small.

(d) Concrete Products

Because of the recent building construction boom in the area and coupled with relatively low investment requirements for the concrete factories, the number of the concrete factories has been increased recently and so did the products. The scale of the factories ranges from the family size factory with a few workers to those with almost 20 staff. The factories require relatively wide space for curing their products, but the water use for the process seems to be relatively low and wastewater discharge is small.

(e) Clothing Manufacturers

There are now two private clothing manufacturing companies in the City, one each for weaving and tailoring. Yarns are brought from Cairo and weaven to white cloths , which are sent back to Cairo for dying process. Workers of the weaving factory is four, while the tailoring factory has fifty staff. The products of the tailoring factory such as trousers and shirts, are marketed in Cairo. Water use in these factories is low.

(f) Restaurants

All restaurants, except those in several large tourist hotels, are small in their scale. The restaurants located along the beach provide only light meals and beverages, wihtout using much water for cooking and washing.

(g) Embroidery and Handicraft Business

All of the handicraft factories producing embroideries and other various handicrafts are small in size generally with only two or three workers. Embroidery business is one of the major handicrafts of El-Arish City and much of the products are primarily marketed in Cairo. For this reason NSG has been encouraging this business by providing an embroidery training course for women in the Business Training Centre.

(h) Wood and Furniture Factories

Wood materials mainly imported are in general brought from Cairo. They produce various kinds of furnitures which are mostly consumed in El-Arish area. The scale of the factories is small with an average five workers. They do not use much water for the process of the products.

Some additional information on the businesses in El-Arish are available from previous studies (Reference No.6).

2.4.2. Agriculture and Fisheries

Thanks to relatively high rainfall precipitation in winter, there are some thousand feddans of rainfed agriculture. Even though sparse, the rainfall is useful for growing about 350,000 trees of date palms. The most common crop in this area is barley which is grown in scattered small areas under intermittent cultivation. Besides the barley, watermelon and caster beans are widely grown, but the profitability of these crops is not so high compared with those of other vegetables and fruits.

It is noticeable that there are about 4,000 feddans of irrigated agriculture. Not only vegetables and olives but also alfalfa, berley, berseem, groundnuts, sorghum, beans and fruits are grown in the irrigated fields. Irrigation is mostly dependent upon the groundwater. In areas extending in the eastern part of El-Arish City, advanced farming is conducted by large-scale farmers holding 30 - 40 feddanss of farm lands. On the other hand, in scattered small areas sited between the sand dunes, primitive farming

is carried out in 5-feddan parcels of land by small-scale farmers.

Traditionally, the livestock sector is very important. As known already, goats, camels and sheeps produce milk, meat, fibre, hide and others. Out of these, camels are useful for transportation. Beside the above livestock, there are small number of donkeys, very few horses and less than 100 beef cattles.

There is at present one slaughter house in El-Arish, situated at the east side of the Wadi in the southeastern part of the City. The kinds of animals slaughtered are:

- Female cows
- Female buffalos
- Male cows
- Male buffalos
- Bulls
- Goats
- Sheeps
- Camels

Of the above animals, bulls are imported ones while beef cattles and buffalos are those bred widely in Egypt and Sudan. The animals are mostly brought from outside El-Arish area, but the meats are consumed in El-Arish area, only small portion being consumed in Bir El Abd and Rafa.

The work is undertaken in early morning on Thursedays, Fridays and Saturdays. The numbers and kinds of animals slaughtered in the last three years from 1980 through 1983 are as shown in the following table:

Table 2.4.1. Numbers and Kinds of Animals Slaughtered from 1980 to 1983

Year	Femal cow	Female buffl.	Male cow	Male buffl.	Bull	Goat	Sheep	Camel	Total
1980	9	24	516	322	1	847	129	112	1960
1981	0	0	601	468	1	778	167	7	2022
1982	16	0	543	898	0	581	262	5	2305
1983	26	119	980	156	0	644	772	108	2805

Source: Dr.Hassan Amla, General Director of Veterinary Department, City Council.

During the last 19 months from January 1983 to July 1984, a total of 4,346 animals have been slaughtered with an average monthly number of 230. In July 1984, the house had been in work for 13 days, with an average number of animal slaughtering of 14.

Water is used mostly for cleaning of floors of the house, but the amount of water use is small, as such a one-inch city water pipe supplies sufficient water to the house. For the wastes no treatment equipment is provided, and all the wastewaters including blood are disposed of through the transh system without problems. Since the slaughter house is located close to residences, removing of the facilities to other remote place is now under consideration by the City Council.

Fishery in El-Arish area is mostly of coastal fishing and small in scale. Most of the catches are consumed in El-Arish and its suburban area. Small amount of fish caught in El-Mazar is brought to El-Arish and marketed. No particular processing of fish is made but only salting of small quantity of fish. For this reason, water use in the activity is low.

2.4.3. Tourism

Aside of the premature activities of manufacturing industry and commerce or trade, tourism in El-Arish has already given preference. As pointed out in the Section 2.2.2. in this chapter, warmth and sunshine on the Mediterranean coast with supurb white-sand-beach and dune and green oasis with date-palm groves are conventional assets and also immediate cash-earning industry now to El-Arish.

There are nearly 20 hotel facilities with capacities of over 1,000 beds and additional over 10 facilities with some 1,200 beds are under construction or are projected. Besides, youth-hostel and shallets as well as tents specially for young generation and family circles are rather innumerably set up. In 1983, Tourism Department of NSG counted 71,161 as the total tourists who seemed to stay in this city. Among them, except the tourists for lodging facilities of sporting/recreation, the occupied numbers of

hotel guests reached 62,705, of which 34,798 or 55.5 per cent were the guests in high-season as the latter half of the year with 50,685 tourist-nights.

In the first half of 1984, although in off-season, the Department counted the occupied numbers of 30,269 which are 8.3 % increase compared to the same period of 1983. Their tourist-nights in the period were 54,579 that were equivalent to 7.7 % increase compared with even the high-season's records in the latter half of 1983. It is to say, in sany way for a year from July 1983 to June 1984, that 65,067 is totally counted as the occupied numbers with 105,264 tourist-nights, for which Table 2.4.2. would clarify.

According to the statistic brochures prepared by the Department, the weighted average of hotel charges is assumed to be L.E. 13 per tourist-night (Refer to Appendix - Five, Table V-43). If the least-expense of the hotel guests is quoted, to which approximately one-third for hotel charges is internationally assumed, a tourist might spend less/over L.E. 18 per tourist-night. It can be said, therefore, that an equivalence of some L.E. 2 million might be able to expect as a yearly gain to El-Arish. For noting down, the gain is assumed at the base except the tourists for lodging facilities of sporting/recreation.

Table 2.4.2. Tourism in El-Arish

	Public Hotels		Tourist Hotels		City Council's		Total	
	on	tn	on	tn	on	tn	on	tn
1983 Jan.	4,487	n.a.	165	130	50	n.a	4,702	u.i.
Feb.	5,806	n.a.	237	633	63	n.a.	6,106	u.i.
Mar.	4,644	n.a.	234	243	92	n.a.	4,970	u.i.
Apr.	3,299	n.a.	244	400	184	n.a.	3,727	u.i.
May	3,169	n.a.	291	556	243	n.a.	3,703	u.i.
Jun.	4,059	5,233	221	492	419	n.a.	4,699	u.i.
Jul.	4,809	7,747	295	452	728	674	5,832	8,873
Aug.	6,845	7,653	231	659	898	906	7,974	9,218
Sep.	4,756	7,397	566	1,210	988	504	6,310	9,111
Oct.	4,665	6,385	499	884	95	999	5,259	8,268
Nov.	4,439	6,488	533	761	50	948	5,022	8,197
Dec.	3,783	4,633	548	948	70	1,437	4,401	7,018
1984 Jan.	*	*	*	*	*	*	4,571*	9,102*
Feb.	*	*	*	*	*	*	3,730*	7,232*
Mar.	*	*	*	*	*	*	5,268*	9,019*
Apr.	*	*	*	*	*	*	5,683*	10, 088*
May	*	*	*	*	*	*	5,541*	9,993*
Jun.	*	*	*	*	*	*	5,476*	9,145*

Remarks : on, abbreviated "occupied Number" as guests for hotels.
tn, abbreviated "tourist-nights"
n.a., not available
u.i., unidendified
* , preliminary

Source : Tourism Department, North Sinai Governorate

2.5. PHYSICAL CHARACTERISTICS OF THE STUDY AREA

2.5.1. Geology and Topography

(a) Geology

The El-Arish region is an area of low relief terrain, located north coast of Sinai. The landforms are predominantly sand dunes, sand sheets, and coastal depressions, in different structures.

The soils of the area consist principally of unconsolidated deposits formed from alluvial, aeolian, or lacstrine deposits and developed primarily under arid conditions. Soils erodes easily by stormwater runoffs and are further cut by wind. Near the coast, the slopes level off to low basins which receive rainwater, but the water soon evaporates and leaves behind a dry wadi bed. The soils with agricultural potential consist of alluvial or aeoline deposition. All soils in Sinai have a very low organic matter content, and their water capacity is low. The groundwater flows from south-west to south-east region.

(b) Soil Conditions

Boring data in Masaid area are available in the Technical Office of North Sinai Region for Reclamation and Construction. As shown in Figure 2.5.1, a total of 20 borings were carried out at the housing construction site of 300 m by 600 m near the broadcasting station in Masaid, to an approximate depth of 10 metres. These were made during October 1981.

A boring section No. 10, representing the soil conditions of Masaid, is illustrated in Figure 2.5.2. As shown in the section, the surface soil consists of light green sand medium to fine up to the depth of 1.5 metres, with an "N" value of about 10. Between the depths of 1.5 and 3.5 metres, the sand changes from medium to fine and the N value decreases to at arround 6. The sand at the depth of 3.5 metres to 8.5 metres becomes from medium to coarse, but N value increase higher than 10. From

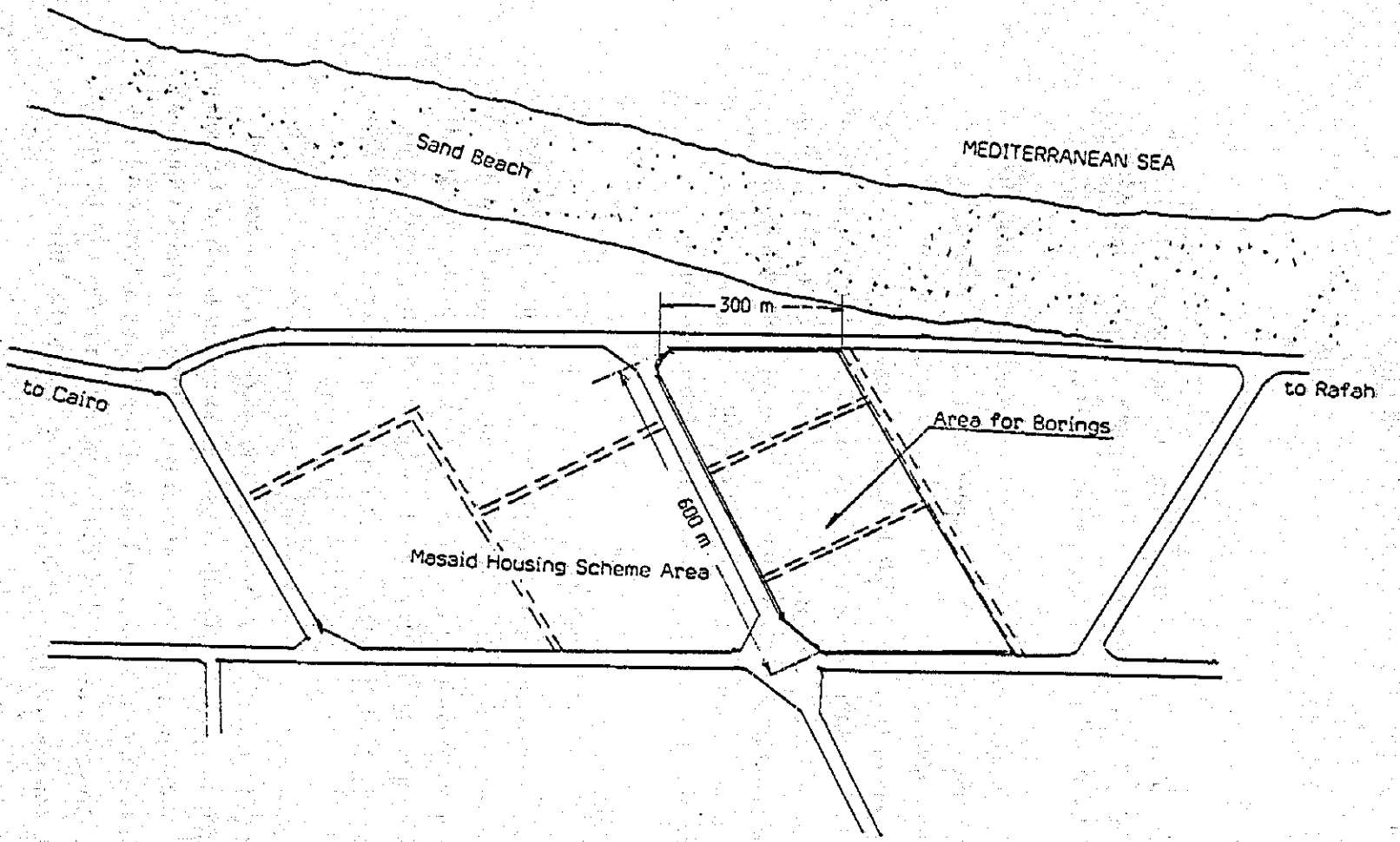


Figure 2.5.1 Location of Masaid Area for Borings

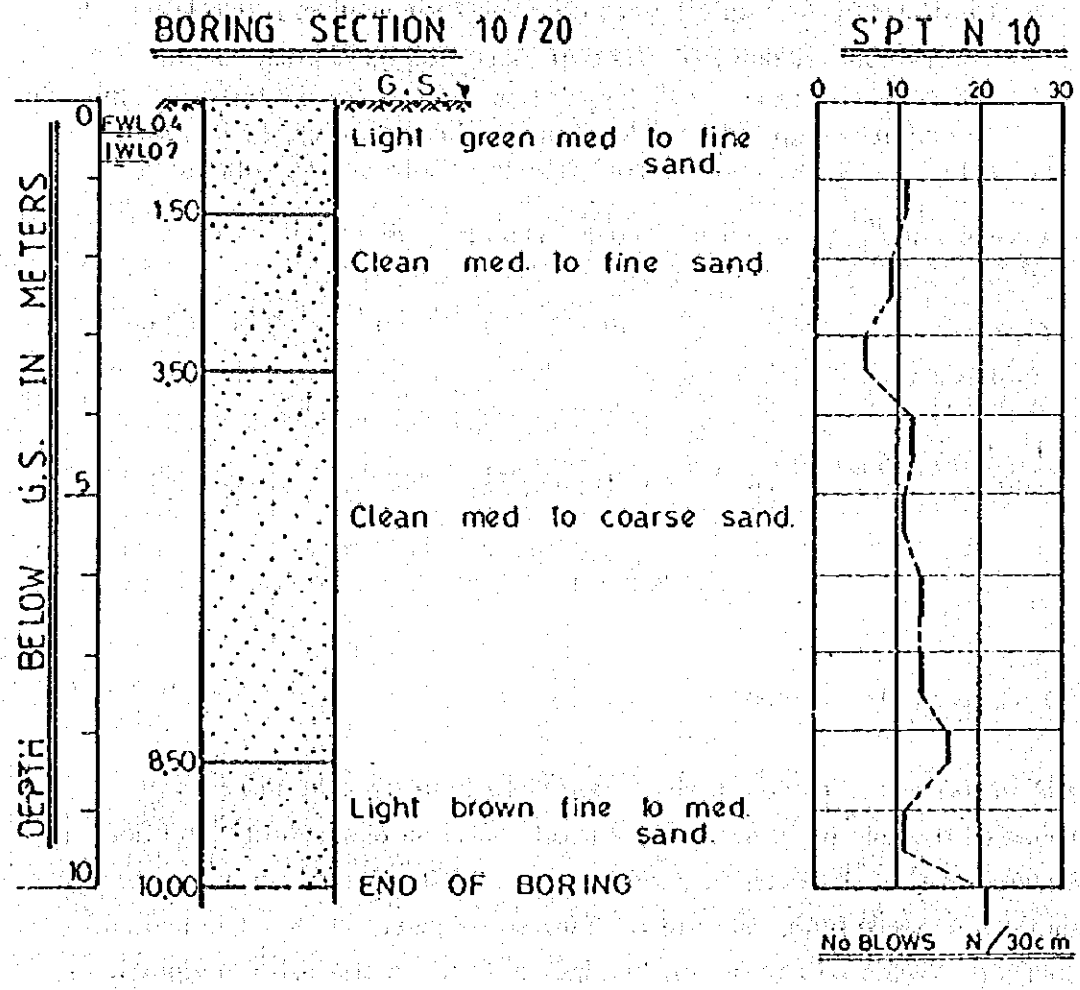


Figure 2.5.2. Boring Logs at Masaid Area

the depth of 8.5 metres to 10 metres, the sand changes to light brown and ranges from fine to medium.

As the result of the borings the following observations are drawn:

- The soil is homogeneous in characters both vertically and horizontally. Sandy layers often change in their colour and consistency.
- Consistency of sandy layers changes from medium rough to rough.
- The relative density of the soil increases as it gets deeper. The surface layer of loose sand has the N value of less than 10. The relationship between N values and consistency of sand, relative density and internal friction angle are as follows:

Consistency of sand	Very loose	Loose	Medium	Dense	Very dense
N	4	10	30	50	50 or higher
Relative density	15	35	65	85	100
Int'l friction angle	28	31	36	41	41 or more

(c) Groundwater Tables

The groundwater tables in the Study Area is in general low except those of the low-lying areas near the coast. As observed by the borings carried out at the housing construction site in Masaid, the groundwater elevations were high, ranging from 0.7 to 0.8 metres below the ground surface. Owing to the high groundwater table in the area, a significant portion of the sewer construction had been dewatered by the well point system. It was also observed in the borings that the groundwater elevations changed according to ebb and tide flow.

Chemical analyses of the groundwaters obtained from three borings, No. 1, 10 and 19 clearly indicate that the groundwater near the coast is influenced by the sea water. The results of the chemical analyses are as follows:

(in mg/l)

Boring No.	1	10	19
Total Resolved Salts	23,641	24,305	23,721
Sodium Chloride	4,600	4,750	4,630
S2O3	1,110	1,126	1,115
Alkalinity asSodium Carbonate	730	751	746
pH	7.6	7.5	7.6

Source: Technical Office of North Sinai Region for Reclamation and Construction.

On account of the fact that the low-lying areas close to the coast is influenced by the sea water, the Technical Office recommend s guidelines for building foundation, that;

- The foundation structures be above the groundwater table.
- Net bearing strength of the soil is 0.75 kg/cm2
- Concrete surface directly contact with the soil be painted twice by hot bitumin.
- Concrete cover and other various design of structures should be determined on the basis of the guidelines.

(d) Topography

El-Arish City is situated on the alluvial delta of the Wadi El-Arish, facing to the Mediterranean Sea in the north. In Masaid, approximately 10 km west of the city centre, a housing construction has been underway to cover finally a total area of 106 ha. Salem area located at the west of the city, is also a satelite town of El-Arish, with apartment houses to receive about 10,000 residents in the near future.

Ground elevations of the Study Area range from 2 to over 30 metres above the mean sea water level of the Mediterranean Sea at Alexandria (MSWL). At the highest point of the area near the grave yard, the ground elevation is about 35 metres MSWL. The ground slope of the Study Area runs either to the easterly direction towards the Wadi El-Arish, or to the north towards the Mediterranean Sea. The City is surrounded by sandhills at east and west.

Various topographic maps in different scales are available for study, including those of in the scales of 1 : 500, 1 : 2,500, and 1 : 5,000. In addition, revised topographic maps prepared under the present study are available, which include the new housing schemes in Salem and Masaid areas and other features recently completed.

Under the present study, an intensive topographic survey has been undertaken, to check the present topographic conditions of the Study Area. The survey includes levellings, longitudinal and cross section surveys, and based on the results, contour lines and other features were revised to reflect the latest conditions of the area.

For the convenience of the study and also for the succeeding construction of the sewerage and drainage system, temporary benchmarks were set at 8 locations, of whcih 6 locations in El-Arish, 1 each at Masaid and Salem as shown in Figure 2.5.3. The base benchmark established in 1961 is situated at the old El-Arish railway station. The elevation of the benchmark is + 10.644 m MSWL.

Some more details on the topographic survey are described in Volume Three, Appendix - One.

2.5.2. Rainfalls and Other Climatic Conditions

Rainfall and other climatic data in the Study Area have been collected and analysed for many years at the Meteorological Station located at the El-Arish Airport in the south of the City. These data are sent to the Egyptian Meteorological Authority in Cairo and stored in the Authority.

According to the records since 1960 obtained from the Authority, rainfalls in the Study Area have mostly concentrated in winter from November through March, accounting for almost 85 per cent of the annual precipitation. These rainfalls occurred in 18 days and the number of days having the rainstorm of more than 10 mm per day was 3.5. The maximum rainfall

No.1 At the southeastern corner of the broadcasting station in El Arish
No.2 At the northwest corner of the Governorate guest house at El-Sahry
No.3 At the northwest corner of El-Saha El-Shabia Stadium
No.4 Southwest corner of Food Issue House of Governorate near El-Sheikh Gobara mosque
No.5 Northwest corner of El-Arish Library at the south of El-Refai mosque
No.6 At the northwest corner of El-Naser mosque
No.7 At the southeastern corner of El-Arish Hospital
No.8 At the north corner of El-Salem Club House in Salem area

The base benchmark is located at the old railway station of El-Arish

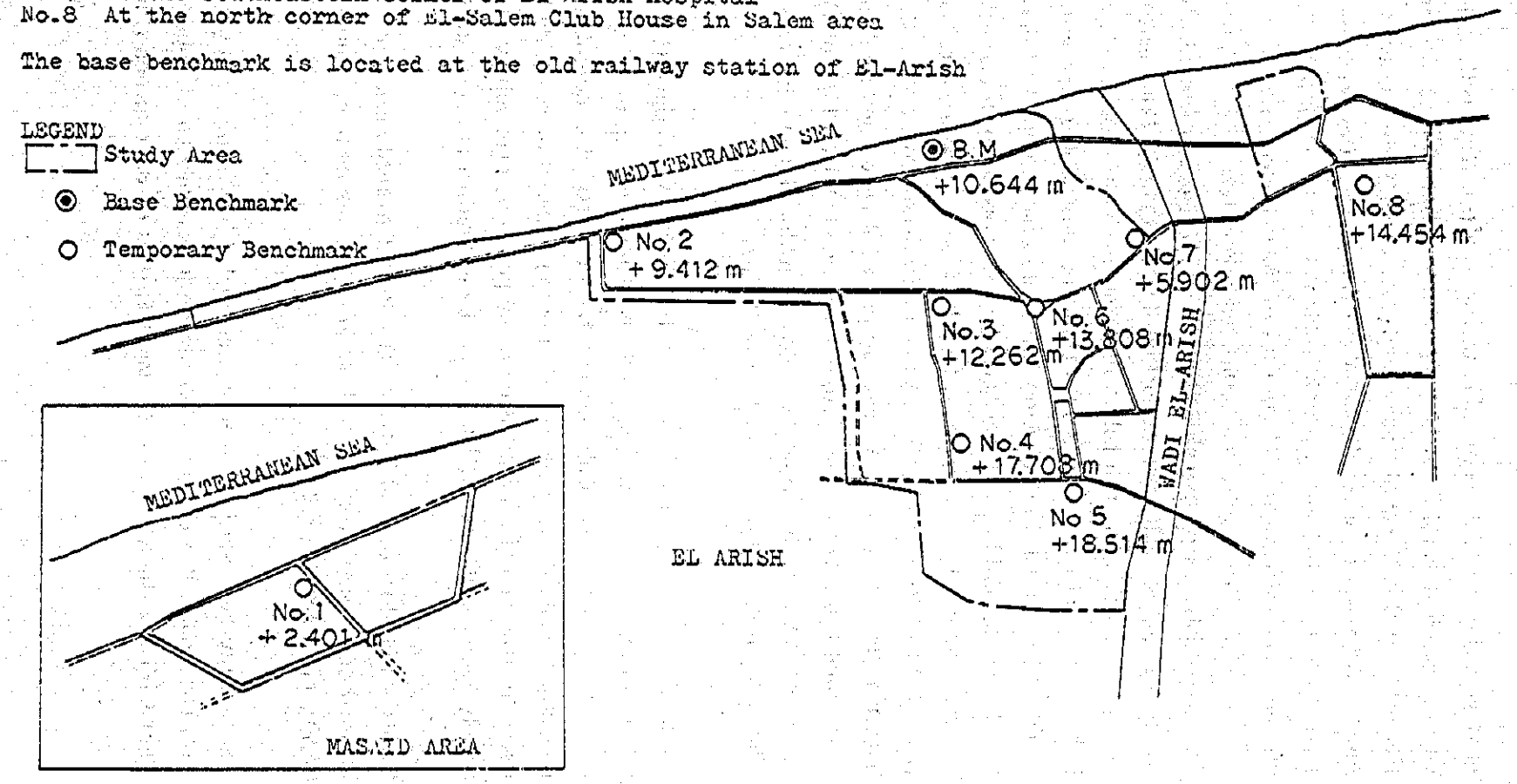


Figure 2.5.3. Locations of Benchmarks

ever recorded was 59 mm per day in the month of May followed by the second heaviest rainfall of 52 mm per day in October. The record from 1960 - 1966 and 1980 - 1983 shows the heaviest rainfall occurred on 21st April 1964 having an intensity of 42.3 mm per day. During summer seasons, from June through August, precipitations have been almost nil with the only recorded daily maximum rainfall of 5.7 mm per day.

Annual or daily rates of rainfall are, however, only of general interest as far as surface water sewer design is concerned. Much more important are the intensities of rainfall over comparatively short periods of time. In the El-Arish Meteorological Station, a self-registering rainfall measuring equipment has been in operation for years and the rainfall data record papers are available at the Meteorological Authority in Cairo. For this study the rainfall record papers for the last 11 years, from 1960 to 1966 and from 1980 to 1983, have been collected. The reord papers of three heaviest rainfalls in each year have been collected and naalysed for developing the intensity-duration-frequency relationships of the rainfalls for stormwater drainage design. Some details of the data and analysis are discussed in Appendix - Four, Volume Three.

An annual rainfall probability curve for El-Arish was developed by Dames & Moore (Ref. No.7). The rainfall probability curve, developed on the basis of the annual rainfall records from 1908 to 1966, indicates the percent probability of precipitation being equaled or exceeded. For example, the annual precipitation of 98 per cent probability is approxi-mately 38 mm while that of 50 per cent probability is about 100 mm.

Relative humidity ranged between the lowest monthly mean of 14 per cent in April and the monthly highest mean of 100 per cent in January, March, April and December.

The monthly average temperatures recorded in the last ten years ranged from the lowest 19.3 degrees Centigrade in January to 31 degrees C in August having the minimum daily temperature of 8.5 degrees C in January.

Surface wind roses in El-Arish area from 1959 to 1966 are available from the El-Arish Meteorological Station data (Ref. No. 7). The predominant wind directions in winter, from December to February, were in southwest with the average percentage frequency of approximately 25 per cent followed by those in southeast direction. During spring, from March to May, the wind directions gradually change from south to north with the average percentage frequency of the northwest wind at approximately 20 per cent. During summer and autumn, particularly from June to September, the wind in northwest direction predominates with the average frequency of about 30 per cent in summer and 20 per cent in autumn. The velocities of wind range between 2.0 and 3.0 m/sec.

Climatic conditions, such as temperatures, monthly rainfalls, evaporations and relative humidities are shown in Table 2.5.1. Maximum amount of rainfall in one day from 1960 to 1966 and from 1980 to 1983 are indicated in Table 2.5.2.

Table 2.5.1 Climatic Conditions in El-Arish (1956 - 1967)

Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Temperatures (^{o}C)												
Mean of day	13.6	13.9	16.0	18.7	21.6	24.7	26.2	27.0	25.6	23.2	19.7	15.5
Mean maximum	19.2	19.9	21.3	23.7	26.9	28.9	30.6	31.4	29.9	28.5	25.3	21.4
Mean minimum	8.5	9.1	10.8	13.3	16.1	18.9	21.3	21.9	20.4	18.0	14.4	10.2
Rainfall (mm)												
Total	20.3	17.1	12.8	6.1	3.2	Trace	0.0	0.2	0.6	6.0	16.2	22.2
Evaporation (mm)												
Evaporation per day	3.6	4.0	4.5	4.7	4.9	4.9	4.8	4.9	5.2	4.8	4.0	3.6
Relative Humidity (%)												
Mean relative humidity	70	69	67	67	68	72	74	75	71	73	71	66

Source: The Egyptian Meteorological Authority, Cairo (Obtained in August, 1984).

Table 2.5.2 Maximum Amount of Rainfall in One Day

(in mm)

Year		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
1960	Amount	5.8	1.0	4.4	4.0	3.3	-	-	-	-	-	11.6	1.0
	Date	22	2	23	8	9						2	13
1961	Am.	26.7	11.6	10.0	-	0.6	-	-	-	-	10.4	15.8	3.7
	Date	19	27	19	-	6	-	-	-	-	13	22	31
1962	Am.	17.0	3.7	-	5.8	1.0	-	-	-	-	0.2	1.9	4.0
	Date	20	20	-	19	9	-	-	-	-	7	7	4
1963	Am.	Trace	7.2	5.0	0.7	4.6	-	-	-	-	3.3	9.6	35.0
	Date	17.26.31	10	7	23	7	-	-	-	-	20	20	2
1964	Am.	7.0	9.8	1.0	42.3	0.5	-	-	-	-	-	5.2	17.4
	Date	25	12	11	21	10						17	15
1965	Am.	40.5	-	9.8	17.5	0.3	0.1	-	-	-	18.9	0.7	0.4
	Date	11		21	2	6	10				23	17	16
1966	Am.	7.5	12.1	9.0	-	0.1	-	-	-	-	1.7	0.7	3.8
	Date	25	7	22		1					12	11	19
1980	Am.	5.8	12.0	9.7	1.2	-	-	-	-	-	-	-	21.6,24.7
	Date	24	24	2	14								11 26
1981	Am.	1.3	0.9	1.7	0.4	-	-	-	-	-	2.5	2.5	1.8
	Date	12	19	25	15						11	12	29
1982	Am.	9.8	8.6	10.5	1.4	-	-	-	-	-	0.2	29.4	9.9
	Date	5	4	26	4						22	9	5
1983	Am.	11.4 6.8	5.2	8.6	0.1	0.1	-	-	-	-	0.1	0.2	5.8
	Date	18 25	2	5	1	14					14	6	25

Source: The Egyptian Meteorological Authority (Obtained in August, 1984)

2.6. WASTEWATER TREATMENT AND DISPOSAL

2.6.1. Transh System

Presently, most of the human excreta and sullage water have been disposed of into ground through the transh system. which is composed of flush toilet, bath, kitchen utensils, sewer pipes and transh. The excreta is flushed and carried away to the transh through the sewer mixed with the sullage water. The transh is a kind of leaching tank either circular or rectangular in shape somewhat similar to the septic tanks, sited just below ground level, in which the excreta, mixed with the sullage water, is retained for several days. During the time, the solids settle to the bottom of the chamber where they are digested anaerobically as they undergo in the septic tanks.

The circular transh is widely used for home use, with the internal diameters of 1.5 to 2.0 m and 3 m deep having a capacity of approximately 10 m3. The rectangular transh, generally used for the system of larger capacity, range in their sizes from 3 x 4 x 3 m to 3 x 10 x 3 m with the capacities from 36 to 90 m3 or more. The side wall of the transh is constructed either by crushed stones or concrete blocks specially produced for the purpose. For the efficient percolation of the wastewater into the surrounding subsoil, the crushed stones are generally placed without any mortar joints. The concrete block, 50 cm x 20 cm x 15 cm in size, is curved at the radii of 0.75 or 1.0 m to form the transh with the diameter of 1.5 or 2.0 m circular wall when they are placed. The block is provided with two hollows both at interior and exterior to increase the wastewater exfiltration. The blocks are laid with mortar joint alternately.

The top of the wall is covered by a concrete slab with a manhole of 60 or 75 cm diameter cast iron manhole cover and frame either circular or rectangular in shape for the cleaning and maintenance of the transh. Salt is reportedly used some times to resolve the accumulated scum or sludge on the transh wall.

Structures of standard transhes are illustrated in Figures 2.6.1., 2.6.2. and 2.6.3.

Digested solids and water in general infiltrate into subsoil effectively without much trouble because of high permeability of the soil. As the permeability factor "k" for the soil in the area, an average value of 0.0003 m/sec has been suggested (Ref. pp.29, Vol. I of KUP Report). The comparatively high permeability of soils allow the residents to use the transh system without much troubles and the system becomes dominant in the region as the most economical way to dispose of the wastes. During the house to house visit investigation of the system under the present study, it has been revealed that most of the transhes had been functioning for many years without noticeable defects but only necessitated occasional cleaning of the tank contents as required. In low-lying areas along the beach where the groundwater elevation is generally high and permeability of soil is low, many of the transhes are not functioning to absorb the wastes thereby cleaning of the tank contents is frequently required.

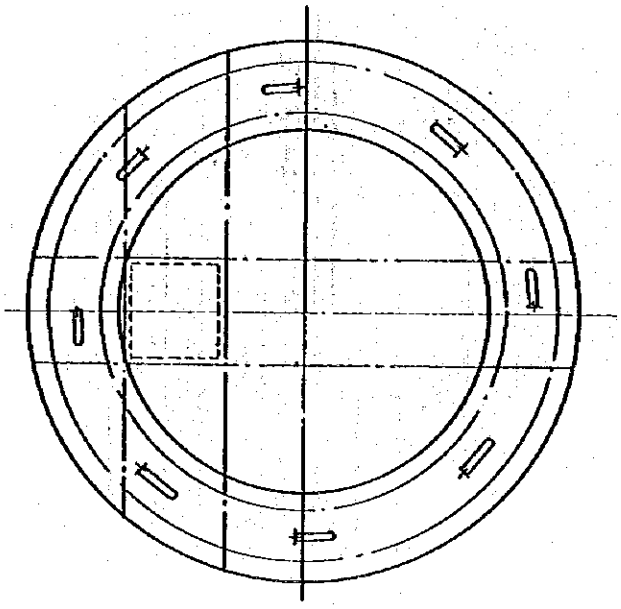
2.6.2. Sewerage Systems

Presently, no sewerage system has been in operation in El-Arish and its suburban areas except that for Hotel Egoth Oberoi. All other wastewater produced from residences, commercial and institutional areas are disposed of directly into the ground through the transh system.

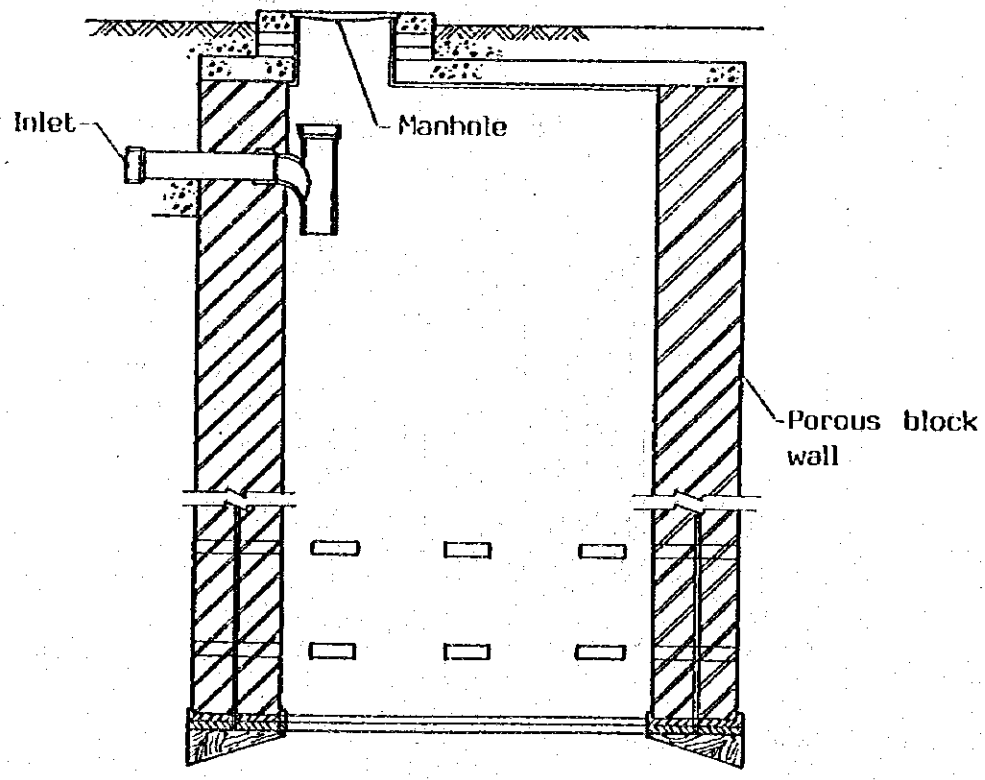
A construction of modern sewerage system has been now underway at Masaid housing scheme area to serve 10,000 tenants within 1985 and 20,000 persons in the final stage. The sewerage system will collect the wastewater from each house through the sewer reticulation and flows to the westerly direction finally leading to the wastewater treatment plant site. The wastewater is lift at two intermediate pumping stations and transported to the treatment plant by two cast-iron pressure pipes. The treatment plant applies the activated sludge process and the final effluent is planned to be used for irrigation of farm land near the Masaid housing area. During the inspection it was explained by the engineers in charge that the first stage facilities would have a total hydraulic capacity of 1,500 m3 per day, remaining portion being planned to be added as the wastewater discharge increased.

The sewage treatment plant for Hotel Egoth Oberoi has a capacity of 300 m3/day produced from 300 guests, according to the hotel engineer in charge of operation and maintenance of the plant facilities. In the treatment system, all the wastewaters from the rooms, kitchens, restaurant, swiming pool, etc., are collected through the sewer pipelines and led to the treatment plant by pressure pipe crossing the highway. The plant applies the extended aeration process consisting of pumping equipment, grit chamber, aeration tank, final settling basin, chlorine contact bed and storage tank for effluent. All the effluent is stored in the storage tank and periodically distributed to the nearby dates palm field for irrigation. From our review of the design drawings for the treatment facilities, it seems that the plant has some surplus capacity.

Figures 2.6.4., 2.6.5. and 2.6.6. illustrate the existing Hotel Oberoi treatment plant flowsheet, Masaid treatment plant flowsheet, and Masaid plant layout plan, respectively.



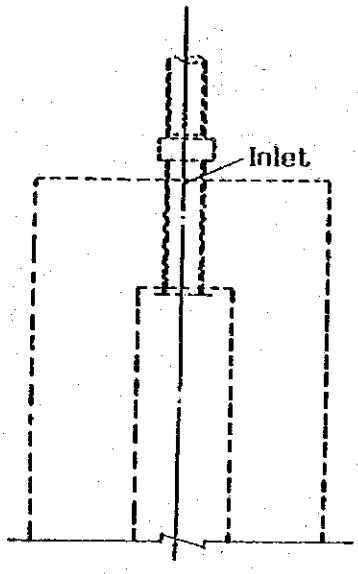
Plan



Section

Source: Housing Department, NSG.

Figure 2.6.1. Typical Circular Transh



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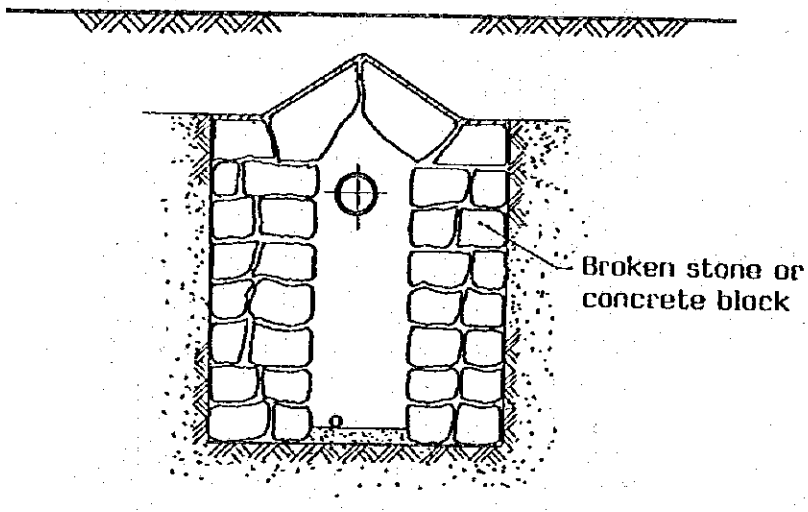
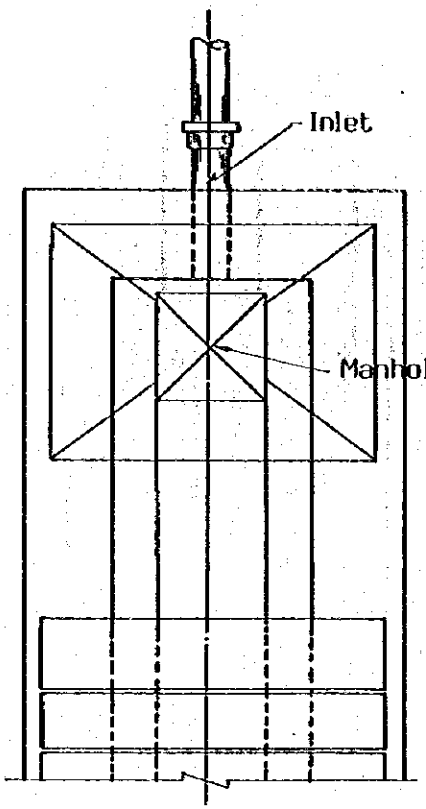


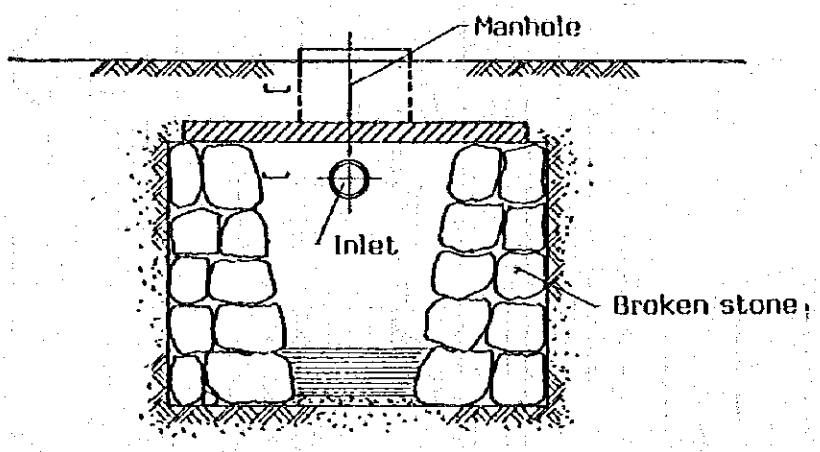
Section

Source: Housing Department, NSG.

Figure 2.6.2. Typical Rectangular Transh (Small capacity)



Plan



Section

Source: Housing Department, NSG.

Figure 2.6.3. Typical Rectangular Transh (Large capacity)

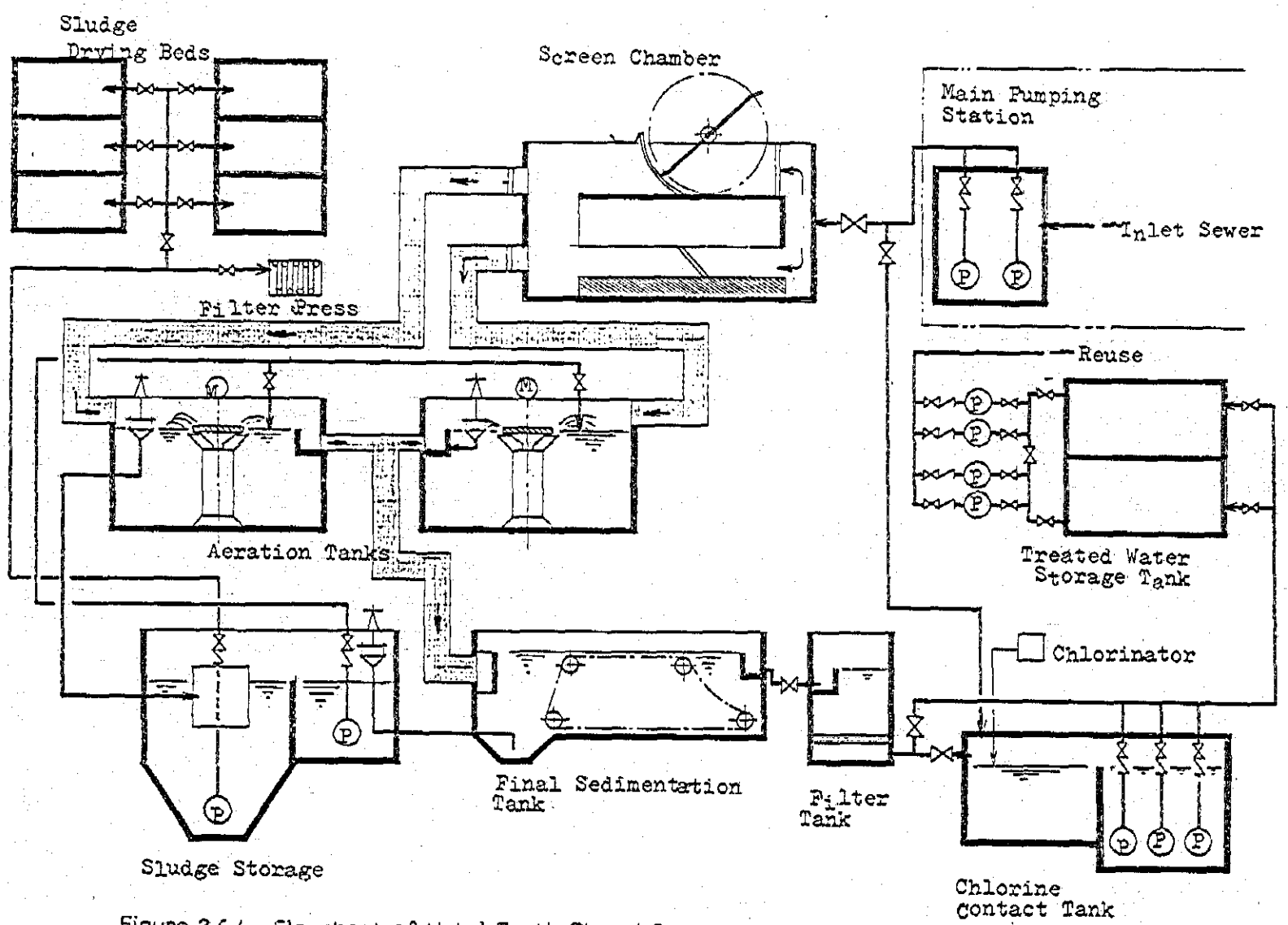


Figure 2.6.4. Flowsheet of Hotel Egoth Oberoi Sewage Treatment Plant

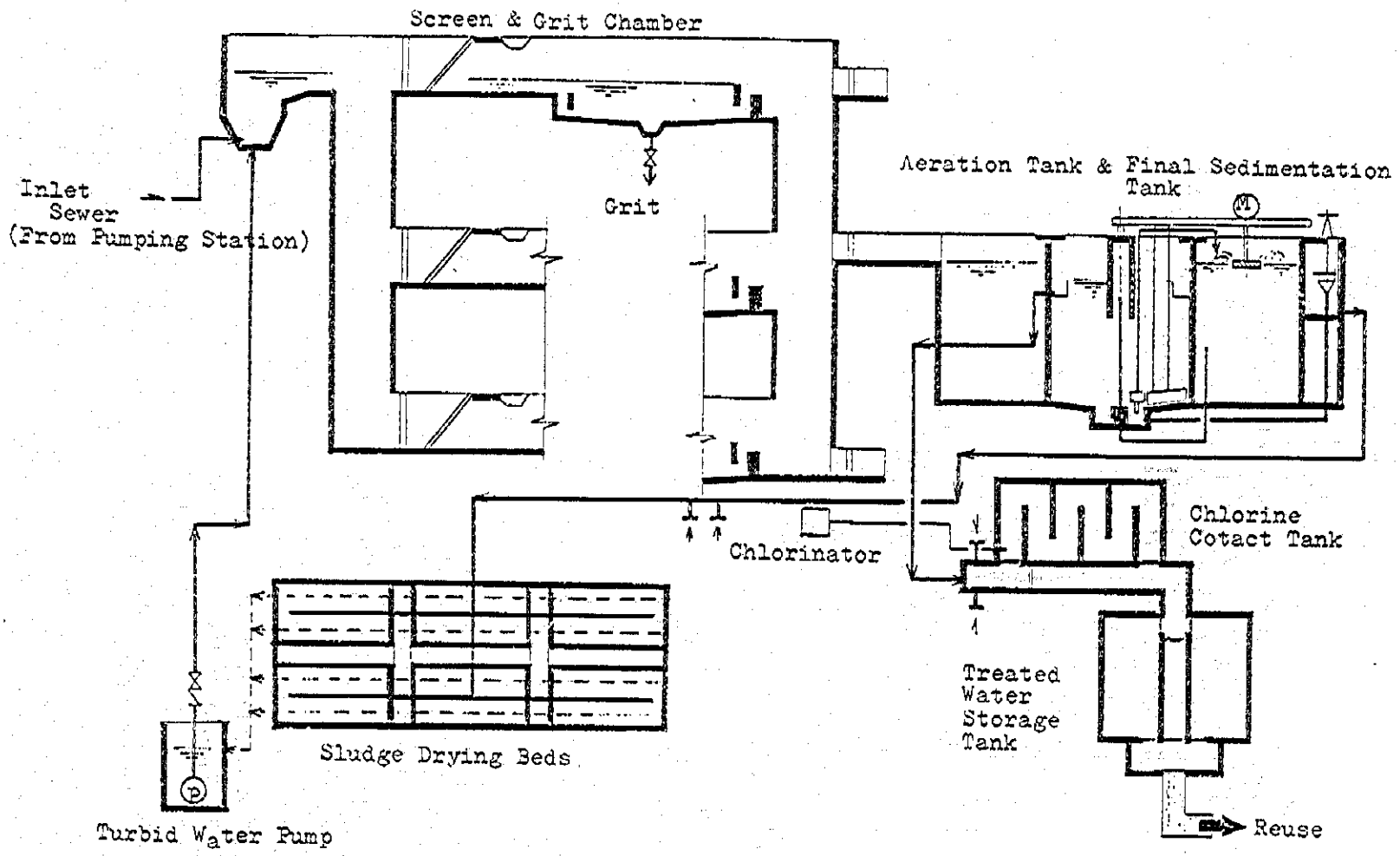


Figure 2.6.5. Flowsheet of Masaid Sewage Treatment Plant

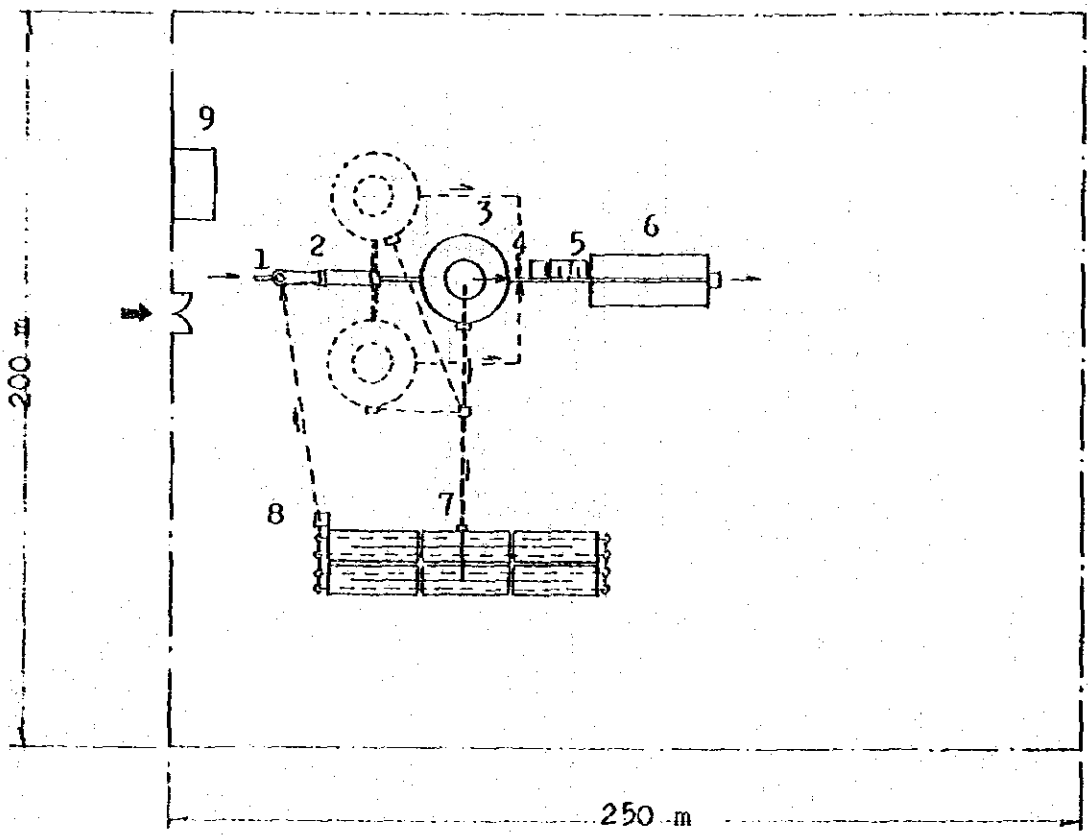


Figure 2.6.6. Masaid Sewage Treatment Plant Layout

Legend

1 : Inlet sewer from pumping station
2 : Screen and grit chamber
3 : Aeration tank and sedimentation tank
4 : Chlorinator
5 : Chlorine contact tank
6 : Treated sewage storage tank
7 : Sludge drying bed
8 : Pump
9 : Administration building

2.7. WATER SUPPLY SYSTEM

2.7.1. Physical System

Presently, El-Arish's water supply source fully depends on the groundwater extracted through the existing 22 deep wells located mostly in the southern part of the City as shown in Figure 2.7.1. The wells of 8 and 10 in. casing diameters with the depth ranging from 24 to 59 metres, have been in operation to supply a maximum gupply of approximately 19,000 m3/day. Of the 22 wells now existing, 3 wells have been out of order and other 3 wells for standby. Some details on the existing wells are shown in Table 2.7.1. A plan is now under consideration to add 4 more wells in Masaid housing development area in the immediate future to supply drinking water to the residents in the new apartment houses.

In order to meet the ever-increasing water demands and to help alleviate the current groundwater salinity problem, a water transmission pipe construction work has been underway to supply a total of 20,000 m3/day soft water to El-Arish City from the Nile River. The construction is now in full swing and said to complete within a year or so and will start the supply possibly in the next year.

The well water is in general sent directly to the main pipelines which range between 6 and 12 " in diam., as shown in Figure 2.7.1. When the water consumption is low and surplus water is available, such water is lifted to the two reservoirs at El-Absy in the old part of the City for the peak demands. For the water supply system, totally three water reservoirs had been constructed, but one of which located near the Central Hospital has been out of order.

According to the information from the Centre System of Statistics, NSG, a total of 8,968 private houses and institutions were connected to the city water supply in 1982, as shown in Table 2.7.2. Most of the houses are provided with a water meter, however, during house to house visit investigations by the study team for water quality and quantitity surveys, it has been observed that many of the household water meters were out of use and

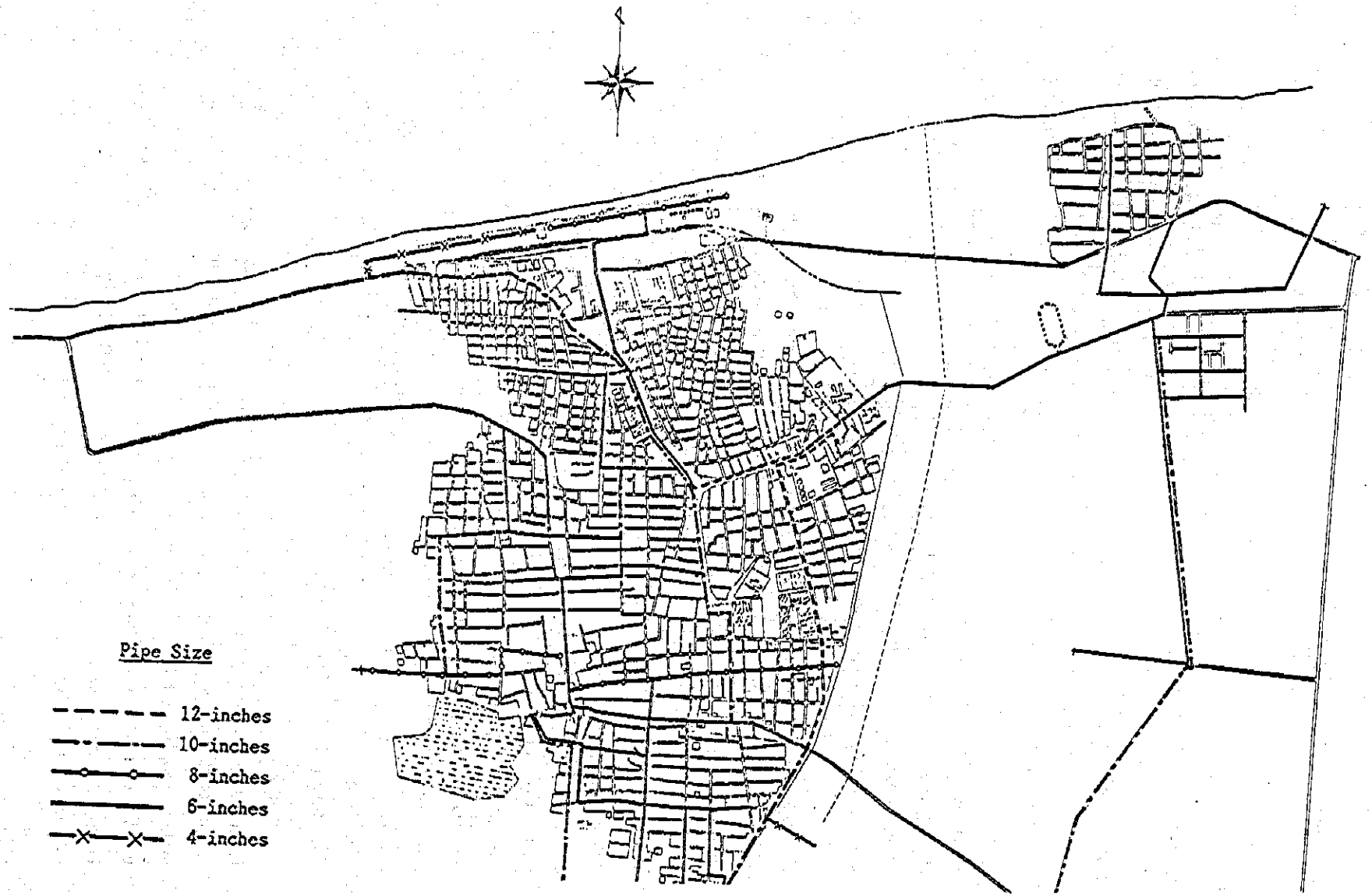


Figure 2.7.1. Existing Major Water Supply Facilities

Table 2.7.1 Conditions of Existing Wells (As of Sept. 1984)

No. & Name of Pump Station	Production (m3/day)	Operation Time (hr.)	Pump Drive	Flow Meter	Year of Pump Installation
1. Salam	45	24	Motor	None	1981
2. "	45	24	"	"	"
3. Abuwali (El-Salam)	50	24	"	Broken	"
6 Wadi	50	24	"	"	(*) Unknown
6. Army	60	24	"	"	"
7. Wadi	60	24	"	"	"
8. "	60	24	"	"	"
9. Wadi (Salayma)	55	24	"	"	"
10. Wadi (El-Salakana)	55	24	"	"	"
11. El-Smran	55	24	"	None	1979
12. Salam	50	24	"	Broken	1981
13. El-Safa	45	24	"	"	"
14. "	45	24	"	"	"
15. El-Smran	55	24	"	"	"
16. "	58	24	"	"	"
17. El-Salayma	50	24	"	"	"
18. El-Hose (El-Safa)	50	24	"	None	"
19. El-Safa	55	18	Diesel	"	"
20. El-Hose	55	24	Motor	Broken	"
21. El-Smran	50	24	"	Usable	1984
22. "	50	24	"	"	"

Note: (*) No information is available due to the war.

the meter reading seemed not properly carried out. The breakdown of the house connections is shown in the following table.

Table 2.7.2 House Connections in El-Arish (in 1982)

Category of connection	Domestic & Commerc.	Buldg. & Halls	Taps Outside of House	Total
Urban resident	7,089	642	285	8,016
Bedwins	112	28	812	952
Total	7,201	670	1,097	8,968

Source: Centre System of Statistics, the Government of Egypt.

2.7.2. Water production and Consumption

The groundwater production from the 19 wells in operation is reported to be approximately 15,000 m3/day, but during summer season when the water demands increase, all the wells are fully operated to produce maximum 19,000 m3/day. All the 19 wells, except for No.19 Well, are driven by electric motor for 18 to 24 hours as required. The water, after being disinfected by chlorination and blended with desalinated water from four existing desalination plants is delivered to the consumers through distribution pipe networks.

Although not sufficient data are available to justify the balance of the groundwater in the region, it is recognized that the limit of the safe groundwater extraction will be in the neighbourhood of 19,000 m3/day if the groundwater salinity level is to be maintained at the present level. The salinity level of the groundwater ranges from 1,000 to almost 4,000 mg/l as NaCl. The existing four desalination plants are in operation to reduce the salinity level to 350 mg/l. Additional three desalination plants with the total capacity of 1,200 m3/day are now under consideration by the City Council to increase the sweet water up to 2,800 m3/day in the next year.

Water consumption varies according to the seasons. During the winter season, the accounted for water in three months from October through

December 1983 was 413,099 m3 according to the information from the City Council. If the present served population is assumed to be 70,000, the average per capita water consumption is about 66 litres. If the total water production during the winter season is assumed to be 9,600 m3/day, then the percentage of the unaccounted-for water is estimated to be almost 52 per cent.

2.7.3. Water Charges

Water meters are said to be read by a water meter reader of the City Council every month but are billed at every three month period. As previously mentioned, however, considerable number of the water meters are out of order and actually meter readings have not been undertaken at many of the houses and institutions. In the case of the broken meter, the reader assumes the amount of the water consumed by the residents taking into account the minimum water rate up to 75 m3 per month.

During the course of the study, every attempts have been made to survey the actual water production and consumption in the water system, however, it has been not possible to gather data indicating exact amount of production and consumption. For billing the water charges, the City classifies the consumers into two categories, namely (1) commercial and domestic use, and (2) industrial use, applying the different rates according to the amount of water used, as shown in the table below.

Table 2.7.3 Water Rates by Category

(in L.E./m3)

Category of User	Amount of Water Used in the Month (m3)			
	up to 75	76 to 150	151 to 240	more than 240
Commercial & domestic	1.5(fixed) (up to 15)	0.05 (16 to 150)	0.1	0.15
Industry	1.5(fixed)	0.1	0.15	0.25

At the four desalination plants in operation, desalinated water is sold for citizens or water vendors at L.E. 2.5 per m3. According to the records by the Accountant Section of the City Council, the water metered during the winter months from October through December 1983 was 413,099 m3, of which 337,852 m3 by private houses, 13,108 m3 by shops, stores, restaurants, hotels, etc., and 14,674 m3 by industries. The revenue from the consumers, including private houses, institutions, hotels, and factories, for over a year from July 1983 to June 1984 was reported to be L.E. 129,622.656, which accounted for approximately 70 per cent of all the billed consumers. From the remaining 30 per cent consumers no charges were collected. This practice resulted in a substantial loss in revenues.

2.7.4. Management of Water Supply System

The water supply system of El-Arish City is managed by the Water Supply Department of the El-Arish City Council. The Department consists of three sections, namely 1) Water Counter, 2) Net Pipeline, and 3) Pump, each being responsible for the assigned works, as illustrated in Figure 2.7.2. The Department is responsible for construction, operation, maintenance, accounting and financing of the system. Presently, a total of 30 personnel and several well operators belong to the Department.

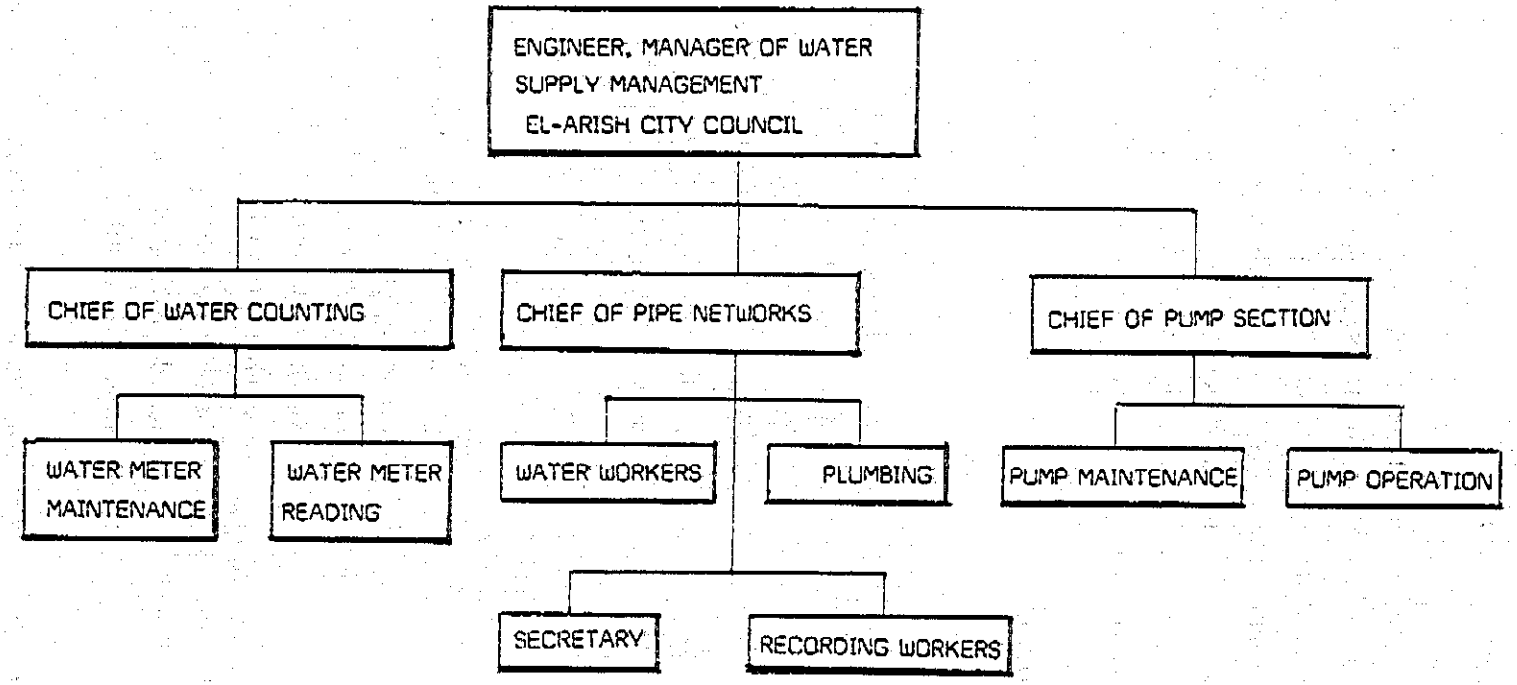


Figure 2.7.2. Organization for Water Supply Department

2.8. CHARACTERISTICS OF GROUNDWATER AND WASTEWATER

2.8.1. Water and wastewater Survey

Groundwater and wastewtaer surveys have been conducted during the course of the field work, from 18th July through 11th September 1984 at the selected locations representative for the conditions of the area. A total of 19 wells, 16 wells for drinking water and 3 for irrigation, raw domestic sewage, septic tank effluent, and the effluent of hotel sewage treatment plant, have been sampled and analysed on physical, chemical and biological characteristics. Locations of samplings are shown in Figure 2.8.1.

The analyses performed on the groundwater and wastewater are as follows:

Well water

- Temperature
- pH
- Conductivity
- Alkalinity
- Acidity
- Turbidity
- Total hardness
- Ammonia Nitrogen
- Nitrite Nitrogen
- Chloride Ion
- Coliforms
- Total Bacteria
- Nitrate Nitrogen

Wastewater

- Temperature
- pH
- Alkalinity
- Suspended Solids
- Biochemical Oxygen Demands (5-day, 20 degrees C)
- Chemical Oxygen Demands (COD Mn at 20 degrees C)
- Chemical Oxygen Demands (COD Cr)
- Chloride Ion
- Ammonia Nitrogen
- Total Phosphate
- Nitrite Nitrogen
- Nitrate Nitrogen
- Kjeldal Nitrogen
- Hexane Extracts

Of the above analyitical items, BOD, COD (Potassium Dichromate Method), Kjeldhal-N, and Total-N were analysed at National Research Centre, Water

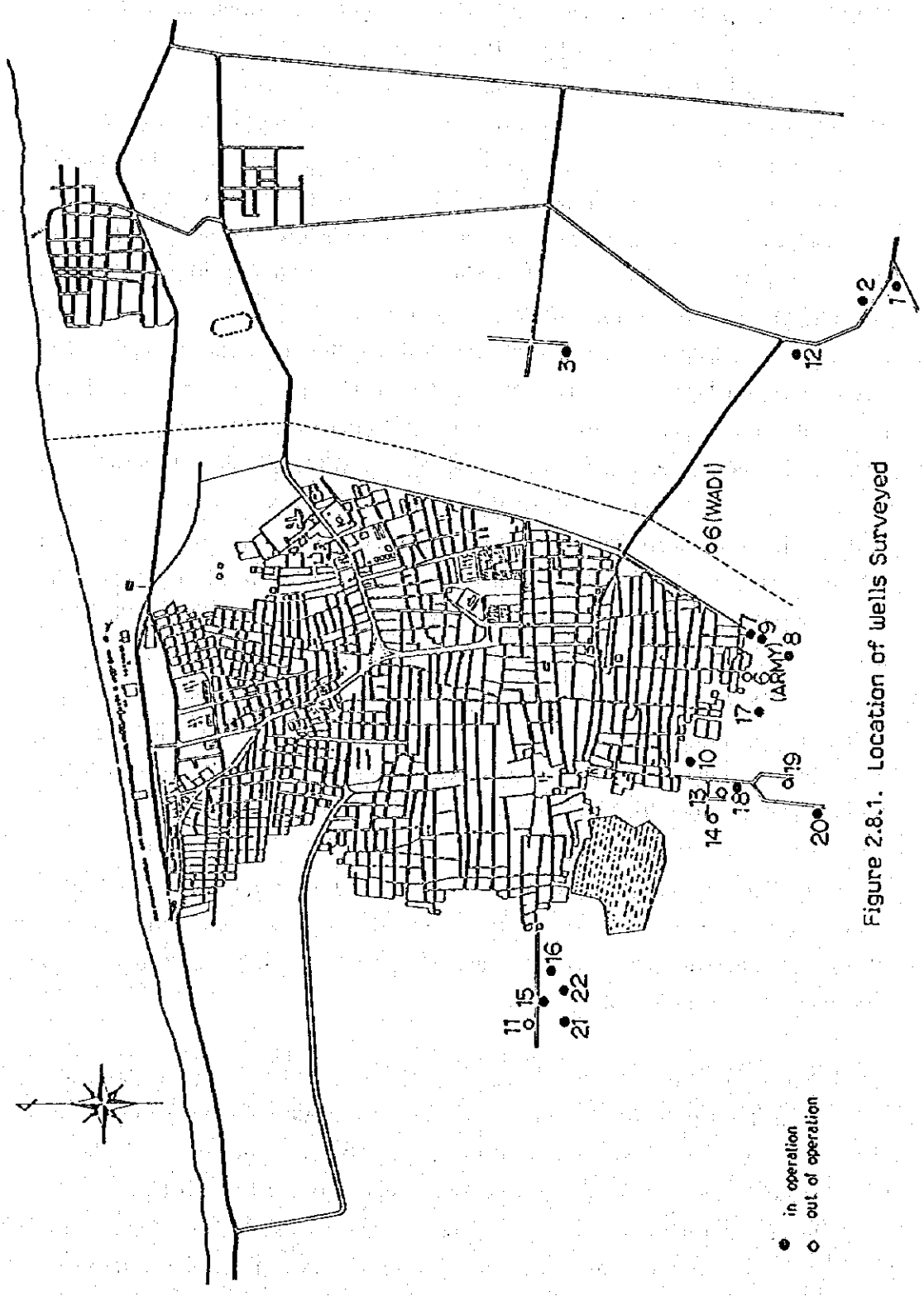


Figure 2.8.1. Location of Wells Surveyed

Pollution Control Laboratory, Cairo. Other items have been analysed by the study team at the project site during August and September, 1984.

2.8.2. Well Waters

(a) Drinking Water

Presently, a total of 19 wells have been in operation to supply drinking water to the city water system. As shown in Figure 2.8.1., the wells are located mostly in the southern part of the city removes from the builtup urban area. Due to the rapid expansion of the urban districts, however, many houses have been and further will be constructed in this part of the city, and the resulted groundwater contamination by the increased wastewater discharge through transh system has now become a deplorable level.

According to the well water quality survey conducted by the City Council in 1982 and 1983, as shown in Table 2.8.1.(3) and (4), ammonia nitrogen and, in one case coliform bacteria, were observed in the water, which indicate a contamination of the groundwater by human wastes is in progress. Although the survey indicated that well water qualities varied according to well locations, groundwater elevations, and many other conditions, it is not possible by only these data to ascertain the actual variations of water quality and to verify the extent of the groundwater contamination.

In view of the situation, a total of 16 wells now in operation have been surveyed by the study team and the sampled waters analysed in August 1984. The results of the survey are tabulated in Table 2.8.1. et. seq. and observations are summarized below:

- Waters of No. 1, 2, 3 and 12 wells, located at the east of the Wadi have high chloride ion concentration of around 1,200 mg/l (2,000 mg/l as salt concentration). Well waters in the west of the Wadi have in general lower chlorine ion concentration than those in the east to the Wadi, with average concentrations of 500 to 700 mg/l (800 to 1,200 mg/l as salt concentration), although some of the well waters indicate high chlorine ion concentration.

- Even between two wells closely located,there was certain difference in water quality because of the difference in the well structure. For example, wells No. 15, 16, 21 and 22 are located contiguously each other, but there were some differences in water quality, particularly between the group of wells No. 15 and 16 and the group of No. 21 and 22. Total hardness and Chlorine Ion concentrations of Wells No. 15 and 16 were higher than wells No. 21 and 22, whereas the bacterial numbers in No. 15 and 16 wells were higher than those in No. 21 and 22. These may be attributable to the difference of the length of the well blank. The lengths of blank in wells No. 21 and 22 are shorter than those of wells No. 15 and 16, and thus the wells No. 15 and 16 have been influenced by the sea water as well as No.21 and 22 by the transh wastewater.

- Nitrate Nitrogen (NO3-N) is generally high ranging between 2 and 18 mg/l, while Ammonia Nitrogen NH4-N and Nitrite Nitrogen (NO2-N) were not traced.

- Coliform bacetria were not detected from all wells, although in wells No. 10, 18, 21 and 22, total bacetria of 100 or more colonies/ml were traced. Since the wells No. 10 and 18 are situated adjacent to residences, the wells are apparently influenced by the transh wastewater. Wells No. 21 and 22 are located approximately 250 m away from houses, however, these wells seem to be influenced by the wastewater from the houses probably because of the groundwater flows due to extraction of the groundwater by these four wells.

(b) Irrigation Water

Approximately 100 wells are being used in the area for the purpose of crop irrigation. So far no comprehensive water survey for irrigation wells has been undertaken, and sufficient information were not obtained to justify the present conditions of the well water. For the survey of irrigation well waters, three representative wells in Salem area were selected and water sampling was made in September 1984. These wells are in operation only 3 to 4 hours a day, however, the waters contain relatively high Chlorine Ion, ranging from 1,000 to