# PORT SAID
# WATER AND WASTEWATER
# FACILITIES MASTER PLAN

## Final Report
## Volume 2 — Water Facilities

HAZEN AND SAWYER
in association with
ECG-ENGINEERING CONSULTANTS GROUP

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July 26, 1979

Engineer Soliman Abd El Hai, Chairman
Advisory Committee for Reconstruction
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Port Said Water and Wastewater
Facilities Master Plan

Dear Engineer Abd El Hai:

In accordance with our Contract with the Advisory Committee for Reconstruction, we submit herewith Volume 2 of the Master Plan Final Report.

The report is organized in four volumes as follows:

Volume 1. Executive Summary (English and Arabic)

Volume 2. Water Facilities

Volume 3. Wastewater Facilities

Volume 4. Receiving Waters Study

We have enjoyed the opportunity of serving the Advisory Committee for Reconstruction in preparation of the Master Plan. We look forward to successful implementation of the recommended programs.

Very truly yours,

HAZEN AND SAWYER

David Walrath

David Walrath
Resident Project Director

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# ABBREVIATIONS

## Organizations

| | |
|---|---|
| A.R.E. | The Government of the Arab Republic of Egypt |
| MDNC | Ministry of Development and New Communities |
| ACR | Advisory Committee of Reconstruction |
| GOPS | The Governorate of Port Said |
| SCA | Suez Canal Authority |
| GOWS | General Organization for Water Supply |
| GOSSD | General Organization for Sewerage and Sanitary Drainage |
| MOI | Ministry of Irrigation |
| GOPP | General Organization for Physical Planning |
| CAPMAS | General Agency for Public Mobilization and Statistics |
| USAID | United States Agency for International Development |
| PSMP | Port Said Master Plan, prepared by Bullen and Partners; Shankland Cox Partnership; Binnie and Partners; Peat Marwick, Mitchell & Co.; Hanna and Partners - March 1976 |
| PSC | Port Said Canal |
| U.S. | United States (of America) |
| WHO | World Health Organization |
| USEPA | United States Environmental Protection Agency |
| WWFMP | Water and Wastewater Facilities Master Plan (Port Said) |
| EEA | Egyptian Electrical Authority |

## ABBREVIATIONS (Cont.)

### Engineering Units

| | |
|---|---|
| m | meter |
| km | kilometer |
| cm | centimeters |
| mm | millimeters |
| sq m | square meters |
| sq km | square kilometers |
| ha | hectare |
| cu m | cubic meters |
| l | liters |
| ml | milliliter |
| s | second |
| min | minute |
| hr | hour |
| d | day |
| yr | year |
| / | per |
| cu m/day | cubic meters per day |
| cu m/hr | cubic meters per hour |
| lps | liters per second |
| lpd | liters per day |
| lcd | liters per capita per day |
| gm | gram |
| kg | kilogram |
| mg | milligram |
| m/sec | meters per second |



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## ABBREVIATIONS (Cont.)

### Engineering Units (Cont.)

| | |
|---|---|
| t | Tonne (metric) |
| mg/l | milligrams per liter |
| HP | horsepower |
| V | volts |
| P/ha | people per hectare |
| hz | hertz (cycles/sec) |
| lm | linear meter |
| KV | kilovolts |
| KVA | kilovolt-amperes |
| KW | kilowatts |
| KWH | kilowatt hours |

### Engineering Terms

| | |
|---|---|
| Y | wye connected |
| P.F. | power factor |
| dia | diameter |
| O.D. | outside diameter |
| LS | lump sum |
| S | slope |
| EC | Electroconductivity |
| TU | Turbidity units |
| TDS | Total dissolved solids |
| DO | Dissolved oxygen |
| TDH | Total dynamic head |
| COD | Chemical oxygen demand |
| BOD | Biochemical oxygen demand |



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## ABBREVIATIONS (Cont.)

### Engineering Terms (Cont.)

| | |
|---|---|
| SS | Suspended solids |
| ea | each |
| LE | Egyptian Pound |
| N/A | not applicable |
| STP | Sewage treatment plant |
| WTP | Water treatment plant |
| P.S. | Pumping station |
| TF | Trickling filter |
| G | Velocity gradient in reciprocal seconds |
| $D_{60}$, $D_{10}$ | Sand sizes (based on sieve analysis) for which 60% (10%) of grains (by weight) are finer. |
| JTU | Jackson Turbidity Units |
| MPN | Most Probable Number |
| CU | Color Units |
| CPUE | Catch per unit effort |
| Knots | Nautical miles/hour (0.5 m/sec) |
| lcpd | Liters/capita/day |
| Mld | Megaliters/day |
| ppb | parts per billion |
| ppt | parts per thousand |
| ug/l | Micrograms/liter |
| STDO | Salinity, Temperature and Dissolved Oxygen |



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The objectives of this study and report may be summarized as follows:

1. To define the existing setting and the present and future needs to implement the Port Said Water and Wastewater Facilities Master Plan (WWFMP). As stipulated in the terms of reference, the 1976 Master Plan for Port Said (PSMP) has provided the basic framework for this undertaking, with adjustments as necessary to reflect more recent information, planning, and decisions.

2. To assess the adequacy of existing water supply facilities, improvement projects presently underway, and pending programs in the light of future needs, scheduling, and costs.

3. To select and recommend improvements, projects, and programs for improving the Port Said water supply under three headings:

   a) High Priority - Those projects needed immediately to increase the quantity and improve the quality and reliability of the potable water supply.

   b) Immediate Phase - Additional projects which in conjunction with High Priority projects will expand and improve the Port Said water facilities to meet needs at least through 1982.

   c) Final Stage - Additional projects which in conjunction with High Priority and Immediate Phase projects will expand and improve the Port Said water facilities to meet needs through the year 2000.

4. High Priority and Immediate Phase projects are divided into four types:

   a) Local Measures to be carried out by responsible agencies at Port Said, with consultation and assistance by the Engineer's resident staff.

   b) Procurement and Installation of equipment and materials from manufacturers and/or suppliers.

   c) Engineering Design and Construction Contracts for major capital construction projects.

   d) Procurement of Services by contract with organizations having the personnel and equipment needed for the planning and execution of specialized tasks, such as leak detection and training of local personnel.

5. Staged Development projects are limited to procurement of vehicles and equipment and construction of major capital improvements.

ACKNOWLEDGEMENTS

We wish to thank the staffs of the Advisory Committee for Reconstruction in the Ministry of Development and New Communities and of USAID for their assistance and cooperation during preparation of this report. The following organizations and individuals have been most helpful to our work effort:



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Suez Canal Authority, Ismailia

A.M. Abdel Bary
Mourad Solate

Suez Canal Authority, Port Said

Abdel Salam Shams
Osama Ramadan
Helmy El Shamy
Mahmoud Abdel Rahman
Fares Mansour

Ministry of Irrigation

M.S. El Guindy
Maurci Kamel
Hassan Wahby
Ezzat Fayed
Abdel Mohsin Azmy
Esam Rady
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Governorate of Port Said

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Central Agency for Public Mobilization and Statistics



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CHAPTER I

PHYSICAL SETTING

## I.I LOCATION AND TOPOGRAPHY

Port Said is situated on the Mediterranean Sea at the northern terminus of the Suez Canal. The Project Area for the Port Said Water and Wastewater Facilities Master Plan (WWFMP), as shown on Figure I-A, includes Port Fouad, east of the Canal. To the south the Project Area extends to new developments proposed by the Port Said Master Plan (PSMP), including the proposed new port on the Suez Canal. To the west the Area extends, along the sand bar which separates Lake Manzala from the Mediterranean, to the El Gamil inlet.

Initial development in the Project Area was located on this sand bar. Subsequently, land was extended to the south by filling lake areas with material excavated from the Suez Canal. In addition, west of the Suez Canal, the natural accretion of beach sand against the canal breakwater has gradually extended the sand bar northward some 1,500 meters (see Figure i-B).

Existing land areas are narrowly confined: on the north by the sea; and to the west, south and east, by Lake Manzala and El Mallaha, a former part of Lake Manzala cut off by the Suez Canal. Two narrow corridors connect these land areas to the rest of Egypt - one to the south along the west bank of the Suez Canal, the other to the west along the sand bar toward Damietta.

The "study" area for the WWFMP extends beyond the Project Area to include:

- Receiving Waters Study: Areas of Lake Manzala and El Mallaha shown on Figure I-A (excluding Lake Manzala south of Kom Tannis); the surf zone of the Mediterranean Sea; and the Suez Canal south to Lake Timsah (near Ismailia).
- Raw Water Supply Sources, in particular the Port Said Canal from Quantara to Port Said.
- Agricultural Reclamation Areas to the south and west of Port Said.

The Suez Canal Authority (SCA) has planned and is executing a two-stage project to enlarge the Suez Canal to accommodate bigger vessels, as follows:

| | Maximum Depth (m) | Width (m)* |
|---|---|---|
| Present | 15 | 89 |
| Stage I | 19.5 | 170 |
| Stage II | 23.5 | 240 |

*(at 11 m depth)



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This project will include a bypass canal opening into the Mediterranean Sea east of Port Fouad, cutting off possible land connection from the Project Area to the east.

Topography of the Project Area is flat. Ground surface is only 1 to 2 m above sea level. Tidal range at Port Said averages 0.2 m and rarely exceeds 0.4 m. (Elevations in this report are referenced to the National datum at Alexandria.)

## 1.2 CLIMATE

Port Said has a mild, generally agreeable climate. Temperatures are moderated by the Mediterranean Sea, making winter temperatures higher and summer temperatures lower than at most areas in Egypt. Temperatures at Port Said range from 11-19°C in winter and 23-31°C in summer, with an average of approximately 21.5°C (see Table 1.1).

Most of the meager annual rainfall, averaging some 71 millimeters (mm), occurs in the months of November through March (see Table 1.2). During this period, storms of 2 to 3 days duration cause strong winds and intermittent, sometimes heavy, showers. Interspersed are spells of sunny, pleasant weather with lighter winds.

In spring, the temperature contrast between the still cool waters of the Mediterranean and the rapidly warming desert in Upper Egypt and Sudan results in changeable conditions with cyclonic disturbances passing north of Port Said. Ahead of such storms the region is subject to the Khamseen, strong south and southwest winds which produce thick dust as they pass over the desert. The Khamseen may be accompanied by high temperatures, especially in April and May. Generally, however, temperatures at Port Said rise slowly in the spring because of the surrounding waters.

In the summer, conditions are relatively uniform, with nearly 100 percent sunshine each day, a cooling sea breeze and an absence of rain. In spite of high humidity at low levels in the atmosphere, rain almost never occurs from June through September.

Because the Mediterranean waters cool slowly, summer conditions of continued sunshine and warm temperatures persist well into the autumn. The first winter storm usually occurs in mid-November.

Not only are temperatures moderate and rainfall light, but air quality in Port Said is acceptable almost year-round. The wind is chiefly from the northwest and southwest in winter and from the northwest to northeast in summer.

## 1.3 LAND RECLAMATION

Because the Project Area is narrowly confined by waters, future development will depend on creation of additional land. The Port Said Urban Land Reclamation Study (September, 1978), conducted by Golder Associates, provides plans for reclaiming some 1,210 hectares (ha) of land to the south and west of the present urban area (Figure 1-B).

The Ministry of Irrigation has developed plans to drain and reclaim for agricultural use some 66,000 ha from Lake Manzala. Major reclamation areas will extend from Port Said south to Qantara and from El Gamil west to Damietta.

## 1.4 GEOLOGY AND SUBSURFACE CONDITIONS

Based on subsurface conditions, the WWFMP Project Area may be divided into three regions (see Figures 1-B and 1-C):



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1) The original shoreline or sand bar separating the lakes and the sea at the time the Suez Canal was built.

2) The extensive beach deposits which have accreted behind the breakwaters protecting the approaches to the Suez Canal.

3) Developed areas of Port Said and Port Fouad south of the original sand bar. These areas are covered by sandy fill drawn from the Canal and harbor excavations. Underlying the fill is a thin layer of soft "surface" clay increasing in thickness from near zero adjacent to the original bar to about 1 m at the southern end of the built-up areas.

In the proposed urban land reclamation areas and borrow areas to the south and west of the existing city, surface deposits of the same soft clay increase in thickness from about 0.2 m in the north to as much as 3 m in the south.

According to a report prepared for the WWFMP by Mr. L. W. Tunbridge, a geotechnical consultant familiar with the work of Golder Associates, the deposits beneath the surface of the Project Area are quite uniform. The subsurface consists of a 4-to-12-m stratum of compact-to-dense, medium-to-fine sand covering a "lower" clay extending some 50 m below the present ground level, and resting on an ancient Nile Delta surface of stiff clay and/or dense sands.

The compact-to-dense fine sand has a clearly defined upper boundary and its thickness, at borehole locations, averages about 7 m. The sand grades through a relatively thinly layered transition zone into the firm-to-stiff "lower" clay. Although the clay is overconsolidated, it is subject to significant secondary settlement under sufficient loading conditions. This "lower" clay was laid down under marine conditions over the past several thousand years. Originally, the clay was probably deposited in front of the Nile Delta beach head. Then, as the delta advanced, the soils became coarser grained until, ultimately, sand was deposited on the lower clay over the entire Project Area. The sand bar that separates Lake Manzala and El Mallaha from the Mediterranean Sea is part of the sand stratum. This narrow sand bar, which forms part of the land surface in Port Said and Port Fouad, has moved northward to its present position under the combined effects of sediment deposition, regional subsidence, littoral deposition and erosion. A surface clay deposit behind the sand bar has accumulated from sediments brought down by the Nile.

The geology, soil structure, and high groundwater level in the Project Area will not preclude construction of proposed water facilities. Appendices A and B point out subsurface features which require special consideration in establishing design criteria and construction costs.

## 1.5 GROUNDWATER

Above the "lower" clay, the groundwater level averages about +0.5 m, reflecting the Lake Manzala elevation. In the building areas of Port Said, water levels are generally 0.5 to 1.5 m below the ground surface. The groundwater is saline and contains high concentrations of sulfate and chloride (see Section 6.2 and Table 6.2). Steady pumping of significant amounts of groundwater would lower the water table, draw in sea water and cause a rapid rise in chlorides to even higher levels. The groundwater may possibly be usable in some industrial processes, but corrosion control and maintenance would be difficult and expensive.



B

Nile River water fed through the Ismailia and Port Said canals, or through other future sweet water canals, is the only suitable source for public water supply (see Chapter 6).

TABLE 1.1

CLIMATIC DATA, PORT SAID

| | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Maximum Temperature °C | 18.8 | 19.3 | 21.3 | 23.6 | 26.5 | 29.3 | 31.3 | 31.8 | 30.6 | 28.7 | 25.1 | 20.7 |
| Average Minimum Temperature °C | 10.6 | 11.2 | 13.3 | 15.7 | 18.6 | 21.5 | 23.2 | 23.8 | 22.8 | 21.1 | 17.6 | 12.1 |
| Mean Temperature °C | 14.7 | 15.3 | 17.3 | 19.7 | 22.6 | 25.4 | 27.3 | 27.8 | 26.7 | 24.9 | 21.4 | 16.4 |
| Highest Temperature Recorded °C | 29.0 | 33.1 | 38.0 | 40.4 | 43.0 | 43.9 | 38.1 | 37.2 | 40.1 | 37.6 | 36.5 | 29.8 |
| Lowest Temperature Recorded °C | 3.0 | 2.3 | 2.7 | 9.2 | 10.2 | 14.2 | 19.0 | 20.6 | 17.5 | 13.0 | 6.3 | 0.0 |
| Average Relative Humidity % | 72 | 69 | 67 | 69 | 70 | 71 | 72 | 72 | 69 | [illegible] | 71 | 72 |
| Most Frequent Wind Direction and % Occurrence | WSW 19.5 | WSW 14.0 | W 14.7 | N 19.9 | N 31.2 | N 33.5 | NNW 30.7 | NNW 31.5 | N 35.7 | N 25.7 | NNE 17.9 | WSW 18.9 |
| Average Wind Speed km/hr | 17.6 | 19.5 | 21.5 | 19.8 | 17.8 | 16.7 | 15.9 | 14.1 | 13.9 | 14.8 | 15.8 | 15.6 |
| Frequency of Wind over 633 km/hr, days | 0.1 | 0.6 | 0.6 | 0.2 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.3 |

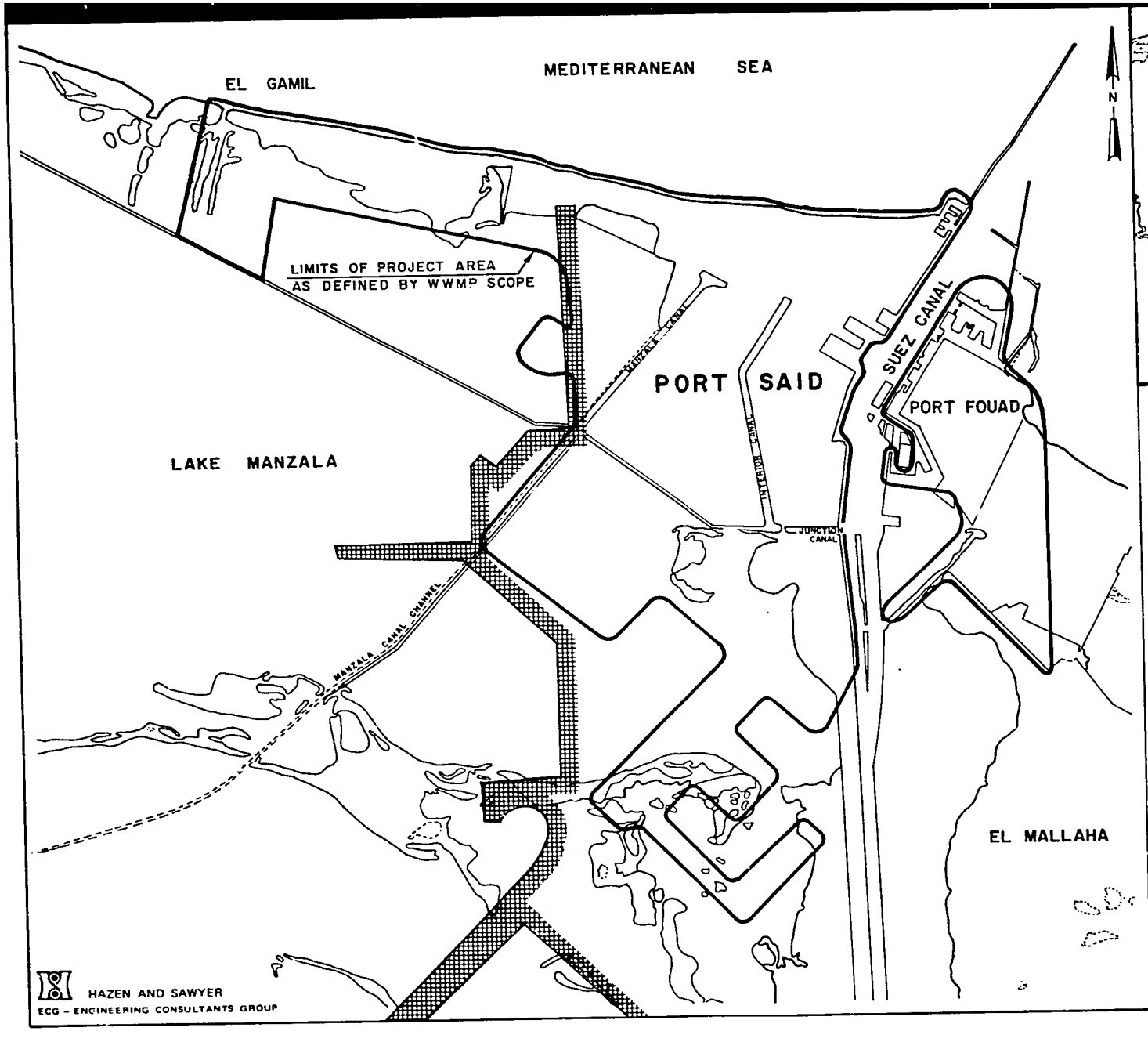
Source: MOHR, Port Said records for 1941-75.

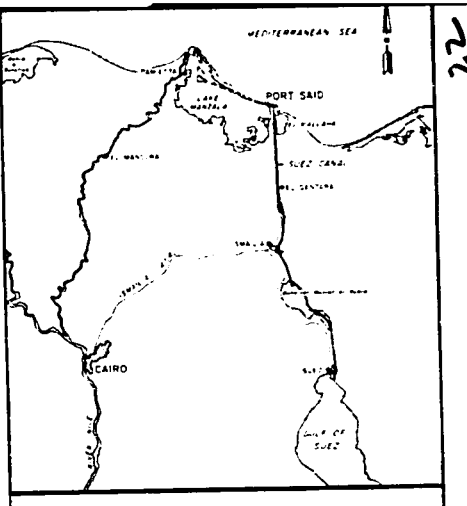
TABLE 1.2

RAINFALL DATA, POR AID

| | JAN | FEB | MAR | APR | MAY | JUNE | JL | AUG | SEPT | OCT | NOV | DEC | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Rainfall, mm | 12.4 | 11.3 | 8.5 | 2.7 | 2.6 | trace | 0 | trace | 0.2 | 7.3 | 9.1 | 17.6 | 71.7 |
| Max. Recorded Rain in One Day, mm | 11.6 | 15.3 | 10.9 | 22.8 | 19.5 | trace | 0 | trace | 5.4 | 39.6 | 18.0 | 47.7 | |
| Number of Days with Rain | | | | | | | | | | | | | |
| 0.1- 1.0 mm | 6.6 | 5.3 | 4.9 | 1.3 | 1.0 | 0 | 0 | 0 | 0.1 | 1.9 | 3.8 | 5.6 | |
| 1.1- 5.0 mm | 3.0 | 2.8 | 2.4 | 0.5 | 0.3 | 0 | 0 | 0 | 0 | 1.0 | 1.9 | 2.5 | |
| 5.0-10.0 mm | 0.9 | 0.5 | 0.5 | 0.2 | 0 | 0 | 0 | 0 | 0.1 | 1.0 | 0.8 | 0.8 | |
| 10.0 mm + | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0 | 0 | 0 | 0 | 0.2 | 0.2 | 0.4 | |
| Average Total of Days with Rain | 10.7 | 8.7 | 7.9 | 2.1 | 1.4 | 0 | 0 | 0 | 0.2 | 5.1 | 6.7 | 9.3 | 52.1 |

Source: MOHR, Port Said records for 1941-75.




LOCATION PLAN

NOT TO SCALE

LEGEND

PROJECT AREA LIMITS

EDGE OF ULTIMATE RECLAMATION
PORT SAID MASTER PLAN

SCALE 1 : 50,000

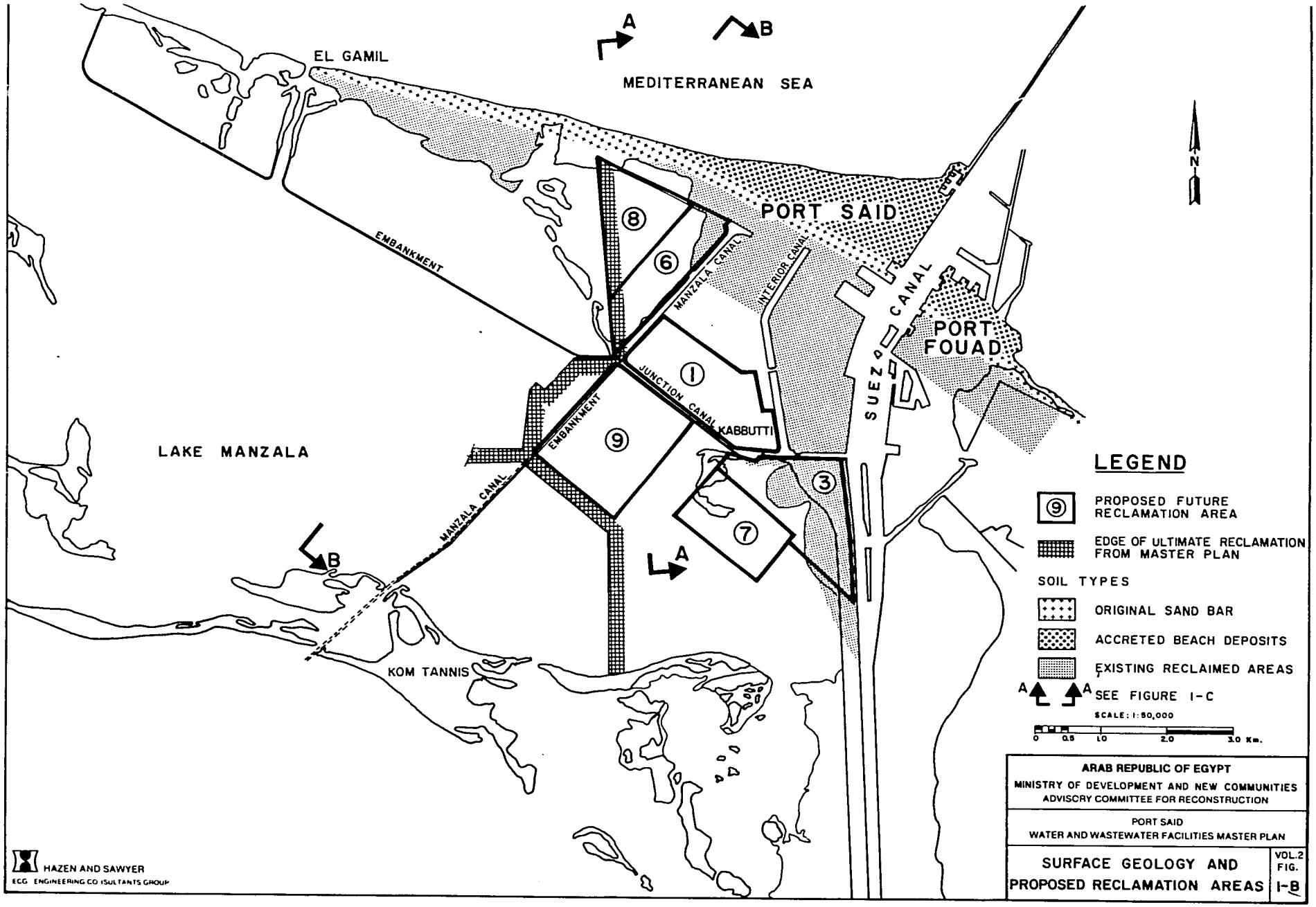
0 1 Km 2 Km

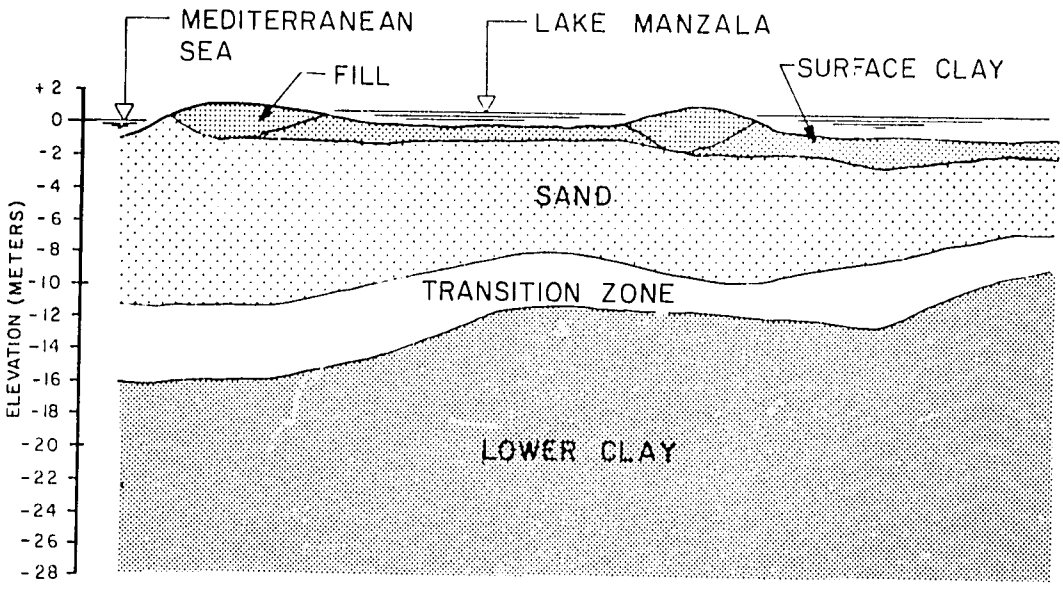
ARAB REPUBLIC OF EGYPT
MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION

PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

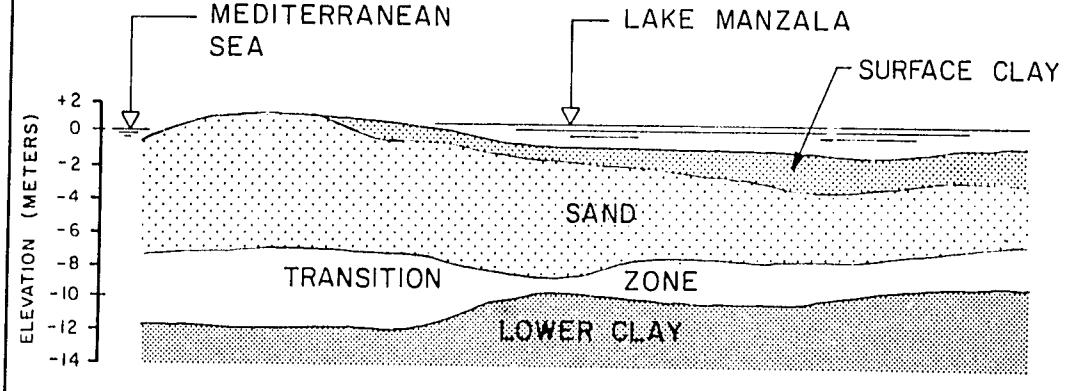
PROJECT AREA LIMITS AND LOCATION PLAN

VOL.2 FIG. I-A


EL GAMIL
MEDITERRANEAN SEA
A
B
PORT SAID
EMBANKMENT
MANZALA CANAL
INTERIOR CANAL
SUEZ CANAL
PORT FOUAD
JUNCTION CANAL
KABBUTTI
EMBANKMENT
LAKE MANZALA
MANZALA CANAL
KOM TANNIS
8
6
1
9
7
3
N
LEGEND
PROPOSED FUTURE RECLAMATION AREA
EDGE OF ULTIMATE RECLAMATION FROM MASTER PLAN
SOIL TYPES
ORIGINAL SAND BAR
ACCRETED BEACH DEPOSITS
EXISTING RECLAIMED AREAS
SEE FIGURE I-C
SCALE: 1:50,000
0 0.5 1.0 2.0 3.0 Km.
ARAB REPUBLIC OF EGYPT
MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION
PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN
SURFACE GEOLOGY AND PROPOSED RECLAMATION AREAS
VOL.2 FIG. I-8
HAZEN AND SAWYER
ECG ENGINEERING CONSULTANTS GROUP




SECTION A-A




SECTION B-B

SOURCE OF DATA: GOLDER ASSOCIATES

SCALE: 1:40,000

0 0.5 1.0 2.0 Km

HAZEN AND SAWYER

ECG ENGINEERING CONSULTANTS GROUP

**ARAB REPUBLIC OF EGYPT**

MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES

ADVISORY COMMITTEE FOR RECONSTRUCTION

PORT SAID

WATER AND WASTEWATER FACILITIES MASTER PLAN

GEOLOGICAL CROSS-SECTIONS

VOL. 2 FIG. I-C

CHAPTER 2

SOCIO-ECONOMIC SETTING

## 2.1 EXISTING DEVELOPMENT

### Population

In 1976 the population of the Port Said urban core, including Port Fouad and the Kabbutti fishing village, was estimated at 262,620 people by the Central Agency for Public Mobilization and Statistics (CAPMAS), as shown in Table 2.1. This represented a decrease of more than 20,000 persons from the population prior to the 1967 war, estimated by CAPMAS at approximately 283,000 persons in 1966.

Approximately 94% (245,942) of the 1967 population lived in Port Said (Census Tracts 1 through 9, 11 and 12 on Figure 2-A), including an estimated 12,000 people in Kabbutti. The remaining 6% (16,678) of the population resided in Port Fouad (Census Tract 10).

The Port Said Master Plan (PSMP), completed in 1975, estimated the total population at 343,000 people. This figure exceeds the 1976 census by about 31% (80,400). Social surveys of the El Arab shiaka (census tract) conducted by the Port Said Demonstration Project in 1977 indicated that the actual population was very close to the 1976 census figure.

Based on the 1976 census, the 1977 surveys, and an analysis of new housing units constructed, the Water and Wastewater Facilities Master Plan adopted a December 1977 base population estimate of 273,000. Population gains from in-migration are expected to exceed natural increases and consequently overshadow the significance of any difference in the base population for projection purposes.

### Economy and Employment

The economy and labor force of Port Said are only now returning to the levels of activity which existed before the 1967 war. In 1966 the labor force was approximately 27% (77,000) of the population (283,000), with 2.5% (7,000) unemployed. The tertiary sector of the economy (service, trade, transportation/communications and port activities) supplied some two-thirds of the jobs (49,700), with industry providing 11,000. Fishing and agriculture accounted for 4,900 jobs. A total of 4,500 jobs were in building, construction and utilities. The port itself provided direct employment in shipyards, loading, and warehousing, along with indirect jobs in import/export, customs and recreational facilities. Port Said's designation as a Free Zone in 1976 resulted in increased overall economic activity, particularly in the port area.

Tourism was for many years a major source of economic activity in Port Said. The port was an entry point for passengers and crews from vessels passing through the Canal. Domestic tourists seeking relief from the summer heat of inland cities were attracted to the seaside location. Since the return of population and the reopening of the Canal after the 1973 war, tourism has revived but with a much higher proportion of domestic visitors on day trips. This change reflects both a decline in ship cruises and a response to expanded shopping opportunities following establishment of the Free Zone.



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Commercial fishing is centered in Lake Manzala and the Mediterranean, with a minor amount in the Suez Canal. Lake Manzala accounts for 75% of the production of the northern Egyptian delta lakes and more than 26% of the national fish catch. The major Lake Manzala fishing station is located at El Matariya on the southwestern shore of the lake. This station is supplemented by the fishing village at Kabbutti. Fish ponds border Lake Manzala.

Agricultural activity is limited by the dearth of suitable land. Some areas between the Port Said/Ismailia road and the Port Said Canal (PSC) are irrigated, taking water from the PSC. Without adequate drainage, farming in this area is marginal at best.

Land Use

The urban core consists of three kisms (large census tracts): El Manakh, El Arab, and El Shark, which occupy approximately 1600 hectares (ha), including some 600 ha of water and marginal land (see Table 2.1 and Figure 2-A). At present, 90% of the habitable 1,000 ha is developed.

El Manakh kism, with the largest population of the three kisms, is characterized by medium residential densities (600-800 people/ha). Public housing areas in El Manakh are nearly devoid of commercial services and public amenities.

El Arab kism contains three distinct residential areas: the north (300 persons/ha) overlooking the Mediterranean coast; the local El Arab district (1,500 persons/ha); and the public housing districts (1,000 persons/ha) constructed during the past 15 years. Many governmental/institutional uses and a growing number of manufacturing facilities are also in the area. Industrial uses include small workshops employing less than 10 people, found in residential/commercial areas, and larger scale industries (food processing, textile production and cold storage) along the barge canals.

The Kabbutti fishing village, located in the southwestern corner of El Arab kism, is physically isolated from the other Port Said residential uses by industries adjoining the Interior Canal. Approximately 12,000 people are housed in the village. Residential densities are relatively low (400 persons/ha), primarily because structures in the village are one-story.

El Shark kism, established as the foreign quarter during canal construction, is the prime residential, business and tourism center. Buildings are larger, streets wider and open space greater than in the rest of Port Said. Residential densities in El Shark kism are low, ranging from 150 persons/ha in the northeast to 650 persons/ha in the southwest. Most industrial land uses, primarily cargo handling and vessel servicing facilities, are concentrated in this kism. Cold storage, distribution and light manufacturing operations in El Shark have increased in number since the establishment of Port Said as a Free Zone in 1976.

Port Fouad, originally built by the Suez Canal Company, is a subtract of the El Shark kism, occupying 173 ha (6.4%) of the urban core. Population densities (140-350 persons/ha) are lower in Port Fouad than in most of Port Said. Most residences are three stories, with considerable open space. Streets provide ample room for vehicles. Industrial uses in Port Fouad are limited to the shipyard, small craft repair facilities and warehousing.



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## 2.2 FUTURE DEVELOPMENT

### Population

The PSMP projected a year 2000 population of 750,000 people for the Port Said Project Area, which includes the urban core and the proposed El Gamil fishing villages (see Table 2.2). The ultimate holding capacity of the Project Area was estimated at 766,000 people, based upon existing and proposed land use patterns.

Estimates developed for the Water and Wastewater Facilities Master Plan (WWFMP) are based on a lower ultimate holding capacity of the Project Area; from 766,000 to 684,000 persons. This reduction of approximately 82,000 persons reflects two specific land use adjustments:

- Continued expansion of Free Zone industrial activity into planned residential areas near the existing port (Area I on Figure 2-B), which reduces the projected population in this area from 100,000 (PSMP estimate) to 5,000 people.

- Development of approximately 22 ha of land in Port Fouad (which the PSMP had shown as already developed) to accommodate an additional 13,300 persons.

The WWFMP assumes that this adjusted capacity of 684,000 people will be reached by the year 2000, which was the PSMP target year. Adjusted population estimates for five-year intervals from 1980 to the year 2000 are shown in Table 2.2, along with the original PSMP projections. The absolute annual increases estimated in the WWFMP follow closely those in the PSMP. Both population growth estimates are closer to arithmetic series than geometric, with annual increases in the range of 17,000 to 19,800 from 1980 on. The overall population added from 1976 to 2000 is estimated at 422,000 in the WWFMP, only slightly higher than the 408,000 in the PSMP. The key point is that by controlling development (new land creation, infrastructure installation and housing) in Port Said, the government can limit in-migration and hence population growth.

### Economy and Employment

The WWFMP has revised the PSMP employment projections to reflect the population and land use adjustments. As shown in Table 2.3, the estimated labor force is the same percent of the population as in the PSMP. Each category of employment represents virtually the same percent of the labor force as in the PSMP, except that: 1) tertiary sector jobs are reduced due to the possibility of lower port employment; 2) industrial sector employment is increased to eliminate the structural unemployment forecast in the PSMP and to make up for the reduction in tertiary sector employment.

Reductions in tertiary sector employment allow for the possible location of the new national port elsewhere than in Port Said (see "Land Use", below). Installation of this port at Port Said was a premise of the PSMP projections. Since other locations are being seriously considered, it is not prudent to assume this employment for Port Said. The WWFMP allows instead for equivalent employment in the industrial sector.

Based on the PSMP port employment figures shown in Table 2.4, potential reductions in tertiary sector employment were estimated as follows:



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| Year | Population |
|---|---|
| 1980 | [illegible] |
| 1985 | [illegible] |
| 1990 | [illegible] |
| 2000 | [illegible] |

These estimates assume that if the [illegible] employment at Port Said would reduce at the [illegible]

The PSMP forecast structural unemployment [illegible] 1990 and 1% by the year 2000 (Table 1.1). However, it would be wrong [illegible] planning on built-in unemployment. Lack of adequate [illegible] a brake on economic growth. Once an adequate [illegible] can be stepped up or slowed down to meet [illegible]

Additional employment [illegible] turing of tertiary sector activities, [illegible] markets beyond Port Said, bringing [illegible] definite plans for port expansion, the [illegible] cient to provide the jobs needed to [illegible] available to project with certainty future employment [illegible] encouraging aspects of new ventures [illegible] especially to the Free Zone.

Based on the [illegible] account for 12% of all jobs by the year 2000, [illegible] projections because of overall [illegible] ulation capacity could lead to a labor shortage [illegible] Further industrial development from 1990 to 2000 [illegible] mately the same rate.

Anticipated tourism employment [illegible] for the hotel/cuisine complex along the Mediterranean [illegible] "Land Use", below). In addition, high water [illegible] terranean, Lake Manzala and large areas in [illegible]

Fishing employment could decline if fishing [illegible] by overfishing and proposed agricultural [illegible] eries management program could [illegible] employment could be expected until the effects of [illegible]

## Land Use

Major land use changes proposed in the PSMP [illegible] ment of the existing 1,000 ha of the [illegible] additional land for residential, industrial and [illegible] adjusted land use for the Project Area [illegible] and planning revisions. These include a reduction in the amount of [illegible] the year 2000 from 2,320 ha to 1,216 ha (Table [illegible] Section 1.D). Major PSMP land use changes are [illegible] summarized below.

New Port

The PSMP proposed construction of the new national port at Port Said. Adjustment: The new port will probably be built in Damietta, not Port Said. However, existing cargo handling capacity will be increased to approximately 4 million dead weight tons/year (in area 1, adjacent to the Suez Canal on Figure 2-B).

Road/Rail Corridor

A regional road/rail corridor was proposed to link Port Said to El Matariya and the Eastern Delta and Canal Cities. Adjustment: Assuming that the new port is not built at Port Said and that widening of the existing Port Said/Ismailia Road is completed, the road/rail corridor (area 5 on Figure 2-B) can be postponed until the year 2000 (see "Transportation" in Section 2.3).

Fishing Villages

Construction of a new fishing village at El Gamil, to replace the Kabbutti fishing village, would begin in 1981, with a 1990 target population of 22,900 people. The site of the existing Kabbutti village would be part of a major urban park (area 4 on Figure 2-B). Adjustment: Start of construction of the new fishing village will be delayed until 1986. However, the 1990 population goal should be met, completing the relocation of the Kabbutti community.

Hotel/Casino Complex

A new hotel/casino complex would be built along the Mediterranean beachfront west of the Port Said breakwater (area 3 on Figure 2-B). Adjustment: The 65 ha of land proposed for development by the PSMP does not really exist and could not realistically be reclaimed. Most hotel/casino facilities may have to be located west of Mazrah, displacing some camping and day use recreational facilities.

Urban Blocks

New urban "blocks" (700 to 750 persons/ha), several stories high, with residential units above ground floor commercial establishments, would be developed in Port Said. Adjustment: As noted earlier, the Free Zone has stimulated industrial development which intrudes on the planned residential areas (area 1 on Figure 2-B). Because of the new industrial activity and the retention of existing port facilities, urban "blocks" cannot be developed between the port and the Interior Canal. This area could house only 5,000 instead of the planned 100,000 persons. Port Fouad can accommodate an additional 13,300 persons (350 to 750 persons/ha) on 22 ha of undeveloped land (area 2 on Figure 2-B). The PSMP had assumed that this land (two parcels) was already developed. In fact, it represents future residential development capacity.

Industrial Parks

New industrial parks (estates) would be developed on 440 ha adjacent to the proposed new port facilities and in the planned road/rail corridor. Adjustment: Most of the 440 ha of industrial parks will be developed on land near the existing port facilities (see Table 2.6 and Figure 2-C). However, up to 20% of industrial development is scheduled for reclaimed land. Both types of development will require careful coordination with water system planning.



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Reclaimed Land

The PSMP proposal for reclamation of 2,370 ha of land included areas to the south related to the proposed new port and transportation corridor. Adjustment: As noted above, the new port and road/rail corridor are unlikely to be developed before the year 2000. Potential land proposed to be reclaimed for a section of the planned urban park (area 6 on Figure 2-B), adjacent to the proposed road/rail corridor, will not be reclaimed.

Reclaimed land and fisheries in El Mallaha adjacent to Port Fouad, as well as existing land on the east side of the Suez Canal, are required by the Suez Canal project now in progress. The Suez Canal Authority is currently widening the Canal, with a new exit to be provided east of Port Fouad (Section 1.1).

A 29 ha area just east of the Mazrah treatment plant (designated as 8A in the small map on Figure 2-C) was included in the reclamation proposals of Golder Associates. This low-lying area, already cut off from Lake Manzala by the road to the refuse fill near Mazrah, is a logical addition to the proposed adjacent reclamation area.

Housing Construction

Housing construction was anticipated by the PSMP to proceed at a rate of 5000 units per year, beginning in 1976. Adjustment: Because of start-up problems, this rate is not expected to be reached until 1981. Furthermore, the phasing of residential development (Figure 2-C) will depend on the reclamation schedule and the provision of utilities. It is assumed that approximately 370,000 people will be located on reclaimed land by the year 2000. Population distribution in the Project Area (Table 2.5) is based on the adjusted holding capacity (684,000 persons) and existing density patterns.

## 2.3 INFRASTRUCTURE

Effect on Public Health

Present unreliability of the potable water supply and breakdowns of the wastewater collection system are responsible for significant public health problems in Port Said (see Tables 2.7 and 2.8). These include water supply related communicable diseases which result from lack of adequate disinfection and/or contamination from indirect cross connections or back siphoning.

Water Supply

The raw water supply to Port Said is under the control of the Ministry of Irrigation (MOI). The remainder of the public water system is the responsibility of the Suez Canal Authority (SCA), which constructs, operates and maintains the facilities. User charges are billed and collected by SCA, but cover only a portion of operating costs. Information on the present water system is detailed in Chapters 6, 7 and 8.

Wastewater Collection and Disposal

Sewers, pumping stations, force mains and treatment facilities are constructed by the General Organization for Sewerage and Sanitary Drainage (GOSSD). The wastewater facilities are operated by the Sewer Department of the Governorate of Port Said (GOPS). Sewer connections and house lateral construction are also the responsibility of GOPS. Major lateral extensions and connection to serve new public housing areas are handled as part of the GOPS housing construction program.

## Storm Drainage

Storm drainage is the responsibility of the GOPS. Although rainfall in Port Said is infrequent (Table 1.2), brief intense storms do occur. The existing sanitary sewer system is inadequate to handle storm flows. In areas of current construction, storm water is being excluded from sanitary sewers. Studies are recommended to develop methods of eliminating stormwater from the present sewer system.

A surface system of transport gutters to open space storage and disposal areas is planned.

## Solid Waste

Port Said is divided into eight zones for refuse collection. In two zones, collection is handled by private collectors with donkey carts. The operation is door-to-door and collection costs are paid by the individual customers. In the remainder of the city, refuse is collected by GOPS employees, hauled to intermediate sites, and later transfered to landfills operated by the GOPS. Pick-up at the intermediate sites often takes several days, creating unsanitary conditions in some areas of the city.

The present landfills and intermediate dumping sites are improperly operated. Their proximity to residential areas creates an unacceptable public health hazard. Leaching from these sites and the potential for degrading water quality in nearby areas should be considered in planning future solid waste disposal methods.

## Fire Protection

Purchase, installation and maintenance of fire hydrants, along with staffing and equipping the fire department, is another major responsibility of the GOPS. The SCA is responsible for providing adequate water for fire flows and installing line tees for hydrant connections. Ground level hydrants presently in service are subject to damage and are a potential source of water supply contamination.

## Electricity

Basic responsibility for electrical power supply in Port Said rests with the Egyptian Electricity Authority (EEA), which operates a new 43 MW turbine power station and a diesel power station of about 9 MW capacity. The SCA operates its own power station, providing 7,140 kilovolt-amperes (KVA) to serve the El Raswa Water Treatment Plant and SCA workshops in Port Said and parts of Port Fouad.

The EEA plans to interconnect the power stations in Port Said with the national supply grid. One 220 KV, double-circuit transmission line running from Suez to Port Said via Ismailia and El Qantara is scheduled for completion in June 1979. A similar line from Zagazig to Ismailia, and a main substation south of Port Said should be finished in 1980.

## Transportation

Two ground transportation corridors connect Port Said to the rest of Egypt: the road and railway route southward to Ismailia, and the narrow coastal road westward to the eastern (Damietta) branch of the Nile. Both roads are currently being improved. Repair of the railway, which was damaged during the 1967 war, has been completed. Boat and ferry service from Port Said across Lake Manzala to El Matariya carries far less traffic than the



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land corridors. Barge traffic on the Suez Canal transports heavy bulk material such as concrete aggregates. Air service to Port Said has been discontinued since the war period.

The new transportation corridor proposed in the PSMP was intended to meet long-term traffic needs for the port and the city, including more direct connections to Cairo and the Eastern Delta. The 1978 Suez Canal Regional Industrial Plan, predicting substantial spare capacity in the existing corridors to Ismailia, recommended postponement of the new corridor and improvement of the existing rail services and highways to Port Said.

The PSMP called for an arterial highway south of the Junction Canal that would link major industrial facilities and the main highway from the south to the Damietta highway. The right-of-way is only partially included (after 1990) in presently scheduled land reclamation. An arterial highway is needed along the north side of the Junction Canal, connecting to the proposed arterials along the new lakefront near Reclamation Areas 6 and 8 (Figure 2-C).

## TABLE 2.1

## EXISTING POPULATION AND DENSITY

| Census Tracts(1) Kism/Shiaka | Population(2) (November 1976) | Gross Area hectares (ha) | Gross Density (people/ha) | Residential Use (ha) | Residential Density (people/ha) |
|---|---|---|---|---|---|
| El Manakh | 123,649 | 663.4 | 150-1850 | — | 600-800 |
| 1. El Saroya | 15,684 | 8.8 | 1,782 | 8.8 | 1780 |
| 2. El Adly | 15,731 | 16.4 | 959 | 13.0 | 300-1500 |
| 3. El Gallaa | 38,812 | 308.1 | 126 | 49.7 | 550-1000 |
| 4. El Manakh(3) | 53,422 | 330.1 | 162 | 78.9 | 700 |
| El Arab | 78,009 | 383.0 | 500 | — | 1500 |
| 5. El Abbasey | 10,705 | 25.2 | 425 | 14.6 | 1500 |
| 6. Abu El Hassan | 11,588 | 15.1 | 767 | 11.0 | 300-1500 |
| 7. Al Taiofiki | 10,129 | 22.0 | 460 | 18.5 | 300-1500 |
| 8. Montozet Sand | 22,129 | 30.9 | 716 | 25.8 | 1500-300 |
| 9. El Arab(4) | 22,641 | 289.8 | 78 | 40.7 | 400-1000 |
| El Shark | 60,962 | 553.6 | 100-300 | — | 300-600 |
| 10. Port Fouad | 16,678 | 173.1 | 96 | 91.5 | 140-350 |
| 11. Ibrahim Hasson(5) | 17,654 | 97.0 | 182 | 76.3 | 150-275 |
| 12. Mostofa Hamza(6) | 26,630 | 283.5 | 94 | 50.6 | 275-650 |
| Total or Average | 262,620 | 1,600.0 | | | |

(1) See Figure 2-A for location of census tracts.
(2) Central Agency for Public Mobilization and Statistics (CAPMAS), November, 1976.
(3) Western edge of kism/limits of Mazrah property (airport excluded).
(4) Includes Kabbutti fishing village.
(5) Includes port area.
(6) Includes area now used by military.

TABLE 2.2

ADJUSTMENTS TO FUTURE POPULATION

| Year | Original Projection | | Adjustment | |
|---|---|---|---|---|
| | PSMP | Increase per year | WWFMP | Increase per year |
| 1975 | 343,000 | - | - | - |
| 1976(1) | - | 8,300 | 262,600 | 9,500 |
| 1977 | - | - | 273,000 | 10,700 |
| 1980 | 384,400 | 17,300 | 305,000 | 17,000 |
| 1985 | 470,800 | 18,000 | 390,000(2) | 19,400 |
| 1990 | 560,500 | 18,700 | 487,000 | 19,600 |
| 1995 | 653,000 | 19,200 | 585,000 | 19,800 |
| 2000 | 750,000 | | 684,000 | |

(1) November 21/22 Country-Wide Census.
(2) PSMP adjusted for 5 year lag.

TABLE 2.3

ADJUSTMENTS TO FUTURE EMPLOYMENT

| | 1980 | | 1985 | | 1990 | | 2000 | |
|---|---|---|---|---|---|---|---|---|
| | PSMP | WWFMP | PSMP | WWFMP | PSMP | WWFMP | PSMP | WWFMP |
| Population | 384,000 | 305,000 | 471,000 | 390,000 | 560,000 | 487,000 | 750,000 | 684,000 |
| Labor Force | 114,000 | 93,000 | 151,000 | 116,000 | 184,000 | 154,000 | 266,000 | 229,000 |
| Labor Force/Population | 30% | 30% | 32% | 32% | 33% | 33% | 35% | 35% |
| Unemployment(1) | 10,000 | - | 18,000 | - | 15,000 | - | 3,000 | - |
| Unemployment/Labor Force | 9% | - | 12% | - | 8% | - | 1% | - |
| Employment | 104,000 | 92,000 | 133,000 | 116,000 | 169,000 | 161,000 | 263,000 | 239,000 |
| Tertiary(2) | 64,000 | 56,000 | 80,000 | 59,000 | 101,000 | 82,000 | 161,000 | 127,000 |
| Industrial(3) | 15,000 | 13,000 | 22,000 | 33,000 | 32,000 | 45,000 | 56,000 | 69,000 |
| Construction | 12,000 | 11,000 | 12,000 | 9,000 | 13,000 | 11,000 | 19,000 | 17,000 |
| Fishing, Agriculture | 9,000 | 8,000 | 14,000 | 11,000 | 17,000 | 17,000 | 19,000 | 19,000 |
| Utilities | 4,000 | 4,000 | 5,000 | 4,000 | 6,000 | 5,000 | 8,000 | 7,000 |
| Percent of Total Employment in: | | | | | | | | |
| Tertiary(2) | 56 | 61 | 53 | 51(4) | 55 | 51(4) | 61 | 53(4) |
| Industrial(3) | 12 | 14 | 15 | 29(5) | 18 | 28(5) | 21 | 29(5) |
| Construction | 11 | 12 | 8 | 8 | 7 | 7 | 7 | 7 |
| Fishing, Agriculture | 8 | 9 | 9 | 9 | 9 | 11 | 7 | 8 |
| Utilities | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 |
| Unemployed | 9 | 0 | 12 | 0 | 8 | 0 | 1 | 0 |
| | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

(1) Average
(2) Service, trade, port, transportation/communications.
(3) Includes Free Zone and Non-Free Zone
(4) Reduced by following amounts to allow for possible location of new national port elsewhere than Port Said: 1985 - 2%; 1990 - 3%; 2000 - 4%
(5) Increased to eliminate structural unemployment.

Source: Port Said Master Plan, Vol. 1, Table 6.3; PSMP Vol. 4, p. 175.

## TABLE 2.4

## PSMP PROJECTION OF PORT RELATED EMPLOYMENT

| | 1980 | | 1990 | 2000 |
|---|---|---|---|---|
| | Old Port | New Port | New Port | New Port |
| In The Port | | | | |
| 1. Management Offices | 200 | 50 | 250 | 300 |
| 2. At Breakbulk Berths | 2,500 | | 3,550 | 5,000 |
| 3. At Bulk Cargo Berths | 50 | | 150 | 150 |
| 4. At Container Berths | | 500 | 750 | 1,000 |
| 5. At Roll On - Roll Off Berths | | | 75 | 75 |
| Port Warehousing | 230 | 20 | 425 | 750 |
| Suez Canal Authority | 1,400 | | 1,500 | 1,500 |
| Customs and Security | 450 | 50 | 750 | 1,000 |
| Bunkering | 150 | 50 | 250 | 400 |
| Shipping Services | 300 | 50 | 500 | 800 |
| Mariners | 1,700 | 300 | 3,000 | 5,000 |
| | 6,980 | 1,020 | 11,200 | 15,975 |

Shipyard employment excluded.

Source: PSMP, Vol. 5, p. 101

TABLE 2.5

POPULATION DISTRIBUTION

WATER AND WASTEWATER FACILITIES MASTER PLAN
(Year-End Figures)

| Area(1) | 1976 | 1977 | 1980 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|---|---|
| A | 233,900(2) | 243,500 | 252,300 | 251,100 | 226,500 | 207,300 | 188,000 |
| B | - | - | - | 5,000 | 5,000 | 5,000 | 5,000 |
| C | - | - | 19,500 | 71,800 | 80,000 | 80,000 | 80,000 |
| D | - | - | - | 18,500 | 81,400 | 82,000 | 82,000 |
| E | 12,000(2) | 12,000 | 12,700 | 14,100 | - | - | - |
| F | - | - | - | - | 17,000 | 48,700 | 48,700 |
| G | - | - | - | - | 16,400 | 71,000 | 76,300 |
| H | - | - | - | - | - | 23,600 | 68,300 |
| I | - | - | - | - | - | - | 62,700 |
| J | 16,700 | 17,500 | 17,500 | 17,500 | 17,500 | 17,500 | 17,500 |
| K | - | - | 3,000 | 12,000 | 12,000 | 12,000 | 12,000 |
| L | - | - | - | - | 8,500 | 8,500 | 8,500 |
| M | - | - | - | - | 22,900(3) | 29,000 | 35,000 |
| Total | 262,600 | 273,000 | 305,000 | 390,000 | 487,000 | 585,000 | 684,000 |

(1) Location of each area shown on Fig. 2-C.
(2) Breakout of Kabbutti approximated by applying estimated densities to distinct areas.
(3) Assumes new fishing village built and existing Kabbutti converted to park use.

## TABLE 2.6

## ADJUSTED INDUSTRIAL AREA DEVELOPMENT
(Hectares, Year-End Figures)

| | Amount of Land Required(3) | | | | | |
|---|---|---|---|---|---|---|
| Area(1) | 1977(2) | 1980 | 1985 | 1990 | 1995 | 2000 |
| A | 21 | 21 | 21 | 21 | 13(4) | 13 |
| B | - | 29 | 135 | 191 | 205 | 205 |
| D | - | - | - | 40 | 40 | 40 |
| E | 32 | 32 | 32 | 32 | 32 | 32 |
| F | - | - | - | 8 | 8 | 8 |
| G | - | - | - | - | 40 | 40 |
| I | - | - | - | - | - | 11 |
| M | - | - | - | 44 | 44 | 44 |
| N | - | - | - | - | - | 7 |
| O | - | - | - | - | 17 | 40 |
| Total(5) | 53 | 82 | 188 | 336 | 399 | 440 |

(1) Location of each area shown on Figure 2-C.
(2) Specific area development follows the land reclamation study filling sequence.
(3) Estimated area requirements assume gross density of 100 employees per hectare. This density figure approximates PSMP Table 17.5, Volume I, average.
(4) Reflects relocation of boat works from head of Manzala Canal.
(5) Estimated total sufficient to permit industry to provide full employment.

TABLE 2.7

INCIDENCE OF PARASITIC DISEASES
(Number of Recorded Cases) (1)

| Disease | 1975 | 1976 | 1977 |
|---|---|---|---|
| Schistosomiasis | 2,622 | 2,017 | 2,126 |
| Ancyclostomiasis | 30 | 57 | 35 |
| Ascariasis | 5,329 | 5,426 | 6,486 |
| Oxyuriasis | 4,383 | 4,031 | 4,533 |
| Heterophiasis | 241 | 381 | 256 |
| Amoebic Dysentery(2) | 1,409 | 1,742 | 2,706 |

(1) Inadequacies in record keeping allow some multiple entries for the same individual.
(2) Dr. Hanne, Director of Preventive Medicine, Ministry of Health, Port Said, estimated that at least 50 percent of the population suffers from amoebic dysentery.

Source: Ministry of Health, Port Said

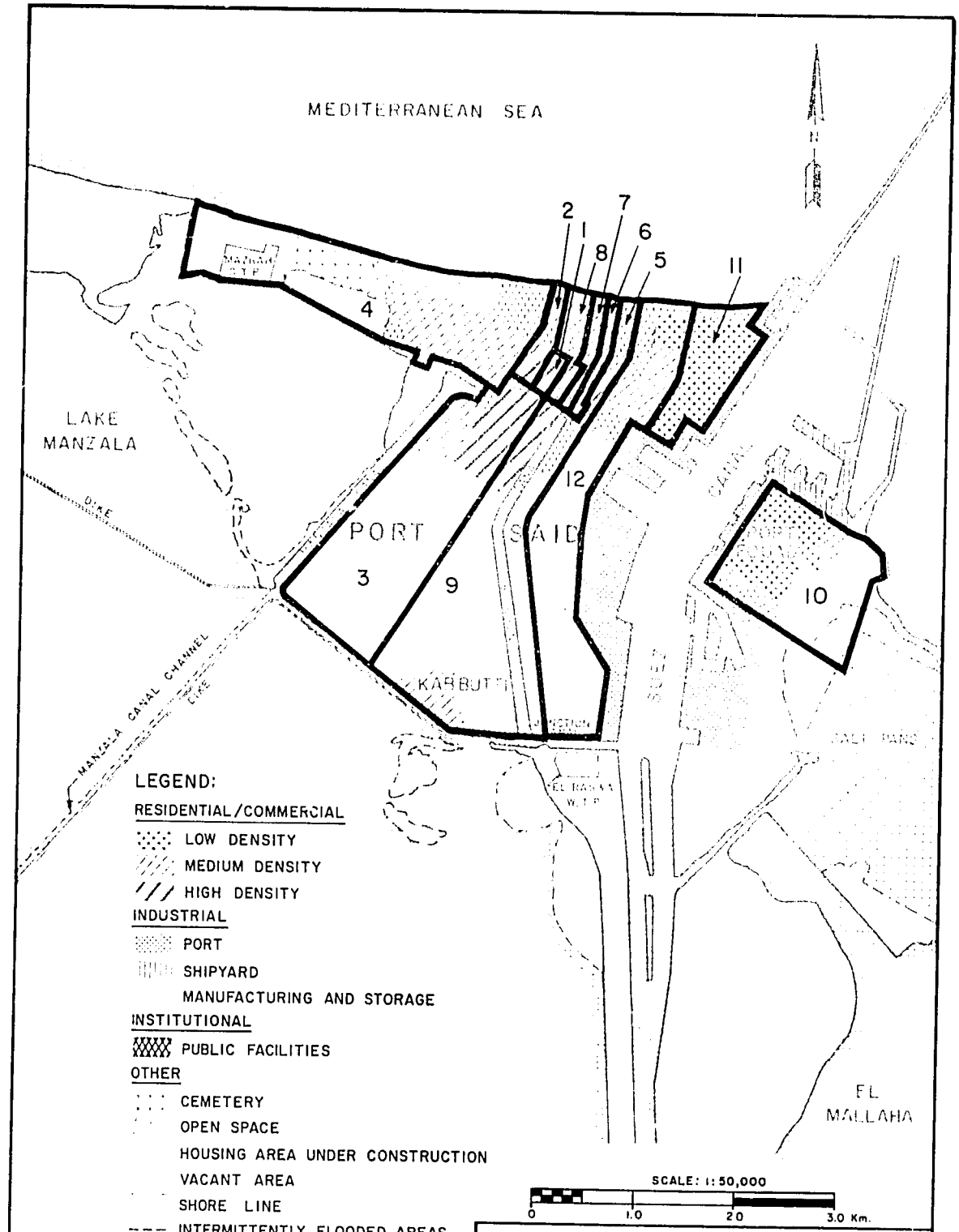
TABLE 2.8

INCIDENCE OF PROBABLE WATERBORNE COMMUNICABLE DISEASES
(Number of Recorded Cases) (1)

| Disease | 1974 | 1975 | 1976 | 1977 | Jan-June 30 1978 |
|---|---|---|---|---|---|
| Typhoid | 75 | 23 | 37 | 15 | 5 |
| Paratyphoid | 11 | 14 | 29 | 17 | 10 |
| Infectious Hepatitis | 273 | 266 | 226 | 395 | 138 |
| Bacillary Dysentery | 0 | 6 | 8 | 19 | 3 |
| Erisepelas | 47 | 84 | 105 | 146 | 41 |

(1) Inadequacies in record keeping allow some multiple entries for the same individual.

Source: Ministry of Health, Port Said

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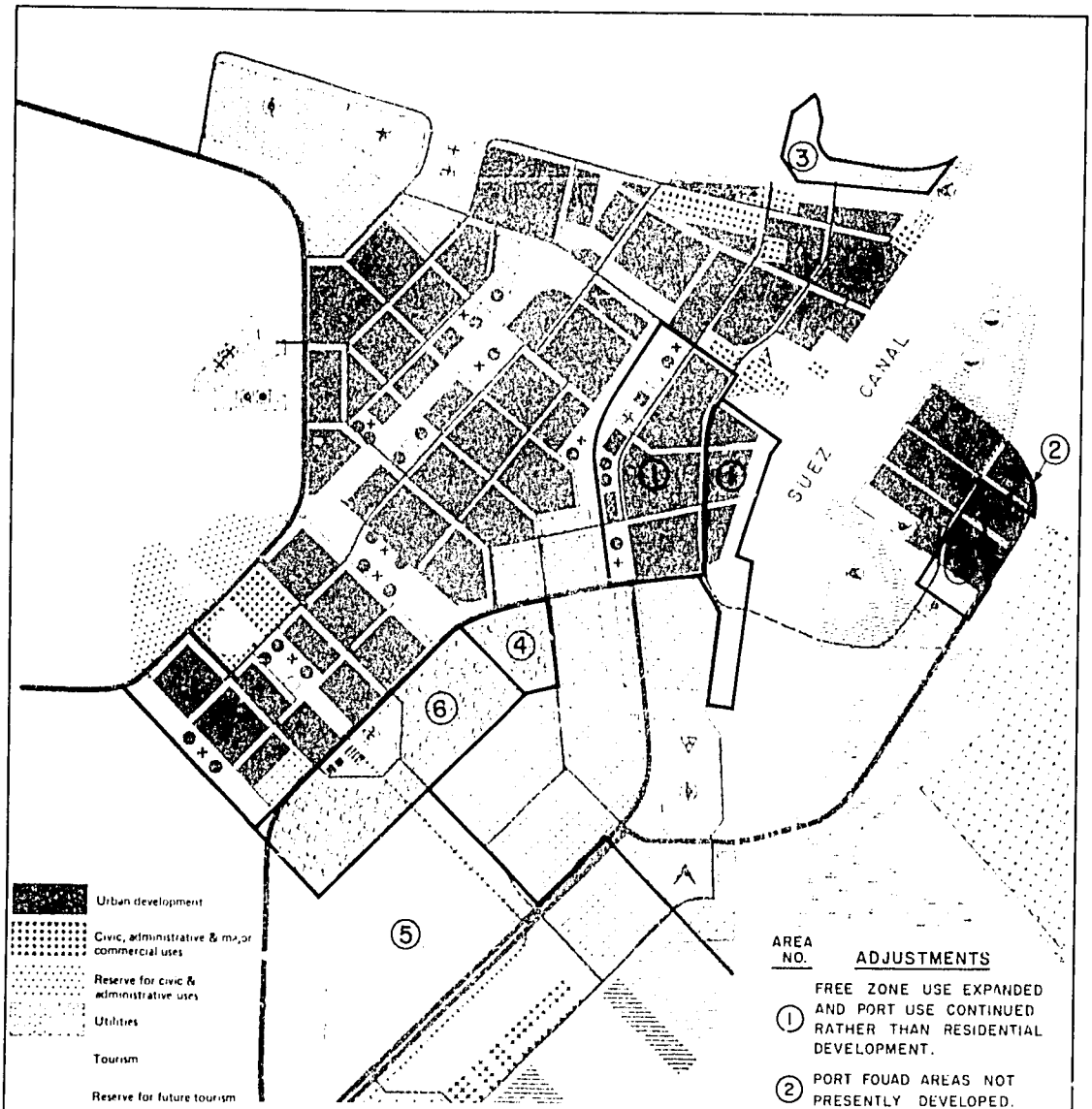
**ARAB REPUBLIC OF EGYPT**

MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION

PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

PRESENT URBAN DEVELOPMENT

VOL. 2
FIG.
2-A




Urban development

Civic, administrative & major commercial uses

Reserve for civic & administrative uses

Utilities

Tourism

Reserve for future tourism

Associated tourism facilities

Industrial Estates

Warehousing & storage

Reserve for future industry

Land reserve for heavy industry

Saltworks

Water related industries

Port area

Reserve for port

Port administration & maintenance

Railway marshalling yard

Marginal land

Urban amenity areas

City park

Parkland with institutional uses

Reserve for future open space

| AREA NO. | ADJUSTMENTS |
|---|---|
| 1 | FREE ZONE USE EXPANDED AND PORT USE CONTINUED RATHER THAN RESIDENTIAL DEVELOPMENT. |
| 2 | PORT FOUAD AREAS NOT PRESENTLY DEVELOPED. |
| 3 | TOURIST FACILITIES TO BE RELOCATED WEST OF MAZRAH |
| 4 | START OF KABBUTTI RELOCATION DELAYED 5 YEARS. |
| 5 | ROAD / RAIL CORRIDOR DELAYED TO AFTER 2000. |
| 6 | LAND NOT RECLAIMED FOR SECTION OF URBAN PARK. |

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BASEMAP: PLATE 9-2
VOLUME I, PSMP
GOLDER ASSOCIATES

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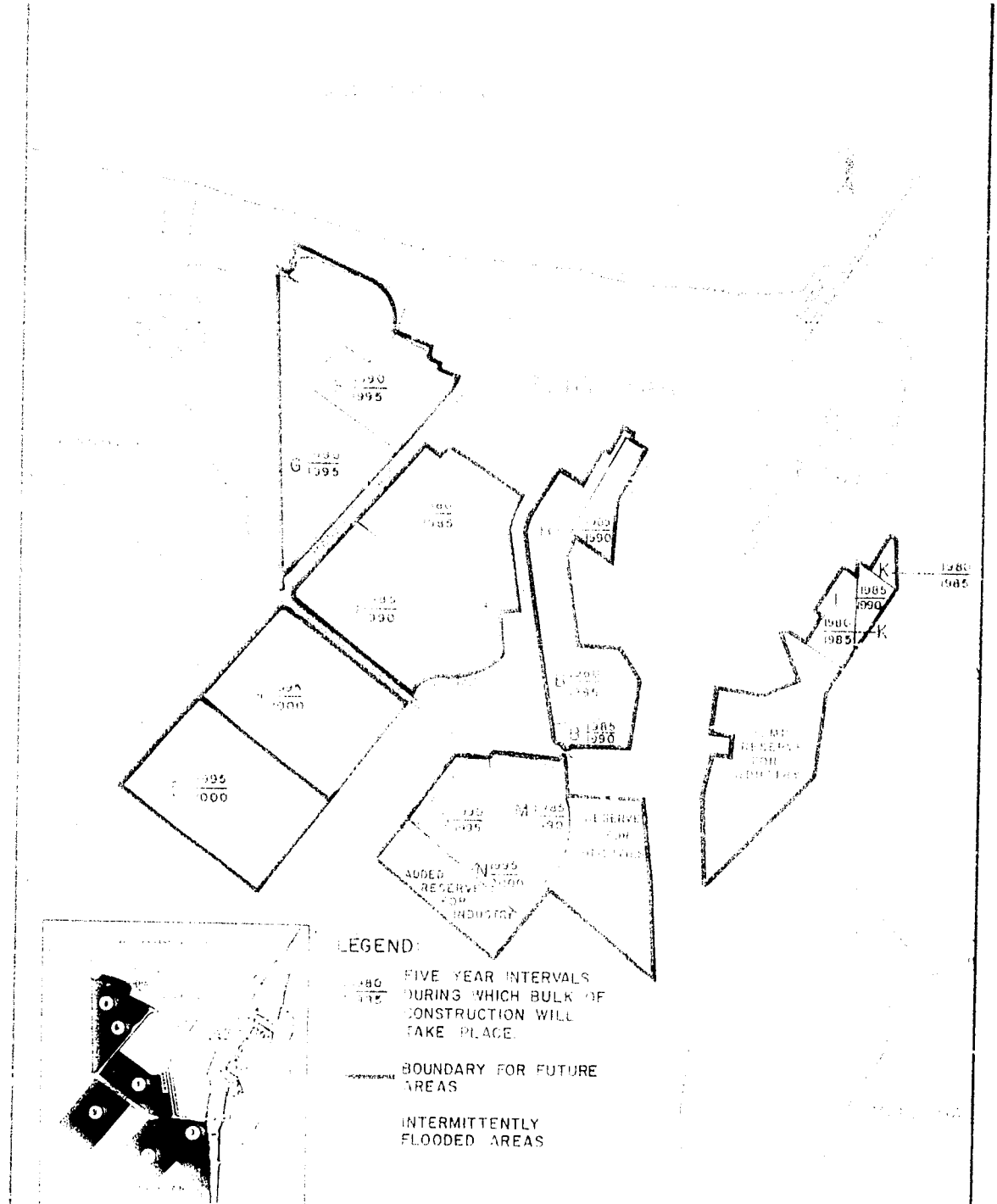
PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

ADJUSTMENTS TO PSMP LAND USE

VOL.2 FIG. 2-B

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PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

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PHASING OF FUTURE AREA DEVELOPMENT

VOL. 2
FIG.
2-C

CHAPTER 3

NATURAL ENVIRONMENTAL SETTING

## 3.1 HABITATS

The terrestrial habitats of the Port Said Project Area are limited in extent by the shortage of land. Only minor areas of such habitat remain undisturbed. Some stands of natural vegetation exist along the shorelines of Lake Manzala and El Mallaha. Elsewhere, land reclamation, urban development, and military installations have produced large and often irreversible changes in the terrestrial system.

Aquatic habitats (Lake Manzala, El Mallaha, the Suez Canal and the Mediterranean Sea) remain much more intact than the terrestrial habitats, despite some encroachment by dikes and land reclamation.

Lake Manzala receives agricultural drainage and some wastewater discharges from Cairo and Port Said; hence it is only moderately saline. Although the range of fish species is narrow, consisting mainly of mullets and tilapia, the lake produces more than one-quarter of the Egyptian fishing industry's total production.

El Mallaha, to the east of Port Fouad, receives little or no fresh water drainage and is considerably more saline than Lake Manzala. El Mallaha is much less productive than Lake Manzala in both plankton and fish yields.

The Suez Canal links two distinct geographical units: the Mediterranean Sea and the Red Sea. As a result, marine plants and animals characteristic of both Seas have established themselves in the Canal. Water movement in the Canal varies with the tidal cycle. Net flow for most of the year is from the south. Levels of salinity vary widely at different points in the Canal.

The Mediterranean Sea, on the northern border of the Project Area, features a shallow coastal shelf, relatively low biological productivity, and west-to-east offshore currents. Indications point to a lowering of productivity and fish catch since the completion of the Aswan High Dam in 1964. The waters along the Port Said coast are safe for bathing, with coliform bacteria levels well within bathing criteria recommended by the U.S. Environmental Protection Agency (USEPA).

## 3.2 LIFE FORMS

A distinct feature of the Port Said surroundings is the limited diversity of biological species. This is true especially of the terrestrial environment. Even the variety of aquatic species is limited in comparison with other locales, such as salt marshes, where a mixing of waters usually is accompanied by highly diverse and productive fauna and flora.

Terrestrial species are limited to a few species of small reptiles, fish-feeding birds and insects, with flora consisting mainly of sedges and perennial wood shrubs.

Aquatic life forms, more varied than the terrestrial forms, differ in the four main water bodies. The Suez Canal exhibits its greatest productivity in the Port Said zone. Many species of plankton and fish found in the Suez Canal and the Mediterranean near Port Said have migrated from the Red Sea. The ecological implications of these migrations

have not been established, but it is hoped that these new species will offset a general decline in fish catches which has occurred since the 1960's. Shrimp, crabs and finfish also represent a significant resource in the Mediterranean.

## 3.3 ECOLOGICAL RELATIONSHIPS

The characteristics of the habitats in the Port Said Study Area suggest that a stable ecosystem has not been established. Stable, mature ecosystems are characterized by diversity; a well-developed, non-linear food chain; and the presence of large predatory species. The aquatic and terrestrial systems in the Port Said area lack diversity and contain large numbers of small inhabitants with a highly linear food chain. These systems are extremely sensitive to environmental change.

CHAPTER 4

# CURRENT WATER CONSUMPTION AND FORECAST OF FUTURE DEMANDS

## 4.1 PRESENT USAGE

### Historical Data

Historical water use or production data are of little use in estimating water consumption in Port Said. Although the system is designated a "metered system", about one-third of approximately 12,000 services are unmetered. Of the remaining 8,000 services, about 40 percent of the meters examined were found to be damaged or missing. Only one-third of the industrial users surveyed had operational meters. A 1978 survey of meters on domestic, institutional and governorate services, conducted for the WWFMP, indicates that meter failure extends over much of the city (see Table 4.1). Overall, it appears that less than 40 percent of the water used is actually metered. Suez Canal Authority (SCA) billings for premises lacking meters or with inoperative meters apparently are based upon water consumption in prior years.

Prior to the 1967 war, the total amount of water going to Port Said was metered and recorded regularly at El Raswa water treatment plant. War damage and neglected repairs have rendered the flow measuring equipment inoperative or inaccurate. Plant production has been estimated by multiplying hours of pump operation by rated pump capacities and applying variable efficiency factors to obtain total daily flow. These records of water production are necessarily approximate, as pumps frequently operate against throttled valves and some pumps have had locally manufactured replacement impellers installed, changing their rated capacities.

### Current Water Production

To obtain a more suitable base for estimating water demands, the amount of water pumped to Port Said was measured in April and August, 1978 by pitometers in the water mains leading from the El Raswa plant. With readings taken every half hour, the water discharge was measured for 24 hours in April and 48 hours in August.

The variations in flow are summarized below and shown graphically on Figure 4-A. Locations of the pitometers at El Raswa are shown on Figure 4-B.

Water Discharged from El Raswa - Pitometers, 1978

| | 24 Hour Total cu m/d | Cubic Meters per Hour | | |
|---|---|---|---|---|
| | | Average | Max. | Min. |
| April 24/25 | 92,000 | 3,840 | 4,500 | 2,565 |
| Aug. 15/16 | 82,550 | 3,440 | 4,475 | 1,920 |
| Aug. 16/17 | 89,480 | 3,730 | 4,280 | 3,130 |

The summer measurements, taken during Ramadan, may be atypically low for mid-August. However, the relatively high pumpage for April production was caused in part by a 16,000 cu m/d leak in one of the siphons to Port Fouad. The siphon was valved off in



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July. According to the Port Said Master Plan (PSMP) report, August water demands (1962-1966) exceeded the average annual demand by 18%, and early spring demands ranged from 12 to 15% below the average. Had the leaky siphon been closed prior to the April test, it is reasonable to assume that the 92,000 cu m/d measured in April would have dropped below 80,000 cu m/d.

Removal of the leaking siphon raised the water pressure in the distribution system near the center of the urban area (see Figure 4-C) and eliminated periods of low pressure during high demands. More importantly, the problem in recent years of reductions in pumping at El Raswa, and even complete shutdowns, was alleviated.

Assuming a population served of 273,000 (see Section 2.1), pumpage of 90,000 cu m/d is equivalent to 330 liters per day per capita. This figure, unusually high for a community with few wet industries, is over 1-1/2 times the daily water produced per capita for a comparable population in Port Said before the war.

Among factors contributing to this high water use are other leaks in the distribution system marked by the presence of water at the ground surface; the low number of consumer meters and the consequent wasteful use of water, especially by customers with unmetered services and no incentive to save water; and inadequate and defective plumbing which leaks 24 hours a day.

Existing Demands: Assumptions

The evaluation of water needs, as distinguished from total pumpage at El Raswa, requires a knowledge of the number, type and distribution of the several categories of consumers. For this purpose four categories of water use were selected: 1) Domestic or residential (including small commercial stalls and shops drawing water from the building service); 2) industrial, including port activities; 3) institutional, including hotels; and 4) public facilities, including gardens.

Preliminary estimates of the current water demands of these categories were made early in the program, based on data available from the PSMP reports, SCA and other officials, the Census Bureau and inquiries in the field. Major differences between the present situation and the pre-1967 conditions described in PSMP reports compelled adjustment of earlier data. Following are the assumptions made and procedures used in our adjustments:

Domestic

Domestic customers were subdivided into low, medium and high water consumers.

| Use Level | % of Pop. at Use Level | Per Capita Use - lpd |
|---|---|---|
| Low | 40 | 85 |
| Medium | 40 | 170 |
| High | 20 | 250 |
| Weighted Average | | 150 |



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Industrial

1. Ship water = 1,260 cu m/d (water sales in 1977).

2. Port consumption = 1,700 cu m/d based upon meter records. 1975 PSMP estimate was 600 cu m/d.

3. Shipyard = 2,500 cu m/d (employment at 1980 level).

4. Industrial = 5,200 cu m/d (PSMP estimate for 1976 plus allowance for Free Zone development).

Institutional

1. 25 lcd for total residential population distributed on a land area basis. 13 percent to Port Fouad, 4 percent to Horeya and 83 percent to existing urban core of Port Said.

2. Seasonal use estimated at 250 lpd/bed for 3,000 beds, distributed to Port Said, El Shark and El Arab district beach facilities.

Public

1. Includes 500 cu m/d for gardens, 800 cu m/d for public taps and 1,200 cu m/d for public wash facilities. Estimates for gardens based on 1962-1966 consumption levels; other estimates based on field tests of public taps.

Water Use and Wastage Studies

To investigate wastage, a study was made of 278 domestic accounts chosen at random from 8039 SCA accounts, plus 54 institutional and industrial accounts. The customers selected were in the northern part of the city, extending from the Suez Canal to Manzala Canal (see Figure 4-D).

For each of the 332 accounts, information was obtained as to the size of meter, its location, and present condition; the size, type and function of building, including the number of residential apartments; and the water consumption in 1977 as billed by SCA.

In addition, for 41 of these accounts which were selected for detailed study, the population housed and the number of plumbing fixtures were determined. Meters at the 41 services were read 30 to 60 days apart to determine total and average water consumption during the test period. Each of the meters was also read at 30 minute intervals over 48 hours, with supplementary readings between midnight and 8 AM to determine nighttime consumption.

Water wastage was estimated by comparing the low flow readings with average daily consumption. Where the minimum flow exceeded 20% of the average daily use, the difference was considered to be wastage that would continue throughout the day and night.

Domestic

The detailed study of 41 services included 17 high water users (beach front apartments) with separate meters for each flat and 2 to 10 persons per flat. As detailed in Table 4.2, consumption ranged generally between 100 and 400 liters per capita per day (lcd)

and averaged 288 lcd. Excessive wastage was estimated at an average per service of 69 cu m per annum, or 14% of the 1978 consumption. The 12 medium water users (Table 4.3) included 200 flats, housing nearly 1000 persons, and a public bath house. Not including the bath house, consumption ranged generally between 120 and 350 lcd, averaging 196 lcd for 1978. Annual wastage averaged 1220 cu m per service, or 21% of the 1978 flow. The four low water users (Table 4.4, excluding the veterans hospital) included 17 flats housing 77 persons. Consumption ranged from 56 to 128 lcd, averaging 92 lcd. Wastage was equivalent to 46% of the 1978 flow.

Averages for the 33 domestic or residential accounts are summarized as follows:

| | Consumption | Wastage | Useful Water | % Wastage |
|---|---|---|---|---|
| Low Use | 92 lcd | 42 lcd | 50 lcd | 46 |
| Medium Use | 196 lcd | 41 lcd | 155 lcd | 21 |
| High Use | 288 lcd | 40 lcd | 248 lcd | 14 |

The high percentage of wastage by low use water consumers is offset by the smaller per capita consumption. Wastage per capita is essentially equal for all domestic customers. It should be noted, however, that except for one government housing area (Table 4.3), the SCA consumption figures for 1977 were generally lower than the 1978 annual totals calculated from the meter readings.

Industrial

Faulty metering, or no metering at all, has precluded an accurate appraisal of industrial water use and wastage. The SCA 1977 sales records were examined and the condition of meters checked by inspection. According to the SCA records, 785,000 cu m of water was delivered to some 30 industrial and large commercial establishments in 1977. Of the 35 meters listed in Table 4.5, 14 were found operating and 21 broken, out of service or lost. Metered customers in 1977 accounted for 610,000 cu m (78% of total industrial consumption), including 458,000 cu m to CONSUP for sale to ships, 45,000 cu m to El Nasser Salines Co., 45,000 cu m to Portex, and a total of 62,000 cu m to more than a dozen small customers. Unmetered customers, including Thick Cover, Egyptian Miller and the prison, accounted for 175,000 cu m (22% of total industrial consumption). SCA billings for such accounts apparently were estimated, and in many cases based upon water use in prior years.

The industrial water consumption data obtained from the SCA included no information on water wastage; therefore, a 24 hour study of water demands was made at three establishments. As shown below, wastage at the first two industries, both closed at night, would account for 40 to 47% of the water delivered.

| Name of Industry | Annual Consumption cu m | | Estimated Percent Wastage |
|---|---|---|---|
| | 1977 Billed | 1978 Calculated | |
| Edfina Co. | 17,904 | 23,360 | 47 |
| Egyptian Tea Packing Co. | 7,773 | 12,775 | 40 |
| El Nasser Dehydration Co. | 47,507 | 90,155 | Working 24 hrs/day |



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Institutional

Institutional water demands in the Governorate Area metered during the water use and wastage studies are shown in Table 4.6. Except for the single apartment house listed, per capita data are not applicable. Particularly significant is the high rate of consumption in government buildings closed during Ramadan. The rate of water wasted during this period ranged up to 60-78% of the average annual rate of consumption. It should also be noted that the 1978 average annual consumption computed for the seven buildings studied was twice the amount billed by SCA for 1977. Twenty percent of this discrepancy may be attributed to metering during hot summer months when water demands are relatively high.

Water use was surveyed at 17 schools in Port Said (see Table 4.7). Three schools had broken meters. During the course of the study, three more meters were damaged and one meter stopped. The meter survey of the 10 remaining schools determined that water use ranging from 12 to 111 lcd and averaging 35 lcd, with little or no reduction on holidays. Plumbing in most of the schools was in extremely poor condition. At most schools the water supply is turned off during summer vacation. 1978 annual flows calculated from meter readings, exceeded the SCA 1977 billings by 85%.

Conclusions

Information obtained by the water use and wastage studies has not by itself provided an accurate basis for estimating present demands and future requirements. It has, however, established the validity of 150 lpd as a reasonable assumption for the domestic per capita consumption allowance.

The studies have also demonstrated the unusually large amounts of wastage of water delivered not only to residential customers, but also to industry and institutional establishments, including official government buildings. When this wastage is combined with estimated distribution leaks (see Chapter 8), the total loss of water amounts to 28,000 cu m/d over actual needs ("1977" column in Table 4.9).

With thousands of water meters out of service, the SCA has been forced to estimate at least one half of the water sold. The SCA is therefore in no position to carry out regular meter reading and equitable billing and collection. Establishment of such a program should have high priority.

## 4.2 FUTURE DEMANDS

Careful forecasts of total water demands at Port Said are essential for the realistic appraisal of existing water supply works, treatment plant, and pumping stations, and cost-effective scheduling of needed improvements. Where and in what numbers the population will live and work, and the special water needs of future industrial and commercial areas, must also be anticipated for evaluation and improvement of the distribution system.

Areal Distribution

The major land uses proposed by the PSMP, as adjusted (Figures 2-B, 2-C and "Land Use" in Section 2.2), were carefully considered as to development phases and in the context of the overall water system service area projected for the year 2000 (Figure 4-E). Adjustments to the PSMP population forecasts ("Population" in Section 2.2) were used in calculating the total future demand and its areal distribution.

To the census tract boundaries (Figure 2-A) and existing residential densities in Port Said and Port Fouad (Table 2.1) was added land use information to help delineate the location of several user demands. The City of Port Said was divided into water demand districts. In existing areas, each district was defined by the type and level of water use, e.g., predominately low, medium or high domestic, institutional, industrial. In new areas not likely to be developed for some years, no attempt was made to divide residential districts into levels of water use. Water demand districts for the year 2000 are shown in Figure 4-F. Population forecasts for predominately domestic or residential water demand districts are summarized in Table 4.8.

Assumptions

From a preliminary analysis of PSMP methodology, present water demand and future land use and population distribution, the following assumptions and procedures were developed for estimating future demands:

Domestic

1. Growth in domestic use was projected at 1 lcd/yr, yielding low, medium and high domestic uses of 110, 195, and 275 lcd respectively in the year 2000.

2. Estimated population was distributed by water use level as follows for the year 2000:

| Water Use Level | % of Pop. at Use Level |
|---|---|
| Low | 30 |
| Medium | 40 |
| High | 30 |

3. Distribution of population by use level within existing built-up areas in Port Said and Port Fouad was assumed to remain constant.

Industrial

1. Ship water: 4 percent/yr increase.

2. Port consumption:

| Projections Based on Estimated Tonnage to be Handled (cu m/d) | | | | |
|---|---|---|---|---|
| 1982 | 1985 | 1990 | 1995 | 2000 |
| 2,100 | 2,400 | 3,000 | 3,350 | 3,800 |

3. Shipyard: 2,500 to 7,100 cu m (PSMP Projections).

4. Industrial:

| Projections Based on Industrial Area Development (cu m/d) | | | | |
|---|---|---|---|---|
| 1982 | 1985 | 1990 | 1995 | 2000 |
| 10,500 | 14,700 | 25,000 | 29,400 | 32,300 |

Institutional

1. Present distribution of existing flows was assumed, with new flows at 25 lcd distributed in accordance with increases in population.

2. Additional demand for commercial and civic facilities was included in estimate for area south of Junction Canal.

3. 1980 PSMP estimates of new tourism demands were delayed to 1982.

4. Tourism water demands were based on PSMP tourism projections, distributed between area immediately west of Port Said breakwater (10%) and area west of Mazrah Sewage Treatment Plant (90%).

Public

1. No increase was assumed in demands at existing public facilities or taps.

2. Allowance was made for public wash facilities planned for Kabbutti to serve immediate needs.

Forecasts

Based on the above assumptions and the WWFMP population projections, future average day water demands at Port Said, including wastage and leaks, were calculated at 114,000 cu m/d in 1982, 136,000 cu m/d in 1985, growing to 261,000 cu m/d by the end of the century, as shown in Table 4.9. Maximum day demands for the same years were estimated at 142,000 cu m/d, 169,000 cu m/d and 326,000 cu m/d, with peak hour demands reaching 194,000 cu m/d, 230,000 cu m/d and 440,000 cu m/d.

Future water consumption by demand district is shown in Tables 4.10 (domestic), 4.11 (institutional) and 4.12 (industrial).

The 28,800 cu m/d combined wastage and leaks estimated for 1977 is not expected to change significantly through 1982 (Table 4.9). Thereafter, the total water loss probably will rise to 32,700 cu m/d in 1985, 43,700 cu m/d in 1995 and 50,000 cu m/d for the year 2000, in spite of less wastage with better housing, better plumbing, better control of industrial water use, and inauguration of regular and effective leak surveys.

Figures shown below, exerpted from the PSMP report, indicate water demands lower than the WWFMP forecasts.

| | | 1975 | 1985 | 2000 |
|---|---|---|---|---|
| | | (Average daily supply in cu m/d) | | |
| 1. | Domestic/small trades | 41,200 | 70,500 | 142,500 |
| 2. | Institutional | 7,000 | 10,600 | 16,000 |
| 3. | Industrial | 8,700 | 18,200 | 44,800 |
| 4. | Miscellaneous | - | 800 | 2,000 |
| 5. | Unaccounted for water | 10,300 | 14,100 | 28,500 |
| | Total | 66,600 | 114,200 | 233,800 |

Differences between the PSMP forecast and the WWFMP (Table 4.9) in water demands assigned to the several consumer categories are not surprising nor of major importance. The significant difference is between the PSMP "unaccounted for water" and the "wastage and leaks" in this study. These terms are not equivalent, however, because the PSMP did not consider wastage, and included only leakage ahead of the customers' meters. It was assumed that the system would be fully metered within a short time, and that customers would pay for water wasted on their premises.

The PSMP assumption that major leaks would be corrected and that all customers would be metered in 3 or 4 years appears optimistic. While obvious leaks can be repaired immediately, a long period will be required to put the water distribution system, services, and meters in good order. Purchase of new equipment and deliveries from abroad are likely to take years. A new water rate system is needed (see Chapter 12). All customers, including government buildings and public housing, should be obliged to pay for water. Furthermore, the SCA staff must be trained in the operation, maintenance, and reading of meters. Teaching the public the importance of water conservation and the benefits of metering will move slowly. Certain inherent leaks will continue, such as from the poor quality service taps throughout the system and much of the existing low quality plumbing. For these reasons, as well as difficulties certain to appear in a rapidly expanding water supply system, the WWFMP assumes that large water losses will continue over the next 20 years.

Probably the least reliable of the water demand forecasts is that for industrial use (Table 4.9 and 4.12). In this report, as well as the PSMP, the forecasts anticipate substantial industrial growth and water use, justified by the belief that an adequate supply of water is likely to attract industry. The WWFMP year 2000 population goal of 684,000 is not likely to be achieved without a heavy investment in commercial and industrial enterprises, providing the work opportunities needed by a large labor force.

Peaking factors are commonly based upon total plant discharge. Since wastage at Port Said represents a higher than normal portion of the average flow, the ratio of peak hour to maximum day was reduced from the usual 1.5 to 1.4.



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## TABLE 4.1

## WATER METER CONDITION (1978)

### Domestic Services

| Meter Condition | El Manakh | | El Arab | | El Shark | | Port Fouad | | All Areas | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent |
| Operating | 10 | 36 | 69 | 67 | 43 | 65 | 18 | 62 | 140 | 62 |
| Stopped | 5 | 18 | 5 | 5 | 5 | 8 | 1 | 4 | 16 | 7 |
| Damaged | 9 | 32 | 5 | 5 | 2 | 3 | 3 | 10 | 19 | 8 |
| Removed | 1 | 4 | 24 | 22 | 16 | 24 | 7 | 24 | 48 | 21 |
| Jumpers | 3 | 10 | 1 | 1 | 0 | 0 | 0 | 0 | 4 | 2 |
| Domestic Total | 28 | 100 | 104 | 100 | 66 | 100 | 29 | 100 | 227 | 100 |

### Institutional and Governorate Services

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Operating | 9 | 69 | 10 | 63 | 4 | 44 | 9 | 69 | 32 | 61 |
| Stopped | 2 | 15 | 6 | 37 | 1 | 12 | 2 | 15 | 11 | 20 |
| Damaged | 1 | 8 | 0 | 0 | 4 | 44 | 1 | 8 | 6 | 15 |
| Removed | 1 | 8 | 0 | 0 | 0 | 0 | 1 | 8 | 2 | 4 |
| Jumpers | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| I&G Total | 13 | 100 | 16 | 100 | 9 | 100 | 13 | 100 | 51 | 100 |

### Combined Total

| | Number | Percent |
|---|---|---|
| Total Meters Operating | 172 | 62 |
| " " Stopped | 27 | 10 |
| " " Damaged | 25 | 9 |
| " " Removed | 50 | 18 |
| Jumpers | 4 | 1 |
| | 278 | 100 |

TABLE 4.2

WATER USE AND WASTAGE STUDY

HIGH USE (BEACH FRONT APARTMENTS)

| Service Number | Number of Flats | Population/(1) Fixtures | Annual Consumption cu m SCA Billed 1977 | Annual Consumption cu m Calculated 1978 | lcd 1978 | Annual Wastage(2) cu m | Annual Wastage(2) Percent |
|---|---|---|---|---|---|---|---|
| 9159 | 1 | 5/6 | 502 | 367 | 201 | 47 | |
| 9163 | 1 | 7/6 | 156 | 299 | 177 | 87 | |
| 9164 | 1 | 6/6 | 297 | 1610 | 735 | 0 | |
| 9165 | 1 | 6/6 | 213 | 289 | 131 | 0 | |
| 9166 | 1 | 4/6 | 221 | 341 | 234 | 0 | |
| 9168 | 1 | 8/6 | 1149 | 1268 | 434 | 360 | |
| 9169 | 1 | 5/6 | 255 | 133 | 72 | 0 | |
| 9170 | 1 | 4/6 | 131 | 194 | 133 | 0 | |
| 9171 | 1 | 2/4 | 303 | 732 | 1002 | 88 | |
| 9172 | 1(3) | closed | 106 | - | - | - | |
| 9301 | 1 | 5/7 | 107 | 93 | 51 | 0 | |
| 9302 | 1 | 7/7 | 190 | 588 | 230 | 0 | |
| 9303 | 1 | 10/6 | 367 | new meter | 313 | 0 | |
| 9304 | 1 | 5/7 | 290 | 575 | 320 | 195 | |
| 9306 | 1 | 4/7 | 255 | 283 | 176 | 188 | |
| 9300 | 1 | 5/7 | 131 | 97 | 177 | 0 | |
| 9517 | 1(3) | cooperative service | 104(3) | 147(3) | common area and cleaning | | |
| Average Per Service | | | 290 | 490 | 288 | 69 | 14% |

(1) Population served - 83
(2) Wastage assumed if minimum night flow exceeded 20% of average consumption.
(3) Not included in averages.

TABLE 4.3

WATER USE AND WASTAGE STUDY

MEDIUM USE

| Service Number | Number Of Flats | Population/Fixtures (1) | Annual Consumption cu m SCA Billed 1977 | Annual Consumption cu m Calculated 1978 | lcd 1978 | Annual Wastage (2) cu m | Annual Wastage (2) Percent |
|---|---|---|---|---|---|---|---|
| | | | El Manshia Square | | | | |
| 480 | 9 | 34/13 | 857 | 13,911 (3) | 1,120 (3) | 0 | |
| 5944 | 5 | 20/18 | 1,206 | 2,662 | 365 | 145 | |
| 5934 | 12 | 39/45 | 217 | 2,618 | 184 | 555 | |
| 4498 | 10 | 46/43 | - | 5,529 | 329 | 1,880 | |
| Average Per Service | | | 760 | 3,600 | 293 | 860 | 24% |
| | | | Kuwait Government Housing (4) | | | | |
| 10217 | 20 | 77/80 | 5,276 | 2,349 | 84 | | |
| 10214 | 20 | 75/80 | 5,276 | 1 | 121 | | |
| 10194 | 20 | 80/90 | 8,200 | 1 | 174 | | |
| Average Per Service | | | 6,250 | - | 126 | | - |
| | | | Dept. 3 Government Housing | | | | |
| 8241 | 16 | 137/80 | 10,469 | 7,840 | 157 | 1,900 | |
| 8242 | 16 | 149/80 | 5,571 | 9,362 | 172 | 1,630 | |
| 8208 | 16 | 152/74 | 7,372 | 9,896 (4) | 178 | | |
| 8243 | 16 | 130/86 | | - (5) | | | |
| 10483 | 40 plus public bath house | | 15,857 | 48,864 (3) | - | | |
| Average Per Service | | | 9,450 | 9,030 | 169 | 1,765 | 20% |
| Combined Total Average | | | 4,940 | 5,750 | 196 | 1,220 | 21% |

(1) Combined population served - 939 excluding 40 flats and bath house.
(2) Wastage assumed if minimum night flow exceeded 20% of average consumption.
(3) Not included in averages.
(4) Meters vandalized.
(5) Meter stopped 4 hours after test started.

TABLE 4.5

INDUSTRIAL WATER USE SURVEY

| Name of Industry | Product | Number of Employees | Billed Water Use(1) 1977 cu m | Water Meter Size mm | Water Meter Condition |
|---|---|---|---|---|---|
| Marinjoc | Injection molded plastics | 120 | 630 | 30 | Buried |
| Edfina | Frozen fruit, veg. and meat | 140 | 17,904 | 100 | Not found |
| Slaughter House | 3000 head per month dressed cattle | 27 | 52,252 | 100 | Operating |
| Ice Company | 3000 25 kg blocks per day | 45 | 9,591 | 60 | Damaged |
| Port Said Co. for Engineering | Ship repair | 100 | 11,703 | 100 | Operating |
| Canal Rope Co. | Rope, twine carpets | 200 | 21,100 | 30 | Operating |
| CONSUP | Water supply to ships | 50 | 457,860 | 200 | Damaged |
| Defrex "Fina" | Frozen foods | 200 | 9,092 | Fire meter | Not found |
| Gereco Freezing Co. | Frozen food storage | 15 | 9,076 | 50 | Operating |
| Egyptian Tea Co. | Tea blending and packing | 250 | 7,773 | 200 | Operating |
| Canal Naval Construction Co. | Ship building and repair | Unknown | 1,150 | 60 | Stopped |
| El Nasser Dehydration Co. | Vegetable drying | 150 | 44,507 | 40 | Stopped |
| El Nasar Salines Co. | Salt drying | 300 | 9,963 | 60 | Operating |
| Port Said Shipyard Co. | Ship building and repair | 3,000 | | Fire meter | Operating |
| Marinjoc Cold Storage | Frozen food storage | 6 | 660 | 50 | Not read since 1967 |
| Portex | Spinning, weaving and drying | 1,400 | 45,456 | 60 | Operating |
| Thick Cover | Spinning, weaving and drying | | 38,920 | 100 | Damaged |
| Egyptian Miller | Flour | 70 | 13,936 | (2) | (2) |
| Nalco | Chemical warehouse | Unknown | 7,486 | 30 | Damaged |
| NAAVCO | Auto warehouse | Unknown | 230 | 30 | Operating |
| Freon Corp. | Refrigeration servicing | 5 | 540 | 100 | Operating |
| Attard | General warehouse | 10 | 340 | 100 | Damaged |
| Ivoco | Agricultural warehouse | 0 | 300 | 100 | Damaged |
| El Nil Packing Co. | Produce Packing and Grading | 25 full-time<br>300 part-time | 0<br>2,618 | 60 | Buried |
| Industrial Gas Co. | Acetylene and oxygen | 65 | 6,455 | 40 | Operating |
| EPIXCO | Import export agricultural products | 20 | No charge | 30 | Buried |
| National Marketing Center | Food and hardware warehouse | 20 | 770 | 30 | Not found |
| Prison | Correctional institute | 600 | 15,539 | 30 | Not found |
| Electric Generating Plant | Power generation | 100 | 312 | 40 | Not found |
| | | | 400 | 25 | Operating |
| | | | | 30 | Not found |
| | | | | 30 | Not found |
| | | | | 40 | Operating |
| | | | | 60 | Operating |
| | | | | | No meter |
| | | | | 20 | Not found |
| | | | | 60 | Buried under |
| | | | | 100 | building |
| | | | | 80 | Damaged |

(1) From SCA records.
(2) Shipyard - 17 meters total (3 operating, 14 damaged).

TABLE 4.6

WATER USE AND WASTAGE STUDY

INSTITUTIONAL (GOVERNORATE AREA)

| Service Number | Number Flats | Population/ Fixtures | Annual Consumption cu m SCA Billed 1977 | Annual Consumption cu m Calculated 1978 | lcd 1978 | Ramadan Test Period Wastage cu m | Ramadan Test Period Wastage Percent |
|---|---|---|---|---|---|---|---|
| 8725 | governorate | | 27656 | 52930 | - | 41,610 | 78 |
| 8726 | governorate | | 15596 | 33554 | - | 20,248 | 60 |
| 8648 | court | | 4072 | 26724 | - | 18,980 | 71 |
| 7181 | hospital El Mebara | | 21663 | 24638 | - | | |
| 7536 | school | | 5640 | 34356 | - | | |
| 9434 | med. off. | | 18767 | 24367 | - | | |
| 2088 | apt. house | 168/140 | 11445 | 13926 | 200 | | |
| Average Per Service | | | 14980 cu m/yr | 30070 cu m/yr | | | 70% |

TABLE 4.7

PORT SAID SCHOOL WATER USE SURVEY

| School | Meter Size mm | Meter Condition | Total Staff & Students | 1977 Billed | 1978 Calculated | lcd | cu m/day (Holiday) Period | cu m/day at 1978 Rate |
|---|---|---|---|---|---|---|---|---|
| P. Said Primary School | 60 | Now stopped | Unknown | 5906 | 12350 | 57 | | |
| A. Moon School | 60 | Damaged | " | Fire Service | | | | |
| P. Said Ind. Sch. Girls | 60 | Now damaged | " | 9624 | 7500 | | | |
| El Salam Primary Sch. | 50 | Damaged | " | 12263(1) | - | | | |
| Nabil Mansour Pri. Sch. | 50 | Now damaged | " | 5814 | 5800 | | | |
| Oum El Moaminin Sch. | 50 | Operating | 600 | 10208 | 12360 | 57 | 53 | 41 |
| Boys Ind. Sec. Sch. | 100 | Damaged | Unknown | 25327 | - | | - | - |
| Ahmed Oraby Pri. Sch. | 50 | Operating | 1175 | 5014 | 8680 | 20 | 40 | 30 |
| Ashton El Gamil Pri. Sch. | 100 | Operating | 2000 | 5640 | 33990 | 47 | 111(1) | 39 |
| El Nasr Pri. Sch. | 40 | Operating | 1570 | 10305 | 6540 | 11 | 18 | 8 |
| El Zaher Pri. Sch. | 50 | Operating | Unknown | 8520 | 18130 | - | 55 | 51 |
| El Canal Prep. Sch. Girls | 50 | Operating | Unknown | 9855 | 12500 | - | 31 | 25 |
| P. Said Sec. Sch. Boys | 30 | Operating | 1750 | 12328 | 26090 | 41 | 41 | 88 |
| P. Said Sec. Sch. Boys | 50 | Operating | - | - | - | - | - | - |
| Teachers Institute | 60 | Operating | Unknown | 10004 | 11180 | - | 44 | 35 |
| Occupational Tng. Ctr. | 65 | Operating | " | 6351 | 11640 | - | 12 | 32 |
| Totals | | | | 106235 | 185190 | — | — | — |
| Average | | | | | | 35 | 38 | 41 |

(1) Not included in total or average.

TABLE 4.8

POPULATION DISTRIBUTION BY WATER DEMAND DISTRICT

| District | Water Use Level | Total Area (ha) | Population(1) 1977 | 1982 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|---|---|---|
| **Port Said (Existing)** | | | | | | | | |
| 1 | Med. | 13.9 | 2,100 | 1,300 | 0 | 0 | 0 | 0 |
| 2 | High | 20.0 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| 3 | High | 53.8 | 14,800 | 14,800 | 14,800 | 14,800 | 14,800 | 14,800 |
| 4 | High | 9.4 | 2,600 | 2,600 | 2,600 | 2,600 | 2,600 | 2,600 |
| 6 | High | 37.2 | 24,200 | 24,200 | 24,200 | 24,200 | 24,200 | 24,200 |
| 10 | Med. | 2.7 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| 12 | Low | 6.7 | 0 | 2,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| 13 | Low | 15.7 | 8,600 | 8,300 | 7,800 | 7,000 | 7,000 | 7,000 |
| 14 | Med. | 44.4 | 44,400 | 44,400 | 44,400 | 40,700 | 37,000 | 33,300 |
| 16 | Med. | 11.6 | 0 | 8,700 | 8,700 | 8,700 | 8,700 | 8,700 |
| 18 | Low | 54.1 | 81,300 | 81,300 | 81,300 | 67,700 | 54,200 | 40,600 |
| 19 | High | 30.0 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 |
| 22 | Med. | 59.4 | 41,600 | 41,600 | 41,600 | 39,600 | 37,600 | 35,600 |
| 23 | Low | 10.5 | 5,300 | 5,300 | 5,300 | 800 | 800 | 800 |
| 26 | Low | 9.0 | 4,500 | 2,700 | 0 | 0 | 0 | 0 |
| 73 | Med. | 10.6 | 0 | 6,400 | 6,400 | 6,400 | 6,400 | 6,400 |
| **Port Fouad** | | | | | | | | |
| 66 | Med. | 78.3 | 11,000 | 11,000 | 11,000 | 11,000 | 11,000 | 11,000 |
| 68 | Med. | 5.24 | 3,700 | 3,700 | 3,700 | 3,700 | 3,700 | 3,700 |
| 69 | Med. | 23.6 | 0 | 4,000 | 9,200 | 17,700 | 17,700 | 17,700 |
| **Port Said (Future Areas)** | | | | | | | | |
| South of Kuwait District | Low ) | | 0 | 19,300 | 32,800 | 40,700 | 40,700 | 40,700 |
| | Med.) | 216 | 0 | 6,900 | 23,300 | 54,300 | 54,300 | 54,300 |
| | High) | | 0 | 17,600 | 34,200 | 66,400 | 67,000 | 67,000 |
| Reclamation Area West of Manzala Canal | Low ) | | 0 | 0 | 0 | 31,000 | 37,500 | 37,500 |
| | Med.) | 167 | 0 | 0 | 0 | 2,300 | 45,200 | 50,000 |
| | High) | | 0 | 0 | 0 | 0 | 37,000 | 37,500 |
| Reclamation Area South of Junction Canal | Low ) | | 0 | 0 | 0 | 31,000 | 37,500 | 37,500 |
| | Med.) | 175 | 0 | 0 | 0 | 0 | 0 | 38,900 |
| | High) | | 0 | 0 | 0 | 0 | 0 | 42,300 |
| Kabbutti | Low | 30.0 | 12,000 | 13,320 | 14,100 | 0 | 0 | 0 |
| New Fishing Village | Low | 46.7 | 0 | 0 | 0 | 22,900 | 29,000 | 35,000 |

(1) All figures are for end of year.

TABLE 4.9

FORECAST OF WATER DEMANDS

WATER AND WASTEWATER FACILITIES MASTER PLAN

| | 1977 | 1982 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|---|
| Population | 273,000 | 339,000 | 390,000 | 487,000 | 585,000 | 684,000 |
| Demands in cu m/d | | | | | | |
| Average Day | | | | | | |
| Domestic | 41,200 | 53,800 | 64,000 | 83,900 | 106,300 | 131,000 |
| Tourism/Seasonal | 800 | 1,300 | 1,700 | 2,200 | 2,600 | 3,000 |
| Institutional | 6,800 | 8,100 | 9,400 | 12,700 | 15,600 | 22,300 |
| Industrial | 9,400 | 15,600 | 20,700 | 32,100 | 38,400 | 43,200 |
| Public Taps/Toilets | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| Gardens | 1,000 | 3,500 | 5,000 | 6,500 | 8,000 | 9,500 |
| Wastage | 10,800 | 15,000 | 15,700 | 17,300 | 18,700 | 20,000 |
| Leaks | 18,000 | 15,000 | 17,000 | 20,000 | 25,000 | 30,000 |
| Total(1) | 90,000 | 114,000 | 136,000 | 177,000 | 217,000 | 261,000 |
| Maximum Day(2) | 112,000 | 142,000 | 169,000 | 220,000 | 271,000 | 326,000 |
| Peak Hour(3) | 153,000 | 194,000 | 230,000 | 299,000 | 369,000 | 444,000 |

(1) Rounded to nearest thousand
(2) 1.25 x average day
(3) 1.7 x average day

TABLE 4.10

DOMESTIC DEMAND BY WATER DEMAND DISTRICT
(cu m/day)

| District | Water Use Level | Total Area (ha) | 1977 | 1982 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|---|---|---|
| Port Said (Existing Areas) | | | | | | | | |
| 1 | Med. | 13.9 | 360 | 220 | 0 | 0 | 0 | 0 |
| 2 | High | 20.0 | 750 | 770 | 780 | 790 | 810 | 830 |
| 3 | High | 53.8 | 3,700 | 3,780 | 3,820 | 3,400 | 3,990 | 4,070 |
| 4 | High | 9.4 | 650 | 670 | 670 | 690 | 700 | 720 |
| 6 | High | 37.2 | 6,050 | 6,170 | 6,250 | 6,370 | 6,510 | 6,670 |
| 10 | Med. | 2.7 | 340 | 350 | 360 | 370 | 380 | 390 |
| 12 | Low | 6.7 | 000 | 180 | 470 | 490 | 520 | 60 |
| 13 | Low | 15.7 | 730 | 750 | 730 | 690 | 730 | 770 |
| 14 | Med. | 44.4 | 7,500 | 7,770 | 7,910 | 7,450 | 7,000 | 6,440 |
| 16 | Med. | 11.6 | 0 | 1,160 | 1,550 | 1,600 | 1,650 | 1,700 |
| 18 | Low | 54.1 | 6,910 | 7,320 | 7,560 | 6,640 | 5,640 | 4,470 |
| 19 | High | 30.0 | 2,250 | 2,300 | 2,330 | 2,370 | 2,430 | 2,480 |
| 22 | Med. | 59.4 | 7,080 | 7,280 | 7,410 | 7,250 | 7,110 | 6,950 |
| 23 | Low | 10.5 | 450 | 480 | 500 | 80 | 90 | 90 |
| 26 | Low | 9.0 | 390 | 250 | 0 | 0 | 0 | 0 |
| 73 | Med. | 10.6 | 0 | 850 | 1,140 | 1,180 | 1,210 | 1,250 |
| Port Fouad | | | | | | | | |
| 66 | Med. | 78.3 | 1,870 | 1,930 | 1,960 | 2,020 | 2,080 | 2,150 |
| 68 | Med. | 5.24 | 630 | 650 | 660 | 680 | 700 | 730 |
| 69 | Med. | 23.6 | 0 | 780 | 1,640 | 3,240 | 3,350 | 3,460 |
| Port Said (Future Areas) | | | | | | | | |
| South of Kuwait District | Low ) | | 0 | 1,690 | 3,060 | 3,990 | 4,240 | 4,480 |
| | Med.) | 216 | 0 | 1,890 | 4,220 | 9,940 | 10,270 | 10,590 |
| | High) | | 0 | 4,620 | 8,960 | 17,470 | 18,030 | 18,430 |
| Reclamation Area West of Manzala Canal | Low ) | | 0 | 0 | 0 | 3,040 | 3,900 | 4,130 |
| | Med.) | 167 | 0 | 0 | 0 | 0 | 9,960 | 10,320 |
| | High) | | 0 | 0 | 0 | 420 | 7,980 | 9,750 |
| Reclamation Area South of Junction Canal | Low ) | | 0 | 0 | 0 | 0 | 2,460 | 5,480 |
| | Med.) | 175 | 0 | 0 | 0 | 0 | 0 | 7,590 |
| | High) | | 0 | 0 | 0 | 0 | 0 | 11,640 |
| Kabbutti | Low | 30.0 | 1,020 | 1,200 | 1,340 | 0 | 0 | 0 |
| New Fishing Village | Low | 46.7 | 0 | 0 | 0 | 2,820 | 3,750 | 4,730 |

TABLE 4.11

INSTITUTIONAL DEMAND BY WATER DEMAND DISTRICT
(cu m/day)

| District | Area Ha | 1977 | 1982 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|---|---|
| Port Said (Existing Areas) | | | | | | | |
| 5 | 33.1 | 2410 | 2610 | 2810 | 2810 | 2810 | 2810(1) |
| 7 | 1.2 | 100 | 100 | 100 | 100 | 100 | 100 |
| 8 | 7.0 | 600 | 600 | 600 | 600 | 600 | 600 |
| 9 | 8.3 | 710 | 710 | 710 | 710 | 710 | 710 |
| 15 | 3.1 | 260 | 260 | 260 | 260 | 260 | 260 |
| 17 | 1.3 | 110 | 110 | 110 | 110 | 110 | 110 |
| 20 | 21.3 | 1810 | 1810 | 1810 | 1810 | 1810 | 1810 |
| 24 | 4.2 | 360 | 360 | 360 | 360 | 360 | 360 |
| 25 | 3.0 | 260 | 260 | 260 | 260 | 260 | 260 |
| 37 | 2.0 | 170 | 170 | 170 | 170 | 170 | 170 |
| Port Said (New Areas) | | | | | | | |
| South of Kuwait | | | | | | | |
| 37 | 14.0 | 0 | 1100 | 1190 | 1190 | 1190 | 1190 |
| 40 | 7.0 | 0 | 0 | 600 | 600 | 600 | 600 |
| 44 | 14.0 | 0 | 0 | 470 | 1190 | 1190 | 1190 |
| 48 | 12.5 | 0 | 0 | 0 | 1000 | 1000 | 1000 |
| West of Manzala Canal | | | | | | | |
| 28 | 14.0 | 0 | 0 | 0 | 850 | 1190 | 1190 |
| 32 | 18.0 | 0 | 0 | 0 | 0 | 1530 | 1530 |
| 35 | 5.0 | 0 | 0 | 0 | 0 | 300 | 430 |
| South of Junction Canal | | | | | | | |
| 53 | 7.5 | 0 | 0 | 0 | 0 | 590 | 640 |
| 56 | 66.0 | 0 | 0 | 0 | 0 | 0 | 5610(2) |
| 59 | 7.5 | 0 | 0 | 0 | 0 | 0 | 640 |
| Port Fouad (Existing Areas) | | | | | | | |
| 67 | 10.0 | 850 | 850 | 850 | 850 | 850 | 850 |
| Port Fouad (Future Areas) | | | | | | | |
| 76 | 1.2 | 0 | 100 | 100 | 100 | 100 | 100 |
| 77 | 4.7 | 0 | 70 | 190 | 400 | 400 | 400 |
| Tourism Complex at Airport | | 0 | 200 | 500 | 1000 | 1400 | 1800(3) |
| New Fishing Village | | 0 | 0 | 0 | 570 | 730 | 880 |

(1) District 5 demand estimates include demands of existing and proposed tourism facilities. All demands were assumed to equal 85 cu m/ha, the same as for existing institutional facilities.
(2) District 56 demand estimates include demands of proposed commercial, governmental and recreational facilities.
(3) Extended stay business tourism which could not be accommodated near Suez Canal breakwater was included with facilities proposed for long-term development in the airport area. The extended stay demands originally proposed in the PSMP were increased 25% to supply needs of long-term facilities through the year 2000.

TABLE 4.12

INDUSTRIAL DEMAND BY WATER DEMAND DISTRICT
(cu m/day)

| District | Water Use cu m/ha | Total Area ha | Demand cu m/d 1977 | 1982 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|---|---|---|
| Port Said (Existing) | | | | | | | | |
| District | | | | | | | | |
| 31 | 108 | 8 | 864 | 864 | 864 | 864 | 0 | 0 |
| 51 | 108 | 32 | 3456 | 3456 | 3456 | 3456 | 3456 | 3456 |
| 63 | 108 | 18 | 0 | 0 | 0 | 0 | 864 | 864 |
| Port Said (Future) | | | | | | | | |
| District | | | | | | | | |
| 64 | 70 | 13 | 910 | 910 | 910 | 910 | 910 | 910 |
| 63 | 70 | 198.5 | 0 | 5320 | 9450 | 13370 | 14759 | 14759 |
| 62 | 70 | 89.3 | 0 | 0 | 0 | 3080 | 4144 | 6251 |
| 50 | 70 | 4.5 | 0 | 0 | 0 | 315 | 315 | 315 |
| 49 | 70 | 35.5 | 0 | 0 | 0 | 2485 | 2485 | 2485 |
| 30 | 70 | 8.3 | 0 | 0 | 0 | 581 | 581 | 581 |
| 27 | 70 | 40.3 | 0 | 0 | 0 | 0 | 2821 | 2821 |
| 60 | 70 | 11 | 0 | 0 | 0 | 0 | 0 | 770 |
| 65 (Shipyard) | | | 2500 | 2900 | 3300 | 4100 | 5600 | 7100 |
| 72 (Port) | | | 1700 | 2100 | 2400 | 3000 | 3350 | 3800 |

APRIL 24/25, 1978

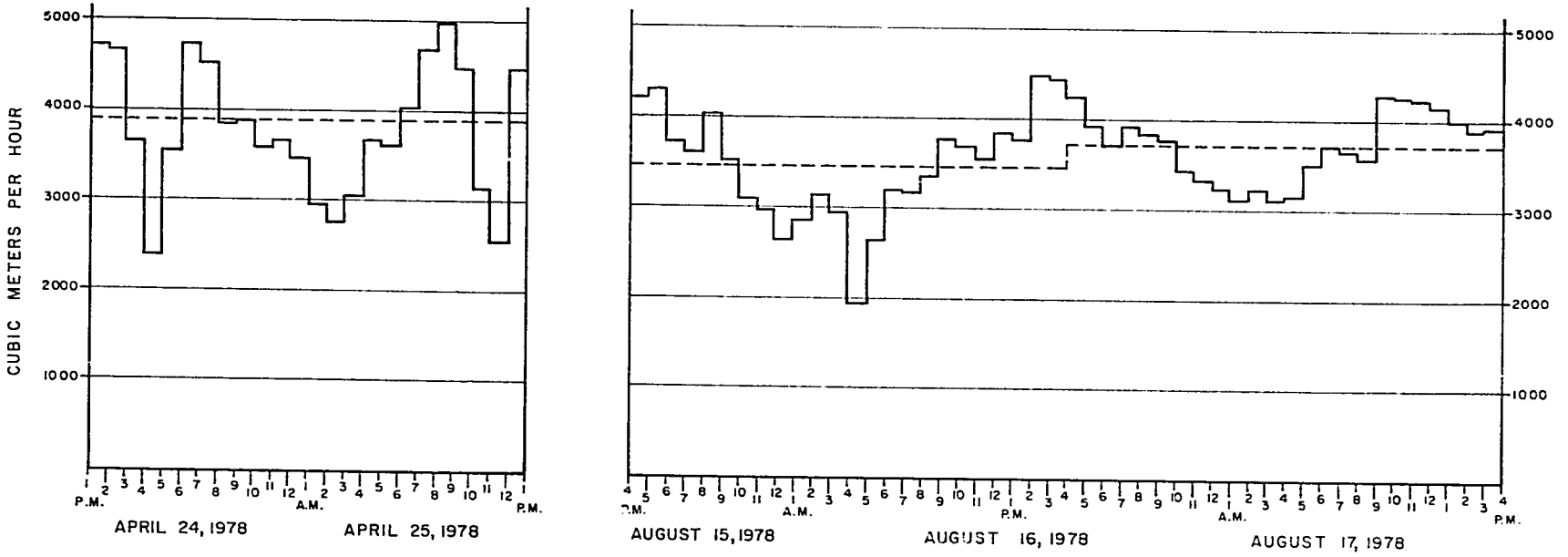
| | |
|---|---|
| MAXIMUM | 4,500 Cu. m. / hr. |
| AVERAGE | 3,840 Cu. m. / hr. |
| MINIMUM | 2,565 Cu. m. / hr. |
| TOTAL | 92,000 Cu. m. / day |

AUGUST 15/16, 1978

| | |
|---|---|
| MAXIMUM | 4,475 Cu. m. / hr. |
| AVERAGE | 3,440 Cu. m. / hr. |
| MINIMUM | 1,920 Cu. m. / hr. |
| TOTAL | 82,550 Cu. m. / day |

AUGUST 16/17, 1978

| | |
|---|---|
| MAXIMUM | 4,280 Cu. m. / hr. |
| AVERAGE | 3,730 Cu. m. / hr. |
| MINIMUM | 3,130 Cu. m. / hr. |
| TOTAL | 89,480 Cu. m. / day |

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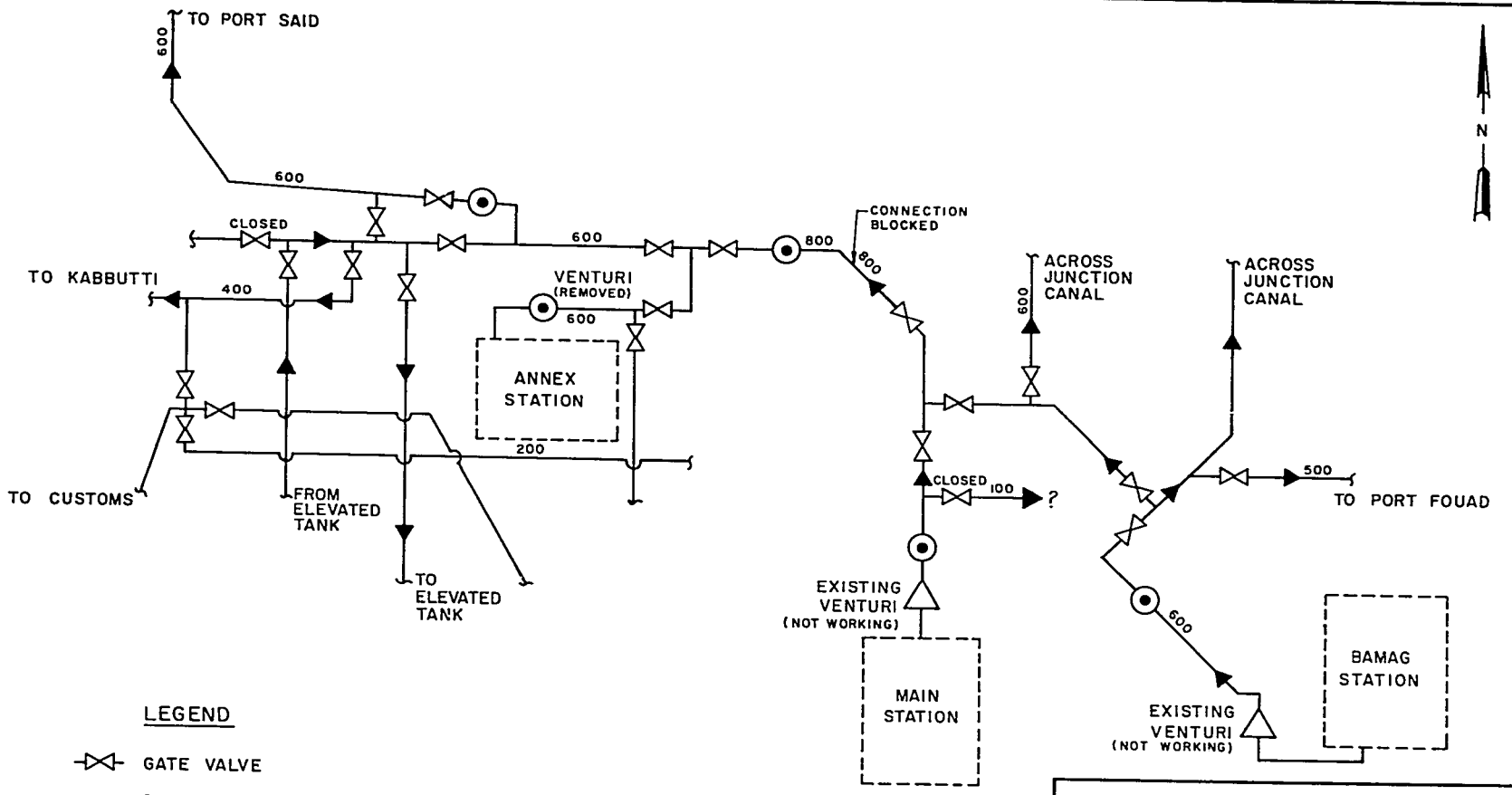
PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

EL RASWA PLANT
WATER DISCHARGE (1978)

VOL.2
FIG.
4-A

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NOT TO SCALE

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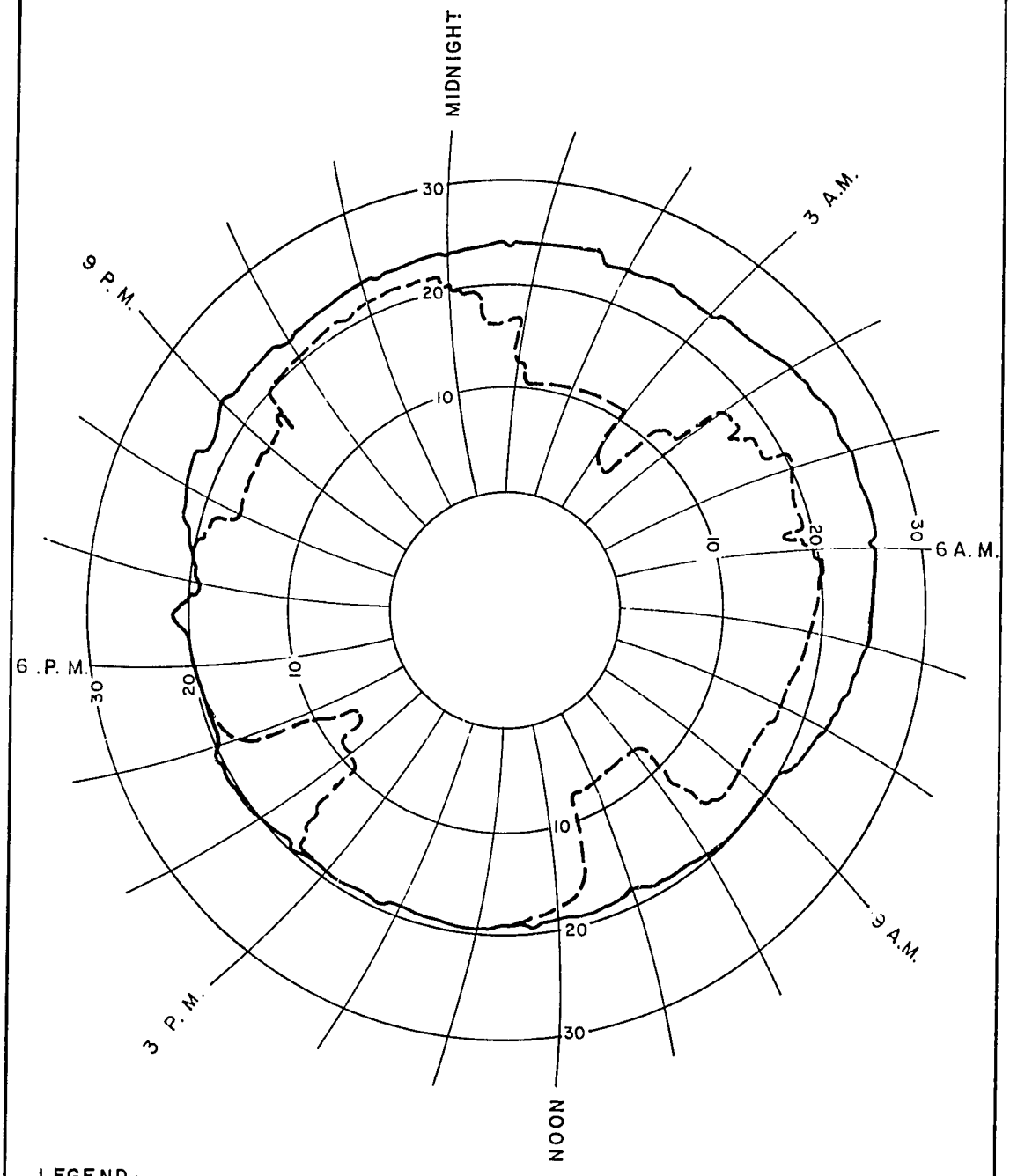
PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

LOCATION OF PITOMETERS AT EL RASWA

VOL.2 FIG. 4-B




LEGEND:

AFTER ISOLATION OF LEAKING SIPHON.
( AUGUST 27, 1978 )

PRIOR TO ISOLATION
( JUNE 25, 1978 )

-10- PRESSURE-m ABOVE GROUND
AT 11 IBRAHIM STREET.
(Ground Elevation 2m ± Above Sea Level)

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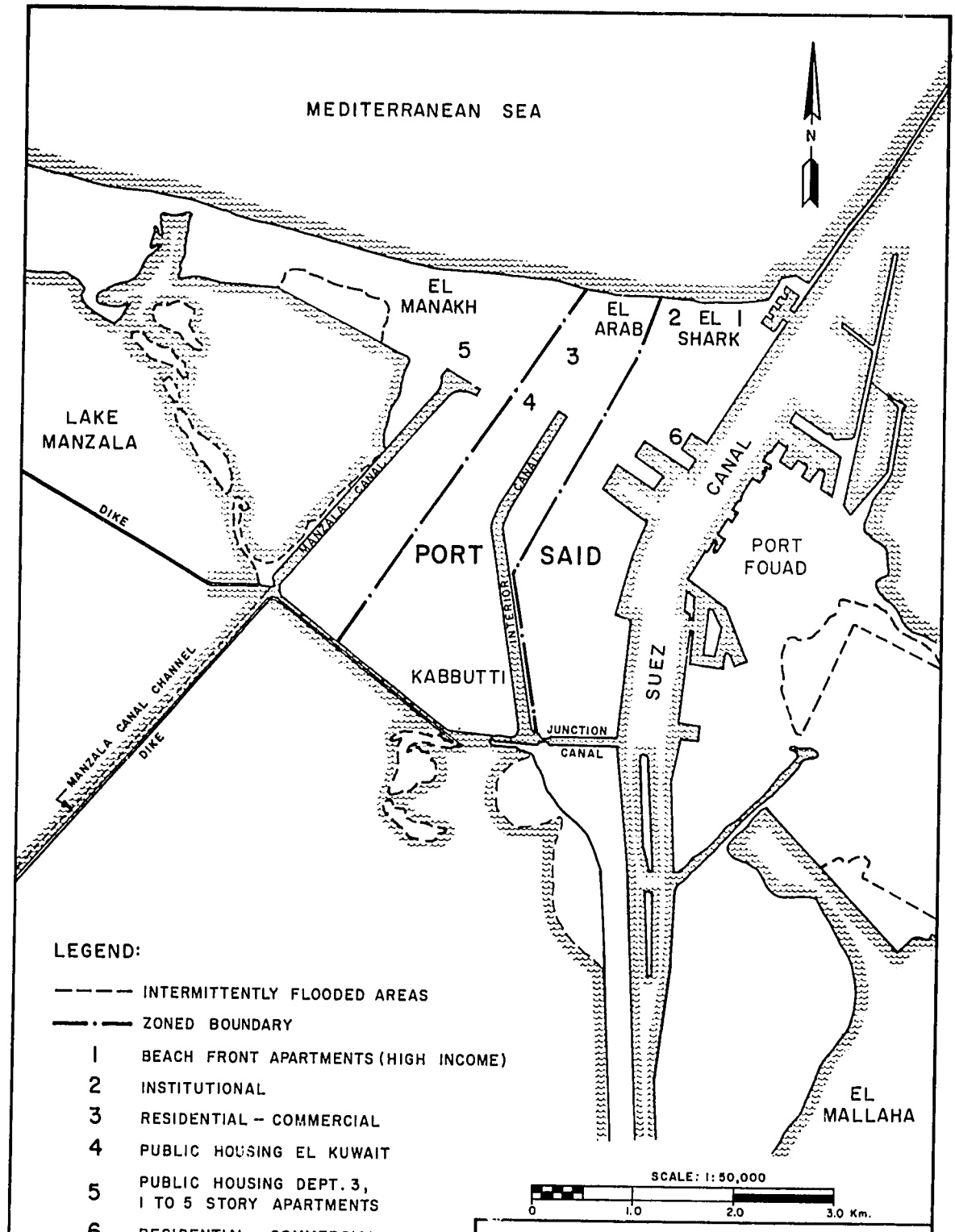
PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

SYSTEM PRESSURE
PORT SAID

VOL.2
FIG.
4-C

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**WATER USE SAMPLING LOCATIONS**

VOL. 2
FIG.
4-D

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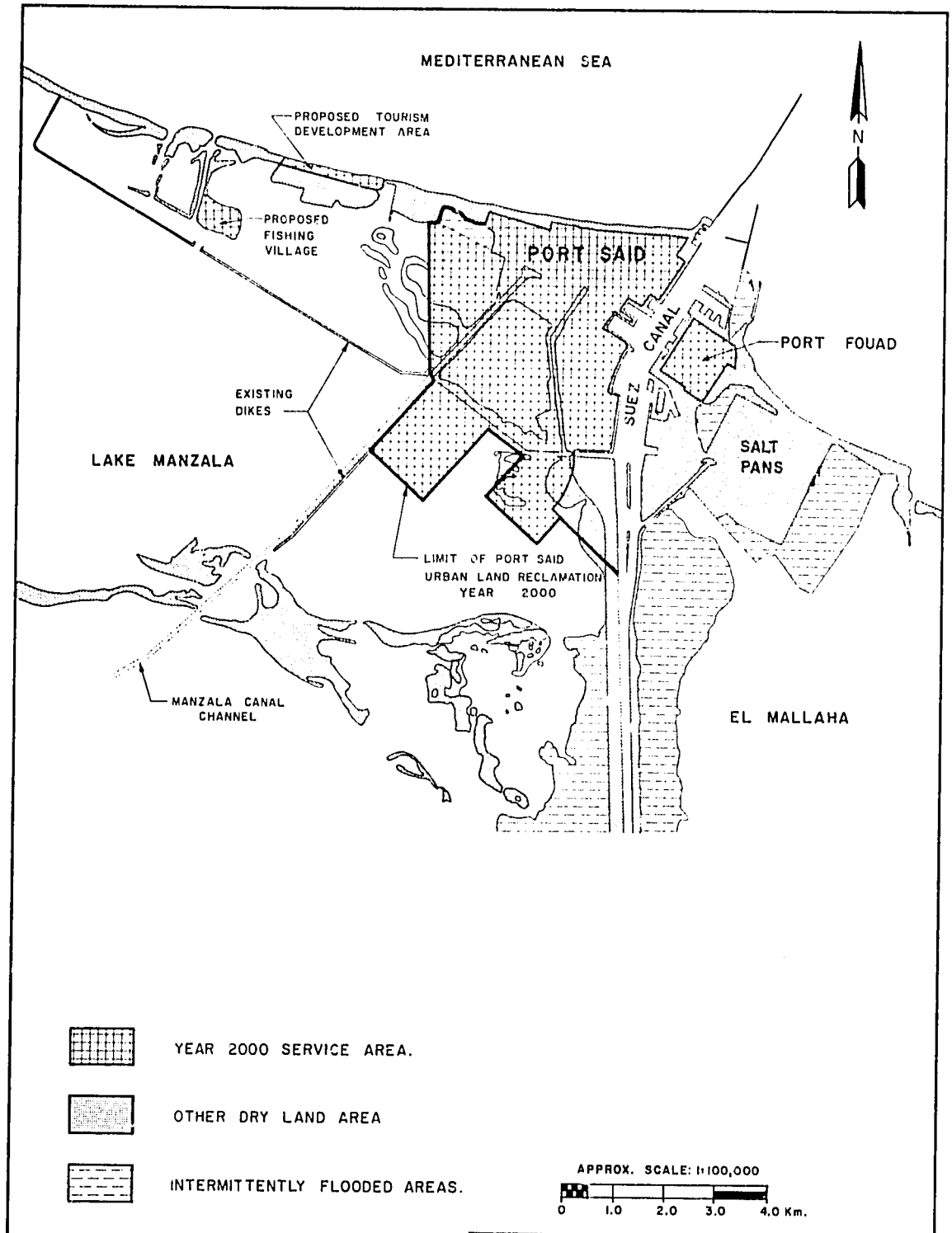


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PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

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YEAR 2000 SERVICE AREA

VOL.2
FIG.
4-E

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# CHAPTER 5

# BASIS OF FEASIBILITY STUDIES

Developing effective recommendations for improvement of the Port Said water system required carefully conducted feasibility studies. These were used to screen alternatives and to establish the technical, financial and economic soundness of the recommended program, so that interested national, international and local agencies may evaluate the program. This chapter reviews the basic methodology and information used in the feasibility studies.

## 5.1 WATER QUALITY STANDARDS

The overall quality goal of the water system is to provide a safe and potable water, free from pathogenic organisms and toxic substances. With proper treatment, safe finished water can be produced even from a poor raw water. Good raw water quality is preferable, however, to minimize complexity and cost of treatment and to reduce risks from any treatment lapses. Appropriate raw water standards are discussed in Section 6.1, "Raw Water Quality". Finished water standards are considered in Section 7.1.

## 5.2 TECHNICAL FEASIBILITY ELEMENTS

Under the WWFMP scope, program elements are considered technically sound if: 1) all pertinent technical aspects have been considered; 2) the projects conform to accepted engineering standards; and 3) the projects are cost effective in relation to reasonable alternatives.

Analysis of technical feasibility involved comprehensive review of:

- Design criteria (see Section 5.5, below and Appendix A)
- Construction and operating cost information (Section 5.6 and 5.7, below and Appendix B)
- Capacity, location and characteristics of major facilities, as related to service requirements and justified in relation to available alternatives (Chapters 6 through 8)
- Investigations, surveys, and preliminary engineering sufficient to eliminate foreseeable critical problems in final design and construction (Chapters 6 through 8)
- Conceptual plans adequate for reasonably firm cost estimates (Chapters 6 through 8)
- Operational aspects, including organization, staffing and training (Chapter 10)
- Project execution, including methods of construction, practical schedules, availability of skilled personnel, adequate materials, equipment and services (Chapter 11)
- Environmental effects (Chapter 13)



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## 5.3 FINANCING

### Present Situation

The Suez Canal Authority (SCA) owns, operates and maintains the El Raswa water treatment facilities and the water distribution system. Most capital expenditures come from the SCA budget as approved by the National Government. In recent years the Governorate of Port Said (GOPS) has contributed to certain water system capital projects.

Revenues derived from water sales cover less than half the operating expenses of the water system at Port Said. The SCA makes up the deficit from other funds. To put present operations of the water system on a self-sufficient basis would require substantially higher water rates.

### Financial Feasibility

The WWFMP scope requires that, for each stage of development, revenues be sufficient to cover fixed charges, amortization, maintenance and operating costs, and a return on investment of not less than six percent. For the WWFMP, it is assumed that loan interest is equivalent to return on investment. Revenues and water charges to meet these requirements were determined as set forth in Chapter 12. Also presented in Chapter 12 are pro forma financial statements through the year 2000, including balance sheets, income statements, and source and application of funds statements.

### Funding

USAID intends to fund major foreign exchange needs for the High Priority Projects of the WWFMP. Local capital costs would be funded through appropriate agencies of the A.R.E. Sources of funding for further projects is undetermined at this time.

The analysis of user charge financing in Chapter 12 is based on constant value (1978) Egyptian Pounds (LE). This permits year-to-year comparison of costs or revenues and simplifies relating user charges to household income (see Section 5.4, below). However, since actual funding must cover inflation, Chapter 12 also projects funding needs through 1985 based on expected escalation of capital and operating costs. In addition, the accumulated deficit is estimated should rates be increased from present levels to cover just inflation, rather than to make the water system self-financing. In the absence of adequate user charges, funding will be needed to cover both capital programs and operating deficits.

## 5.4 ECONOMIC SOUNDNESS

The WWFMP scope calls for determining economic soundness based on an internal rate of return which is "adequate and significantly higher than ... other technically feasible alternatives". Internal rate of return is defined as that value of the discount rate which will make the present worth of benefits and costs equal.

Benefits of the recommended program accrue principally to the users of the water system. These benefits cannot be quantified with meaning beyond the extent that they are 'captured' in the form of user charges to support the system. Hence the economic evaluation in Chapter 13 focuses on whether user charge financing is possible. It does not attempt to calculate internal rate of return based on theoretical or arbitrary benefit values. The recommended program is tested for cost effectiveness. If it also can be financed by

user charges, with a six percent return on capital, presumably the scope intent as to economic soundness would be met.

## 5.5 FACILITIES DESIGN CRITERIA

Criteria for functional design of water treatment, water distribution and electrical facilities, and for design of foundations, are presented in Appendix A. These criteria are sufficiently detailed for direct application to the final design of water system facilities. Key functional elements are discussed in Chapters 7 and 8.

## 5.6 CAPITAL COST ESTIMATES

The basis established for estimating capital costs of projects and project elements in the WWFMP is presented in Appendix B. Information on basic labor and material costs, unit construction costs, and cost curves for principal elements, was obtained from government agencies, local construction contractors, engineering firms, material and equipment suppliers, and other ACR consultants. Appropriate adjustments were made for Port Said conditions.

Cost estimates reflect the impact of physical factors (climate, soils, groundwater, traffic congestion, conflict with existing utilities) and economic factors (contractors' capabilities, skilled labor availability, quality of workmanship and availability of materials).

Most of the basic construction materials required are manufactured locally, but there are chronic shortages of cement, reinforcing bars, and structural steel. To avoid delays, these items will likely have to be imported. Project costs allow for this but are not high enough to cover supplying these materials from U.S. sources.

Ductile iron piping and fittings, and almost all electrical and mechanical equipment, will also have to be imported. Costs for these are based on U.S. origin.

For guidance in project selection and determination of financing needs, costs are divided into local and foreign exchange components, as detailed in Appendix B. Foreign exchange needs related to use of imported cement, reinforcing bars and structural steel are identified separately.

Cost curves reflect commercial prices, excluding duties on imported equipment and material. It is assumed that financing of foreign exchange components would come from agencies outside Egypt and that these agencies would object to imposition of such duties. Curves do not allow for demurrage or construction delays due to hold up of project items by customs.

It is absolutely essential that the national agencies responsible for project construction obtain specific prior agreement of top level customs officials that will avoid delays and haggling over duty free entry of project materials once construction is underway.

## 5.7 OPERATING COST ESTIMATES

For use in cost comparisons and financial projections, operating costs were calculated in constant value (1978 level) LE.

Operation and maintenance budgets for 1976 and 1977 were obtained from the SCA (Table 5.1). These were analyzed to determine outlays for personnel, electricity (SCA

generation), fuel (for vehicles), chemicals and miscellaneous costs, chiefly parts and materials used in maintenance.

Future annual operating costs were projected as follows:

- Personnel costs were based on the staffing and compensation levels recommended in Chapter 10.

- Electrical cost estimates were based on energy needs of 78,000 KWH/1000 cu m of production, assuming power purchased from the Egyptian Electricity Authority (EEA) (see Chapter 7). Energy requirements were based on a total lift of 50 m for raw and finished water pumping, with an added allowance of 10% for backwash pumping, auxiliaries and lighting. Rates were determined on the basis of an installed transformer capacity of 4,000 KW, using the EEA schedule in Table 5.2.

- Chemical costs were estimated at LE 1,130/1000 cu m of production, based on outlays for recent operations.

- Costs for other materials and services were estimated on the bases shown in Table 5.3. Resulting allowances are well above current levels of expenditure, reflecting levels needed for adequate upkeep of the system.

## 5.8 COST EFFECTIVENESS

Where significantly different alternative project elements could meet particular WWFMP goals, cost effectiveness studies were performed to aid in selection.

Significant alternatives were identified for meeting long term needs for raw water and for distribution system storage (Chapters 6 and 8). Comparisons were based on present worth, taking into account capital outlays, including construction costs; operation and maintenance costs, calculated as outlined in Section 5.7; costs for replacement of project components during the evaluation period (through the year 2000); and salvage value of facilities at the end of this period. Inflation effects were not included.

For comparison of alternatives a discount rate of 10 percent was used. Sensitivity analyses were made of the effect of higher and lower discount rates for critical selections. "Shadow pricing" of cost elements was performed where shadow price ratios differed greatly from 1.0, with replacement schedules and salvage based on the useful life figures indicated below (see Section 5.9).

## 5.9 SHADOW PRICING

Shadow pricing is an attempt to determine the real cost (or benefit) to the national economy of goods and services, the market price of which reflects serious distortions due to government subsidies, government imposed wages and prices, foreign exchange restrictions and import duties.

The consultants for the Greater Cairo and Helwan Wastewater Studies made extensive analyses to determine shadow to market price ratios for expected cost elements of their projects. For the Port Said WWFMP project a review was made of these 1977 reports and the following conclusions were drawn:

- Key elements in shadow price calculations, particularly shadow price ratios for skilled and unskilled labor, are highly judgmental.

- Shadow price ratios for materials in the two reports agree quite closely.

- Shadow price ratios of the largest project cost elements (e.g., concrete, piping) have the highest impact on cost comparisons.

- Locally produced materials of importance to project costs (cement, reinforcing steel, piping) are generally underpriced, with shadow price ratios up to 1.5.

- Shadow prices of imported items primarily reflect customs duties.

- Electrical energy has a shadow price ratio of over 3, indicating that it is being sold at a small fraction of the marginal cost of generating and distributing additional amounts.

In an effort to bring shadow price ratios closer to unity, commercial prices estimated for the Port Said WWFMP reflect these factors:

- Customs duties are not included.

- International rather than local market prices of cement and reinforcing steel were used since it is not certain that adequate local supplies will be available.

Comparison studies for the WWFMP did not use an elaborate set of shadow price ratios. Instead, comparisons were based on market prices and tested if the conclusions were altered by applying shadow price ratios (in the general range indicated in the Greater Cairo and Helwan studies) to important cost elements such as concrete, piping materials and electrical energy. This use of shadow pricing was limited to cost elements for which shadow price ratios are not highly judgmental.

Application of shadow prices did not significantly alter the present worth comparisons nor did it affect the final recommendations.



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TABLE 5.1

RECENT ANNUAL OPERATING COSTS (LE) - SUEZ CANAL AUTHORITY

PORT SAID WATER SYSTEM

| | 1976 | 1977 |
|---|---|---|
| Labor | 65,000 | 94,700 |
| Electricity | 69,500 | 68,200 |
| Fuel | 200 | 600 |
| Chemicals | 98,700 | 99,500 |
| Miscellaneous | 136,200 | 215,600 |
| TOTAL | 369,600 | 478,600 |

TABLE 5.2

ELECTRICITY TARIFF

EGYPTIAN ELECTRICITY AUTHORITY
(January 1, 1978)

A. Energy on Extra High Voltages

1) At 220 and 132 KV 5.072 milliemes/KWH
2) At 66 and 33 KV 6.464 milliemes/KWH

B. Energy Supplied for Motive Power

1) For connected loads of 500 KW and above, fed at the intermediate voltage, the annual rate is LE 5.620/KW connected, plus energy charges with steps based on connected load as follows:

| Step in KWH | Rate in Milliemes/KWH |
|---|---|
| 1st 1000 hr x connected load(1) | 10.103 |
| next 500 " x " " | 9.503 |
| next 1000 " x " " | 8.303 |
| next 1000 " x " " | 7.103 |
| next 1500 " x " " | 5.403 |
| Remaining KWH | 4.603 |

2) For connected loads of 8 to 500 KW, there is no charge for connection KW. The energy charge is:

| Step in KWH | Rate in Milliemes/KWH |
|---|---|
| 1st 7,000 per yr | 20.347 |
| Next 100,000 per yr | 16.697 |
| Above 107,000 per yr | 15.847 |

(1) e.g., for connected load of 1000 KW this rate step applies to first 1,000,000 KWH per yr.

TABLE 5.3

WATER FACILITIES

BASIS FOR ANNUAL MATERIALS AND SERVICE COSTS(1)

| Water Facilities Categories | Basis(2) |
|---|---|
| Civil Works | 1% of Capital Cost |
| Mechanical Equipment(3) | 4% of Capital Cost |
| Distribution Lines & Service Connections | 0.75% of Installed Cost |
| Canal (Lined) | LE 300/km of Canal |
| Vehicles and Construction Equipment(4) | LE 1200/unit |

(1) Material costs include spare and replacement parts and consumables such as grease, packing, paint. Also included are allowances for materials used in major repairs such as repairs of water main breaks.
(2) Capital cost includes installation where applicable, but excludes contingencies and support services.
(3) Including water meters.
(4) Including fuel for operation.

## 6.1 PRESENT SOURCE

### Background

Fresh water for the early settlers at Port Said reportedly was hauled overland from the Nile River at Damietta. It has also been reported that sea water distillation was attempted with coal fired boilers.

However, the first sizeable supply of water for Port Said was obtained from the Nile by canal in 1862. The Compagnie Universelle du Canal Maritime de Suez, under its concession from the Egyptian government, built a fresh water canal from the Nile at Cairo to Lake Timsah (Ismailia). Branches paralleled the maritime canal to Suez and to Palusian, the first proposed northern terminus of the Suez Canal, 30 km east of Port Said. By the end of 1862, the canal had been completed to Timsah, with a narrow channel to Port Said. The supply to Port Said was improved in 1864 by the installation of two iron pipes between Timsah and Port Said. Not until 1885, 16 years after the Suez Canal was opened to shipping, was the Port Said water supply canal built.

Today the canal between Cairo and Ismailia, greatly enlarged and designated the Ismailia Canal, provides water for the cities of Ismailia, Suez, and Port Said, and supplies irrigation water for 136,000 ha in the eastern delta area and along the Suez Canal. The Port Said Canal (PSC) carries the Nile River water northward from the Ismailia Canal 77 km to a terminus at El Raswa Water Treatment Plant (see Figure 6-A).

### Water Supply Requirements

Flow from the Nile into the Ismailia Canal ranges seasonally from 8,500,000 cu m/day to 11,000,000 cu m/day. Present potable water demands for the three canal cities total approximately 185,000 cu m/day, or 2 per cent of the canal flow. The average potable water demand at Port Said is expected to reach 114,000 cu m/d in 1982 and climb to 261,000 cu m/d by the year 2000, with maximum day demands projected at 142,000 cu m/d for 1982 and 326,000 cu m/d in 2000 (Table 4.9).

For the first 31 km from the Ismailia Canal turnout, the PSC serves the irrigation needs of approximately 12,600 ha of agricultural land. The final 46 km section (Figure 6-B) is designated specifically to meet water supply requirements of Port Said.

### Canal Capacity

Design capacity of the final 46 km section of the PSC is reported as 270,000 cu m/d. Reduced to less than 70,000 cu m/d by war damage in 1973, the capacity was raised thereafter to about 120,000 cu m/d. Plans by the Ministry of Irrigation (MOI) to increase the capacity still further in 1976 were abandoned because restoration of the railroad adjacent to the the canal took the only suitable location. Depending upon freeboard criteria adopted, the canal can deliver 90,000 to 125,000 cu m/day to Port Said, sufficient to supply the current potable water demands.

Transmission Problems

Aquatic plant growth, canal section irregularities and structural constrictions reduce the canal's ability to convey water. Further limitations on the canal's delivery of water to Port Said are imposed by choice. Despite designation of the canal's final 46 km section for Port Said's water needs, some water is diverted from this section for El Qantara water supply, for irrigation, and for leaching salt from land west of the canal to be reclaimed for farming.

Canal Surveys

Difficulties and delays stemming from Suez Canal Authority (SCA) and military security regulations hindered field investigations and surveys of the PSC. Nonetheless, collection of field data and conversation with SCA officials permitted a preliminary assessment of the present situation and consideration of corrective alternatives. In addition to inspection of the canal at many points, field work included limited topographic surveys, 30 cross sections of the canal, water level measurements, and gaging of the canal flow. Although additional field work and study will be necessary, the following observations were made:

(a) Withdrawals - At El Qantara, 1000 cu m/d are withdrawn for public water supply. North of El Qantara, at 11 controlled irrigation withdrawals between km 41 and 33, each of the gated diversions can draw 200 cu m over a 6 hour withdrawal with a 30 cm opening. The quantity of water taken through uncontrolled drawoffs is not known.

(b) Headloss - Between km 41 and 33, normal friction accounts for 20 cm of 50 cm headloss. The balance can be attributed to canal bottom irregularities, bridge abutments, culverts and other constrictions in this reach. From El Qantara to Port Said the canal has an overall Manning's "n" of 0.05, compared to 0.025 as originally designed.

(c) Water Loss - Canal flow dropped from 155,000 cu m/d above El Qantara to 88,000 cu m/d at El Raswa, indicating an overall loss of 67,000 cu m/d, divided approximately as follows: withdrawals 18,000 cu m/d; evaporation and phreatic plant losses 6,000 cu m/d; and seepage 40,000 cu m/d.

(d) Seepage - Although a number of spots along the canal were cited as potential sources of leakage, no dye measurements or other investigations were made to verify this. Isolation of the principal causes of seepage may be difficult, requiring precise gaging of the canal flow and water level measurements at frequent intervals. These surveys could not be carried out in the time available.

(e) Sealing - It is reported that the canal, when first built, was lined with clay through sections of porous ground likely to cause seepage. Enlargement, repair of canal, construction of bridges and culverts, and other projects have probably moved much of the clay and destroyed the seal in many places.

Furthermore, natural sealing by clay and silt deposited during Nile River floods is no longer available.

(f) Embankments - The capacity of the canal is limited not only by the supply at the Rayah barrage, but also by low spots in the canal embankments at many

places. Some of these low spots can be raised with earth fill; others may require retaining walls of poured concrete or precast blocks. The canal cannot be widened because this would flood the railroad tracks and the SCA highway. Deepening the canal would increase the hazard of salt water intrusion from the Suez Canal and destroy what seal against seepage is still intact.

Operation and Maintenance

Coordination is unsatisfactory between El Raswa WTP operators and MOI personnel responsible for release at the Rayah control barrage. Occasionally, releases fail to satisfy both potable and irrigation needs, and lower the water level at El Raswa. This forces curtailment of water production and consequent water shortages at Port Said.

Maintenance of the PSC is minimal except for periodic cutting of weeds, occasional embankment repair, and treating with Magnacide H, a toxic herbicide specifically prohibited in the United States for use on water supply sources. Acrolein, the active ingredient of Magnacide H, is 10 to 100 times more toxic than herbicides commonly used in weed control. MOI has proposed to test the use of fish to inhibit weed growth, but the results are not known.

Raw Water Quality

Pollution of the Nile River and the Ismailia Canal by untreated sewage and industrial wastes from the Cario metropolitan area is a potential hazard to the public water supply of Cairo, Port Said, Ismailia and Suez . Egyptian law prohibits the discharge of sewage into the Nile. Most of Cairo's sewage is discharged to drains, such as the Bahr El Bakr drain. For users of Nile water from the Ismailia Canal, the greatest danger lies in potential industrial waste discharges into the canal, in the vicinity of Cairo or along the route to Ismailia. These discharges may contribute heavy metals, phenols, hydrocarbons and other toxic substances which are difficult if not impossible to remove by conventional water treatment. For example, the Ismailia Canal receives water from the El Mahsama drain, which parallels the canal upstream of Ismailia and may carry harmful pesticides. The quality of this drain water should be monitored regularly. If found toxic, discharge of this water into the Ismailia Canal should be prohibited.

Analyses of raw water at El Raswa are shown in Table 6.1. The levels of pollutants and heavy metals meet the water quality criteria sought, except as to phenols. The phenols apparently are due to the discharge of oil and other petroleum products from ships and industry at Cairo and from barges using the Ismailia Canal. For comparative purposes, Nile River water quality at Cairo reported by ES-Parsons is included in Table 6.1. Water quality at Cairo is approximately the same as at El Raswa, indicating that little change occurs during travel through the Ismailia and Port Said Canals. The drop in coliforms between Cairo and Port Said reflects the natural die off of the organisms.

Although "safe" water can be produced from a surface source of supply contaminated by sewage or chemical wastewaters, the treatment necessary may be difficult and expensive. Furthermore, with poor raw water, even a momentary lapse of proper treatment may cause serious illness and epidemics. For this reason, many water supply control agencies have adopted maximum raw water limitations as follows:

Raw Water Supply

| Parameter | Raw Water Limits |
|---|---|
| Color | 100 color units |
| Turbidity | 500 NTU |
| Taste and Odor | Minimal |
| pH range | 3 to 10 |
| Iron | 5 mg/l |
| Total Coliform | 100,000 MPN/100 ml |

Raw water from the River Nile and Ismailia Canal presently meets these standards. However, measures are needed to prevent upstream pollution.

## 6.2 ALTERNATIVE SOURCES

### Surface

Possible surface water sources for Port Said other than the Ismailia Canal are:

- Desalination - This alternative is impractical because of prohibitive capital and operating costs.

- Bahr El Bakr Drain - The drain conveys sewage effluent, agricultural drainage and industrial wastes. It cannot be considered as a suitable source of potable water supply.

- Damietta Branch of the Nile - Piping water from this source, whether by a direct route across Lake Manzala (55 km) or by a coastal route (75 km), would involve large pipe line construction costs, large friction losses, and heavy power costs for pumping.

### Subsurface

Groundwater sampled at Port Said and Port Fouad in May, 1978, showed variable but high quantities of minerals, with chlorides ranging from 700 to well over 20,000 mg/l (see Table 6.2 and Figure 6-D). With water of good quality available from the Ismailia and Port Said Canals, there was no incentive to drill wells at Port Said until 1967, when war damage reduced the water output. A number of wells were drilled and used temporarily for fire fighting. The yield was low and the water so mineralized as to be unfit for domestic and other purposes. No groundwater is presently used at Port Said.

Development of groundwater has been suggested in the vicinity of the Bahr El Bakr drain, upstream from its entrance to Lake Manzala. Elevations are close to sea level, and the groundwater lies close to the ground surface. Seepage from the drain into the underlying soil takes place; natural filtration and biological action in this soil would remove organic and pathogenic material, but not inorganic matter. Officials of the MOI, SCA, and the Groundwater Institute, questioned about the feasibility of such a supply, agreed that the water is too saline for normal purposes, and that the evaporation of ponded water outweighs the input of fresh water used for irrigation. Wells drilled in the area by the Institute were for water level and salinity tests only. Even if water of marginal quality could be obtained for emergency use or irrigation, it is clear that sustained pumping would cause intrusion of polluted or saline water. The yield would be small.



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## 6.3 NON-POTABLE WATER SUPPLIES

The feasibility of a non-potable water system to supplement the Port Said supply has been examined. Groundwater, highly mineralized and generally in short supply, would be unsuitable or inadequate for agriculture and most industries. Local surface water, with total dissolved solids ranging from 2800 mg/l in Lake Manzala to sea water salinities, would have few, if any, practical uses.

A non-potable raw water supply from the PSC, bypassing the El Raswa WTP, could be used for parks, gardens, and some industries. However, savings in water treatment expense would be more than offset by transmission and distribution costs. More important would be the hazard to public health from cross connections between raw and filtered water systems.

Non-potable needs of specific new industries can best be met by placing industrial facilities where they can be served directly from the Port Said Canal, or from other more saline sources if such water is suitable.

## 6.4 MINISTRY OF IRRIGATION PROGRAM - NEW CANAL

The preceding canvass of potential water resources shows that the Ismailia Canal is much the best and, in fact, the only practical source of supply for Port Said. Steps to increase the quantity of raw water delivered to El Raswa are imperative.

The Ministry of Irrigation has developed a two-stage program to increase water available for irrigation, municipal and industrial use in the Suez Canal Region. Reported allocations for municipal and industrial use in Port Said are 215,000 cu m/d in the first stage and 750,000 cu m/d in the second stage.

The First Stage, planned for completion by 1985, would increase flow available to Port Said by:

- Widening, deepening and removing obstructions from the Ismailia Canal and from the Port Said Canal above the Rayah Barrage (km 30.4).

- Constructing a new canal from Rayah Barrage to El Raswa. Although most of the canals in Egypt are not lined, the new canal proposed by MOI would be concrete lined for maximum capacity and to prevent seepage and plant growth.

As shown on Figure 6-C, the new canal would pass west of El Qantara, and would carry both Port Said water supply and irrigation flow to a proposed new barrage at km 38.4. From this point irrigation flow would be carried in a separate canal. The new water supply canal for Port Said would continue north to El Raswa, running parallel to, and some 500 m west of the existing PSC. The design capacity to El Raswa would be 750,000 cu m/d.

Based on MOI estimates, it is expected that the Port Said share of the cost of the first stage work, including 10% for contingencies,* would be as follows:

---

*(MOI allowance. See Table B-5 for recommended allowances in this report.)

| | | |
|---|---|---|
| - Improvements above Rayah Barrage | | LE 1,000,000 |
| - New municipal supply canal and share of new joint municipal/irrigation canal | | LE 8,500,000 |
| | Total | LE 9,500,000 |

The preliminary plans of the proposed canal and cost estimates have been examined. As proposed, the bottom of the canal to El Raswa would rest on the fairly low ground level to be traversed, and earth embankments built on both sides to heights necessary. The hazard of salt water intrusion would thus be avoided and gravity flow to El Raswa assured. Estimated earthwork quantities appeared slightly low, but not unreasonable. On the other hand, the unit price based on scraping up the embankment fill locally is inadequate. Most of this fill probably will be drawn from borrow pits many kilometers from the work. This added cost could nearly double the original estimate, with Port Said's share greatly exceeding LE 8,500,000.

The Second Stage of the MOI program would involve concrete lining of the Ismailia Canal and of the Port Said Canal from Ismailia to Rayah Barrage. A definite time schedule for this stage and Port Said's share of the costs have not been announced. We understand, however, that the second stage improvements are estimated to cost approximately LE 130,000,000 for an increase of 2,900,000 cu m/d, equivalent to LE 45 per cu m/d of increased capacity. At this rate, the cost of the Port Said share of the second stage capacity increase would be LE 7,000,000 if Port Said were allocated 370,000 cu m/d (an increase of 155,000 cu m/d from its allocation under the first stage); and LE 24,000,000 if Port Said were allocated 750,000 cu m/d, the proposed capacity to El Raswa.

Regardless of Port Said's need to increase its own water supply, the Second Stage proposed by MOI may be necessary for irrigation and other purposes in the eastern delta. Port Said will depend on these improvements to ensure receiving its share of the water delivered to the Suez Canal region. But it is highly unlikely that Port Said would require the proposed 750,000 cu m/d canal capacity, unless the population in the year 2000 doubles the forecast of the WWFMP and at least 2,000 ha more than scheduled are reclaimed and developed during the next 20 years.

For these reasons, estimates of Port Said's costs if the MOI program is adopted are based upon: (1) construction of the canal to 370,000 cu m/d capacity; and (2) a maximum charge to Port Said of LE 7,000,000 in the year 2000.

## 6.5 ALTERNATIVES TO NEW CANAL

Several alternative plans, more modest and with less ultimate capacity than proposed by MOI, have been examined for comparison with the MOI proposal. In all cases, the principal effort would be directed to improvements in the 46 km reach of the PSC between El Qantara and El Raswa. Improvement of the canal section between the Rayah Barrage and the Ismailia Canal as proposed by MOI is included, although for Port Said alone less work might be needed with some saving in cost. All of the alternatives are sized to deliver at least 370,000 cu m/d.

Alternative 1-A - A booster pumping station would be installed at the Rayah Barrage with a 2000 mm diameter prestressed concrete cylinder pipeline running 46 km to El Raswa and delivering 370,000 cu m/d. The existing canal would be abandoned. Staged construction would be possible if smaller diameter pipelines were used.

Alternative 1-B - Similar to Alternative 1-A except that the existing canal would be retained. A 1500 mm diameter pipeline would deliver 250,000 cu m/d, and the canal 120,000 cu m/d.

Alternative 2-A - Four low lift pumping stations with a nominal capacity of 400,000 cu m/d would be installed within the existing canal. These stations would lift the flow as needed to overcome the hydraulic resistance of the existing canal. They would be spaced to keep the water surface below the present canal banks in so far as possible. Relatively minor canal excavation and canal bank extensions would be required in critical sections. The scheme can be adapted to staged construction.

Alternative 2-B - One low lift pumping station rated at 450,000 cu m/d (increased capacity because of transmission losses) would be installed at the Rayah Barrage to deliver the required flow to Port Said. In many places this higher canal water level would be above existing bank levels, requiring extension of the banks to higher elevations. Concrete retaining walls would be built along both sides of the canal. (Raising the Suez Canal Road and the railway to a higher elevation does not appear practical.) No canal excavation is anticipated. Staged construction would not be feasible.

Alternative 3 - A lining would be installed in the existing canal. The lined canal would be designed to deliver at least 370,000 cu m/d. The cross section would be trapezoidal with a bottom width of 8.5 m, side slopes of 1.5:1 and an overall depth of at least 1.75 m (subject to detailed field surveys and selection of most economical dimensions). Anticipated work includes by-pass facilities for dewatering 500 m reaches of the canal for placement of the lining. Because of mobilization costs for by-pass facilities, staged construction would not be feasible.

## Cost Comparison of Alternatives

Costs of the five alternatives for raising the capacity of the existing PSC are compared in Table 6.3. Included are the capital cost, annual cost, equipment replacement cost, present worth cost of lost water, and the present worth cost at 8%, 10%, and 15% discount rates, using a 40-year evaluation period.

Alternatives 1-A and 1-B, including pipelines paralleling the canal, would cost several times the other three alternatives. For Alternative 1-A, the capital cost would be LE 57,857,000; for 1-B, LE 34,680,000. Annual operation and maintenance costs are estimated at LE 295,000 for 1-A and LE 254,000 for 1-B. Construction of the pipelines in no way would interfere with the canal or its operation.

Alternative 2-A, including the installation of 4 low lift pumping stations along the length of the canal, would have the lowest capital cost: LE 6,636,000. However, annual costs (LE 251,000) would be almost as high as for Alternatives 1-A and 1-B. The pumping stations and auxiliaries would be installed within the existing canal without interrupting canal flow.

Alternative 2-B, including one pumping station at the upper end of the canal instead of four in series, and concrete retaining walls as necessary along both embankments, would cost LE 9,823,000 capital and LE 100,000 annual. The pumping station, wingwalls and appurtenances could be built without interrupting canal operations.

Alternative 3, involving minor enlargement of the canal in some reaches, and lining the canal with poured concrete or precast slabs, is estimated to cost LE 10,605,000, including the cost of temporary facilities for dewatering and lining the canal in 500 m reaches. Cofferdams would be placed at each end of the reach with a connecting pipeline to transmit the canal flow. Occasional interruption in canal flow might be necessary, but not enough to affect delivery of needed water to El Raswa. Annual costs are estimated at LE 19,000, much the lowest of the five alternatives. The widespread use of plastic membranes for lining storage tanks and canals suggests the possibility of substantial cost savings. This should be examined carefully with firms specializing in linings of this type, and familiar with working conditions in Egypt. Reliable cost estimates could then be developed for plastic rather than concrete lining.

The two alternatives involving pipelines (1-A and 1-B) are prohibitively expensive and were dropped from further consideration. Although there is some spread in capital costs for the remaining three alternatives, the present worth of the three are close. Lining the canal (Alternative 3) is preferable to low lift pumping through an unlined canal (Alternatives 2-A and 2-B) because lining will secure the stability of embankments, curtail seepage, and reduce maintenance. Low lift pumping should be reserved for increasing capacity of the lined section, should that be necessary in the future. Except for high priority immediate repairs, canal lining alone is recommended (see below).

## 6.6 NEW CANAL VS. PORT SAID CANAL LINING

### Costs

Comparative capital costs of the MOI proposed new canal and lining the existing PSC (including a 51.5% allowance - 20% for contingencies plus 31.5% for support services) are as follows:

| | |
|---|---|
| New Canal - MOI Preliminary Estimate | LE 11,700,000(1) |
| Lining Existing Port Said Canal | LE 10,600,000 |

Using MOI's estimate for the new canal, the costs of the two projects are essentially the same. However, should the embankment fill for the new canal cost more than the preliminary estimate, the cost difference between the two approaches would be substantially larger (see Section 6.4).

If the new canal to Port Said were built and the existing PSC maintained for standby, the added security would be an important benefit. Even a small fraction of the old canal's former capacity would be invaluable if the new canal were ever out of service. However, a canal lacking proper maintenance, neglected or abandoned altogether, is likely to deteriorate rapidly. Such a "standby" canal would be of little use in the event of an emergency.

The advantages of the proposed new canal do not warrant a significant outlay beyond the cost of lining the existing canal. More reliable security could be obtained, without building the new canal, by providing raw water storage (see below).

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(1) 8,500,000 LE (including 10% contingency - see page 6-6) adjusted using 51.5% allowance for contingencies and support services.



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In estimating project costs, lining the existing canal has been assumed. If the MOI project does not proceed, lining of the existing canal should be completed before 1987 to meet anticipated water demands.

Raw Water Storage

If Port Said continues to depend upon a single supply canal, an emergency raw water reservoir should be built on land south of El Raswa (Plate I) to cover short term outages of the supply because of embankment failure, accidental water contamination, or other problems. The reservoir should have a capacity of 1,500,000 cu m, equivalent to 4 days' flow at 370,000 cu m/d. With curtailment of output at El Raswa WTP, the reservoir could provide water for 10 to 12 days, time for at least temporary correction of likely difficulties.

A 1,500,000 cu m concrete lined reservoir with earth embankments would cost approximately LE 3,900,000. It would have an area of 300,000 sq m and depth of 5 m, with the flow line at elevation 6.45 and top of embankments at elevation 7.28. Capacity and area measurements may be reduced if sufficient land is not available.

Evaporation is estimated at 1500 cu m/d. Inflow (makeup plus throughput) would be 3000 cu m/d, twice the evaporation, in order to limit dissolved solids buildup, and the difference would be bled back to the canal. When larger quantities of water are needed, water would be fed from the reservoir to the canal through outlet controls.

If the new canal is built and the old retained for emergencies, the storage reservoir would not be needed.

Environmental Considerations

Construction of the proposed new water supply canal would have a greater impact on the local environment than would lining the existing canal. At least 240 ha of land would be covered by the new canal and its embankments. Most of this land is in an area where agricultural development is planned. Other than land, the major resources committed would be construction funds and materials, particularly cement.

Lining the existing canal would have limited effects beyond the canal itself. No additional land would be needed. Earthmoving would be minimal in comparison with the new canal. Assuming cement rather than plastic for the lining, the commitment of cement for the two projects would be equivalent. Lining would eliminate high water table due to canal seepage. Preventing emergent plant growth in the canal is a direct objective of lining.

Elimination of the existing canal would have a direct adverse effect on the population along its route who depend on the canal for water.

## 6.7 RECOMMENDED PROGRAM

High Priority Measures

These measures, to be undertaken immediately, are directed toward a reduction of unauthorized diversions from the Port Said Canal, reduction of canal seepage, and control of weed growth as necessary to increase the delivery of water to some 138,000 cu m/d needed through 1981. Recommended actions are:



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1) Design concrete lined Port Said Canal based on detailed topographic mapping - if the MOI does not proceed with the proposed new canal.

2) Reach agreement with MOI on policies and procedures for regulating flows at Rayah Barrage to avoid water shortages at El Raswa.

3) Eliminate unauthorized water diversions for agricultural or other purposes; establish routine procedures for gaging and controlling the quantities of water legally taken.

4) Improve canal hydraulic characteristics through weed control by hand labor or proper chemical treatment.

5) Inspect canal embankments and adjacent land; measure canal inflow-outflow with resistivity tests or tracing by fluorescent dye to locate probable sources of seepage; apply bentonite, resinous polymers, or other suitable sealants at critical locations of high seepage.

Immediate Phase Work

This phase, pointed toward 186,000 cu m/d capacity by 1987, anticipates the Final Stage improvements. Surveys, measurements and planning should be coordinated with final needs. In general, constrictions causing high headloss, severe embankment slippage or narrowing of the channel, unusually harmful bridge abutments or conduits, would be eliminated. Recommended actions are:

1) Dredge and excavate, based on the planned alignment grade and sections of the lined canal; widen the canal as feasible and practical; clear away snags and unnecessary obstructions.

2) Raise with earth fill or concrete the low spots in the canal embankments which currently limit allowable water levels in the canal, and thus the quantities of water that can be admitted through the gates at the Rayah Barrage.

3) Carefully monitor seepage during excavation and dredging, which are likely to increase seepage by removing whatever sealants have accumulated in years past.

4) Seal the canal to stop leakage. Bentonite or polymer sealing would be cost effective if much of the leakage is found to be concentrated at a few points. Sealing the entire canal with these materials would be expensive. Much of the outlay for seepage control (see Table 5.4) would be saved if the Final Stage Improvements (below) were begun at the same time as the Immediate Phase Work.

5) Consider temporary low lift pumping near km 56 of the canal section instead of the above channel improvements - if construction of the new canal is selected in preference to lining the existing PSC.

Final Stage Improvements

Final stage improvements are designed to meet raw water supply needs of at least 370,000 cu m/d. Basic costs of the improvements, as shown in Table 6.4, are for three recommended actions:

1) Line with concrete the Port Said Canal from Rayah Barrage to El Raswa.

2) Provide emergency raw water storage near El Raswa equivalent to about four days flow at canal capacity.

3) Contribute to MOI improvements to the canal system upstream of the Rayah Barrage.

Based on detailed design, it may prove possible to raise the capacity well above 370,000 cu m/d at essentially the same cost. The lined section should be designed to obtain the maximum capacity possible for the investment.

The canal lining would take over two years to install. If anticipated water demands are to be met, the preliminary design of the lined canal must be done in 1980, in order to define Intermediate Phase Improvements to be completed by 1981 and begin work on the lining by 1983. Agreement must be reached in the near future on whether to meet Port Said's long term water supply needs by constructing a new canal or by lining the existing canal.

Costs

Capital costs of the recommended program for improving the existing PSC, totaling LE 22,505,000, are summarized in Table 6.4. Also shown are one-time rehabilitation expenses of LE 517,000, mostly for seepage control, to enable the canal to meet needs until long term improvements are carried out.

## TABLE 6.1

## RAW WATER QUALITY

| | El Raswa WTP July-August, 1978(1) | | Cairo 1976-77(2) | Ismailia Canal 1976-77(2) Mostorod WTP | Ismailia Canal 1976-77(2) Cairo North WTP |
|---|---|---|---|---|---|
| pH | 8.0 | 7.8 | 7.9-8.4 | 8.1 | 8.3 |
| Electroconductivity, u mhos/cm | 380 | 410 | | | |
| Total Dissolved Solids, mg/l | 220 | 230 | 170-300 | 212 | 261 |
| Suspended Solids, mg/l | 9.6 | 8.6 | 5-60 | 18 | 41 |
| Color, Cobalt Units | 25 | 30 | | | |
| Turbidity, NTU | 5.5 | 5.6 | 10-100 | 8 | 11 |
| Alkalinity, mg/l as $CaCO_3$ | 100 | 110 | 110-140 | 138 | 140 |
| Hardness, mg/l as $CaCO_3$ | 120 | 120 | 100-120 | 122 | 116 |
| Calcium, mg/l as Ca | 31 | 27 | 18-28 | | |
| Total Iron, mg/l | 0.5 | 0.7 | 0.007-4.3 | | |
| Manganese, mg/l | nd(3) | nd | 0.004-0.11 | | |
| Hexavalent Chromium ug/l | nd | nd | 0.01-4.1 | | |
| Chloride, mg/l | 30 | 28 | 16-28 | | |
| Silica, mg/l $SiO_2$ | 8 | 10 | 4-8 | | |
| Sulfate, mg/l | 22 | 30 | 15-27 | | |
| Ammonia Nitrogen, mg/l | 0.04 | 0.30 | nd | | |
| Nitrate, mg/l as $NO_3$ | 0.3 | 0.2 | 0.02-3.5 | | |
| BOD, mg/l | 1.0 | 1.6 | 1.5-3.0 | | |
| COD, mg/l | 11 | 10 | 8-30 | | |
| Total Phosphorous, mg/l | 0.28 | 0.05 | | | |
| Arsenic, ug/l | nd | nd | | | |
| Cadmium, ug/l | 0.8 | 0.6 | 0.02-0.8 | | |
| Copper, ug/l | 4.5 | 3.0 | 0-11.0 | | |
| Lead, ug/l | 4.4 | 5.0 | 0.01-2.0 | | |
| Magnesium, mg/l | 10.6 | 13.0 | 9-15 | | |
| Mercury, ug/l | nd | nd | | | |
| Potassium, mg/l | 7.6 | 8.0 | | | |
| Sodium, mg/l | 36.0 | 37.0 | | | |
| Zinc, ug/l | 1.0 | 1.0 | 0.01-2.8 | | |
| Oil and Grease, mg/l | 4.0 | 5.2 | | 0 | 0 |
| Phenols, ug/l | 25.0 | 20.0 | 2-300 | 40 | 10 |

TABLE 6.1 (Cont.)

RAW WATER QUALITY

| | | El Raswa WTP July-August, 1978(1) | Cairo 1976-77(2) | Ismailia Canal 1976-77(2) Mostorod WTP | Ismailia Canal 1976-77(2) Cairo North WTP |
|---|---|---|---|---|---|
| Total Coliforms per 100 ml | Ave | 2,700 | 10-10,000 | 3,480 | 16,000 |
| | Max | 13,000 | | | |
| | Min | 700 | | | |
| Fecal Coliforms per 100 ml | Ave | 740 | | 3,480 | 426 |
| | Max | 1,100 | | | |
| | Min | 500 | | | |
| Fecal Strep per 100 ml | Ave | 1,030 | 10-1,000 | | |
| | Max | 2,200 | | | |
| | Min | 330 | | | |
| Algal Counts cells/l | Ave | 576,000 | $10^5$-$10^6$ | | |
| | Max | 679,000 | | | |
| | Min | 419,000 | | | |

(1) Analyses performed by National Research Center (Dokki, Cairo) for arsenic, cadmium, copper, lead, magnesium, mercury, potassium, sodium, zinc, oil and grease, and phenols. Analysis of all other parameters by Hazen and Sawyer.
(2) Analyses performed by Engineering Science-Parsons.
(3) nd = not detected

TABLE 6.2

CHEMICAL ANALYSES OF GROUNDWATER

| | 1973(1) Sample | Sample A 25 May 78 | Sample B 27 May 78 | Sample C 28 May 78 | Sample(2) D 29 May 78 |
|---|---|---|---|---|---|
| Electroconductivity Micromhos/cm | - | - | 5,900 | 3,200 | 180,000 |
| Total Dissolved Solids, mg/l | 4,720 | 3,160 | 3,130 | 1,690 | 190,000 |
| Chloride, mg/l | 1,740 | 1,350 | 1,180 | 730 | 109,000 |
| Sulfate, mg/l | 590 | 330 | 760 | 200 | 9,600 |
| Alkalinity, mg/l as $CaCO_3$ | - | 450 | 290 | 290 | 300 |
| Hardness, mg/l as $CaCO_3$ | - | 340 | 450 | 280 | 35,000 |

(1) Ministry of Development and New Communities, Port Said.
All other samples by Hazen and Sawyer.

(2) High levels were possibly due to subsurface salt pan or excessive evaporation in nearby Interior Canal.
See Figure 6-B for location of this and other May, 1978 samples.

TABLE 6.3

COMPARISON OF COSTS OF ALTERNATIVES TO NEW CANAL
(Thousands of 1978 LE)

| | ALTERNATIVE | DELIVERED FLOW 1000 cu m/d | CAPITAL[1] COST | ANNUAL[2] COST | EQUIPMENT[4] REPLACEMENT COST | PRESENT WORTH[5] OF LOST WATER | PRESENT WORTH 40 YR. DISCOUNT RATE 8% | DISCOUNT RATE 10% | DISCOUNT RATE 15% |
|---|---|---|---|---|---|---|---|---|---|
| 1-A | 2000 mm Pipeline abandon PSC | 370 | 57,857 | 295 | 2,393 | - | 61,886 | 61,098 | 59,962 |
| 1-B | 1500 mm Pipeline retain PSC | 250[3] | 34,680 | 254 | 1,635 | 810 | 38,869 | 38,217 | 37,277 |
| 2-A | Low lift pumping stations | 370 | 6,636 | 251 | 1,980 | 2,498 | 12,551 | 11,833 | 10,922 |
| 2-B | Low lift pumping station and concrete retaining walls | 370 | 9,823 | 100 | 495 | 2,498 | 13,619 | 13,373 | 13,015 |
| 3 | Concrete lined canal | 370 | 10,605 | 19 | - | 833 | 11,767 | 11,737 | 11,667 |

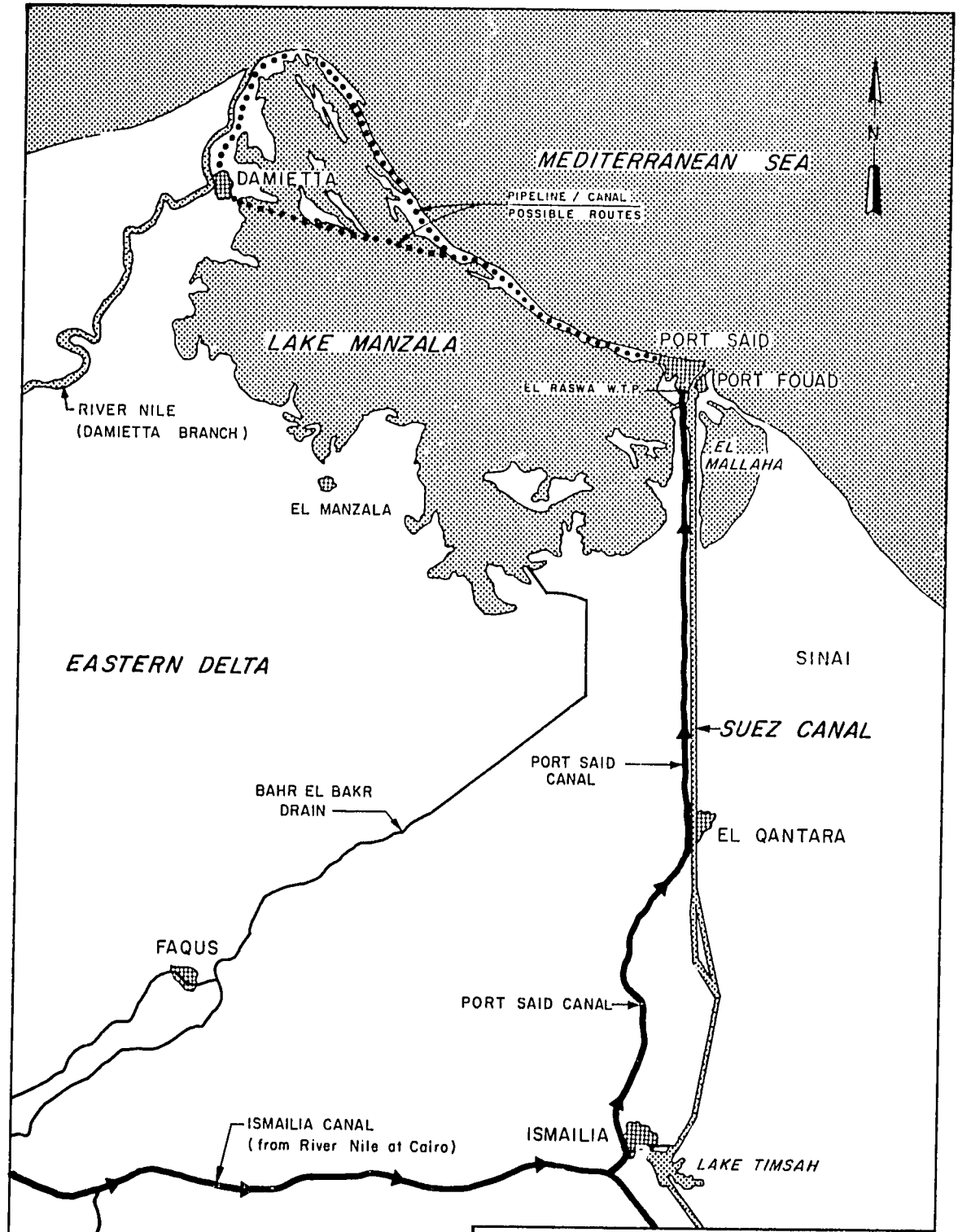
(1) No staging assumed. Includes 20% for contingencies and 31.5% for support services.
(2) Includes pumping power for full capacity plus maintenance and operation. Assumed constant during evaluation period.
(3) Existing canal to convey 120,000 cu m/day.
(4) After 20 years. Includes contingencies and support services.
(5) Based on losses of 5% capacity in lined canal, 15% unlined, 0% in pipeline. Present worth of LE 45 per cu m/d of lost flow.

TABLE 6.4

RECOMMENDED PROGRAM
RAW WATER SUPPLY COSTS(1)
(Thousands of 1978 LE)

| | Civil/ Pipe | Mechanical | TOTAL | Foreign | Local |
|---|---|---|---|---|---|
| HIGH PRIORITY | | | | | |
| Seepage and Weed Control(2) | 86 | - | 86 | 66 | 20 |
| IMMEDIATE PHASE | | | | | |
| Dredging and Sealing(3) | 631 | - | 631 | 266 | 365 |
| FINAL STAGE IMPROVEMENTS | | | | | |
| Concrete Lining(4) | 10405 | - | 10405 | 2076 | 8329 |
| Raw Water Storage (1.5 million cu m)(5) | 3776 | 124 | 3990 | 1209 | 2691 |
| Contribution to MOI Improvements Upstream of Rayah Barrage: | | | | | |
| Initial Stage (1985) | 1000 | - | 1000 | - | 1000 |
| Final Stage (1990) | 7000 | - | 7000 | - | 7000 |
| TOTAL - FINAL STAGE | 22181 | 124 | 22305 | 3285 | 19020 |
| GRAND TOTAL | 22898 | 124 | 23022 | 3617 | 19405 |
| Rehabilitation | 517 | | 517 | 248 | 269 |
| COSTS NOT INCLUDING REHABILITATION | 22381 | 124 | 22505 | 3369 | 19136 |

(1) All figures except contribution to MOI improvements include 51.5% allowance (20% for contingencies plus 31.5% for support services such as engineering, legal and administrative).
(2) Rehabilitation expense.
(3) Includes LE 431,000 rehabilitation expense (seepage control) and LE 200,000 for canal excavation.
(4) Not including LE 200,000 for canal excavation (included above in Immediate Phase).
(5) No value assigned for land, assuming site in unreclaimed land. Site reclamation work included in earthwork.




**ARAB REPUBLIC OF EGYPT**

MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES

ADVISORY COMMITTEE FOR RECONSTRUCTION

PORT SAID

WATER AND WASTEWATER FACILITIES MASTER PLAN

HAZEN AND SAWYER

ECG - ENGINEERING CONSULTANTS GROUP

PRESENT WATER SOURCE

VOL.2 FIG. 6-A

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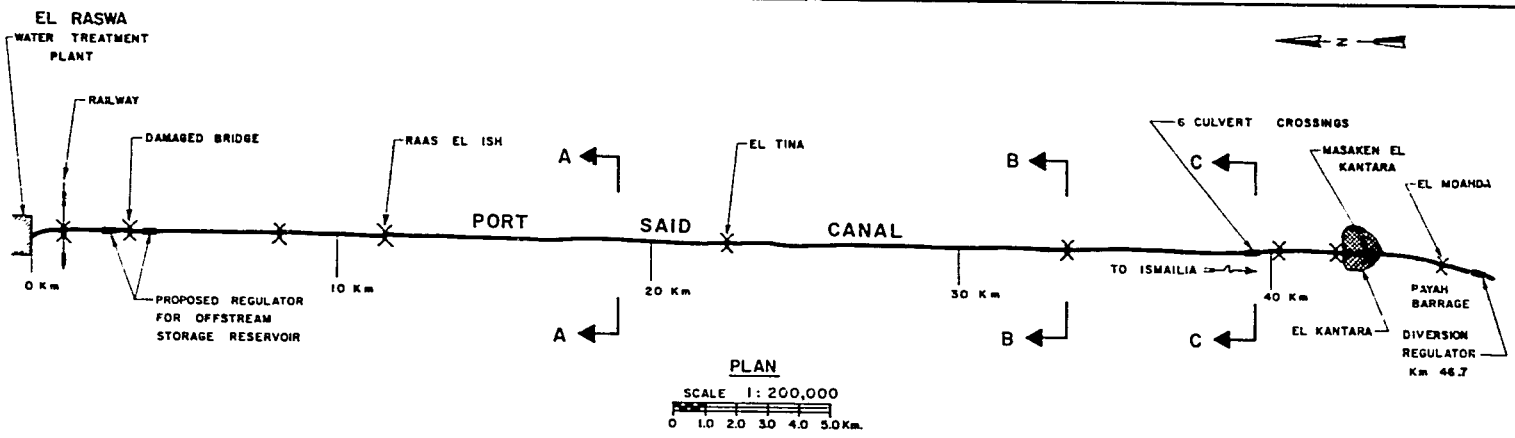
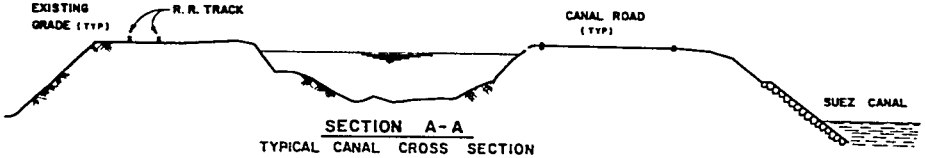
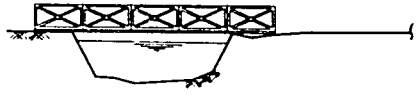


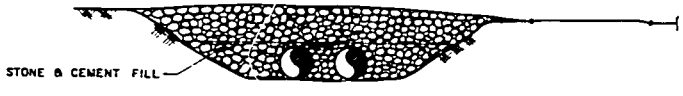

SECTION A-A
TYPICAL CANAL CROSS SECTION
SCALE 1:300
0 1 2 3 4 5 6 M.
APPROX.



SECTION B - B
TYPICAL BRIDGE CROSSING
SCALE 1:300
0 1 2 3 4 5 6 M.
APPROX.

**LEGEND**

BRIDGE




SECTION C-C
TYPICAL CULVERT CROSSING
SCALE 1: 300
0 1 2 3 4 5 6 M.
APPROX.

SCALE AS SHOWN

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# PORT SAID CANAL PLAN AND SECTIONS

VOL.2
FIG.
6-B

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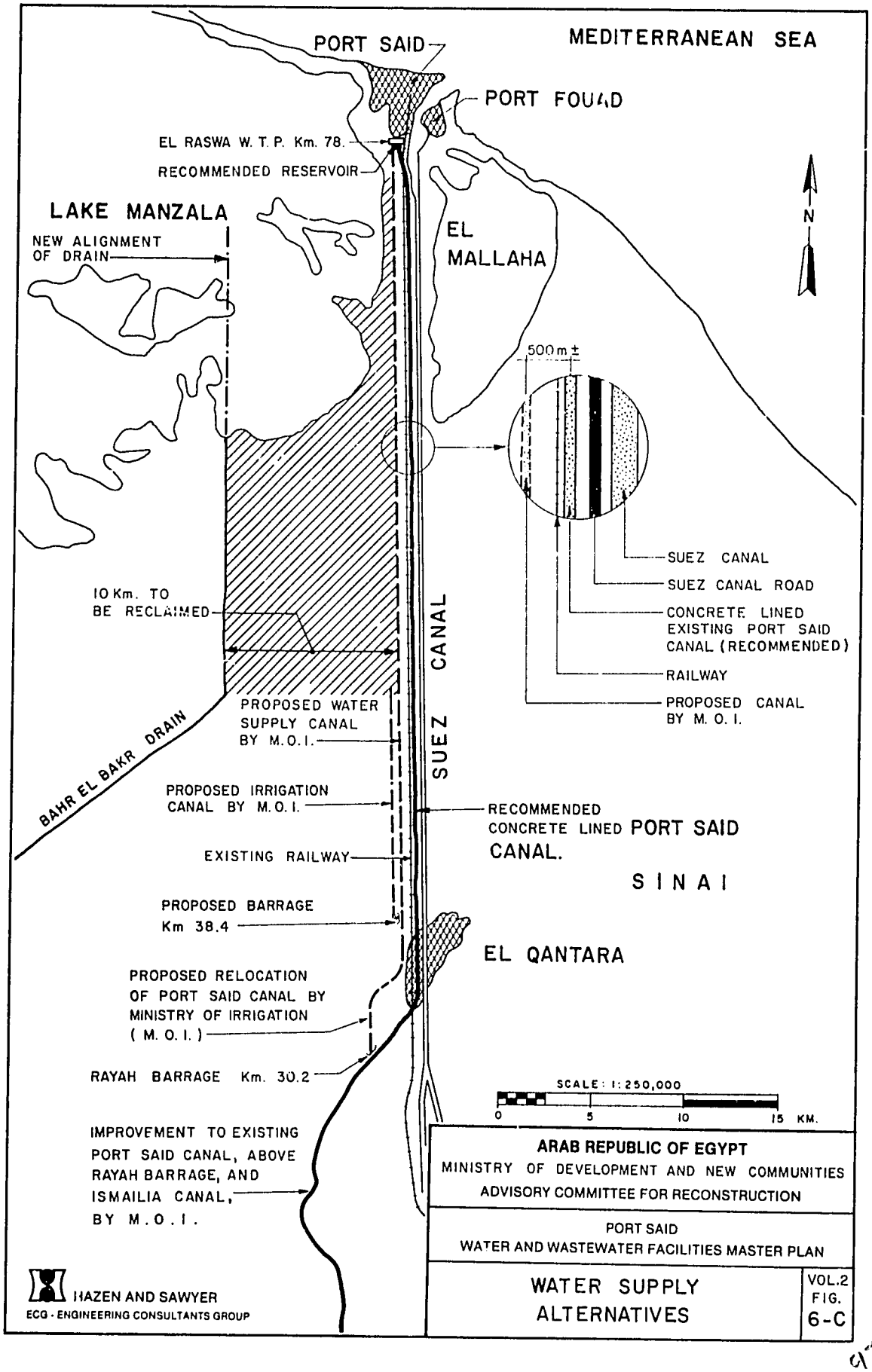
MEDITERRANEAN SEA
PORT SAID
PORT FOUAD
EL RASWA W. T. P. Km. 78.
RECOMMENDED RESERVOIR
LAKE MANZALA
NEW ALIGNMENT OF DRAIN
EL MALLAHA
N
500 m ±
SUEZ CANAL
SUEZ CANAL ROAD
CONCRETE LINED EXISTING PORT SAID CANAL (RECOMMENDED)
RAILWAY
PROPOSED CANAL BY M. O. I.
10 Km. TO BE RECLAIMED
SUEZ CANAL
PROPOSED WATER SUPPLY CANAL BY M.O.I.
BAHR EL BAKR DRAIN
PROPOSED IRRIGATION CANAL BY M.O.I.
RECOMMENDED CONCRETE LINED PORT SAID CANAL.
EXISTING RAILWAY
SINAI
PROPOSED BARRAGE Km 38.4
EL QANTARA
PROPOSED RELOCATION OF PORT SAID CANAL BY MINISTRY OF IRRIGATION (M. O. I.)
RAYAH BARRAGE Km. 30.2
SCALE: 1:250,000
0 5 10 15 KM.
IMPROVEMENT TO EXISTING PORT SAID CANAL, ABOVE RAYAH BARRAGE, AND ISMAILIA CANAL, BY M.O.I.
ARAB REPUBLIC OF EGYPT
MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION
PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN
WATER SUPPLY ALTERNATIVES
VOL.2
FIG.
6-C
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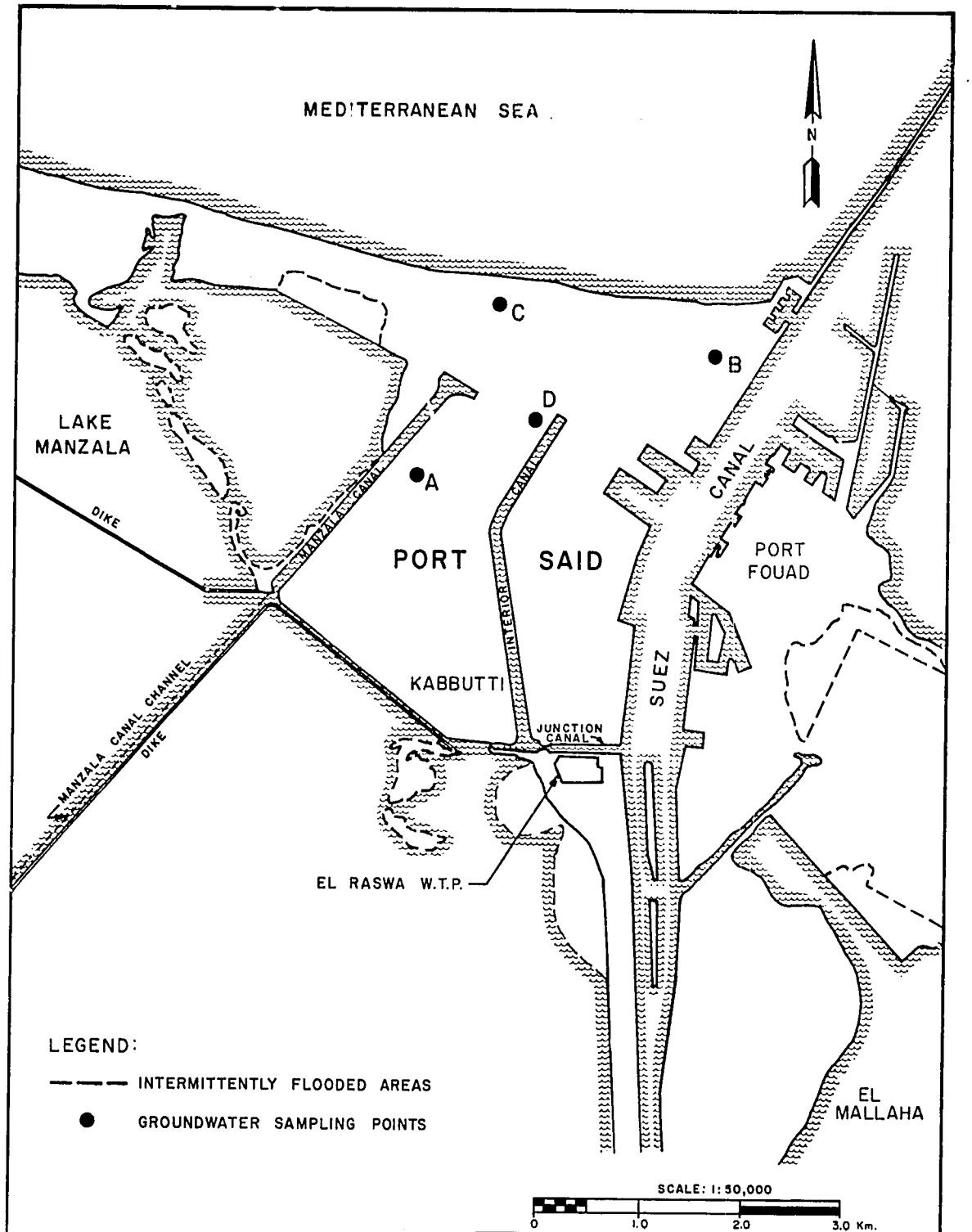


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GROUNDWATER SAMPLING POINTS

VOL.2 FIG. 6-D

CHAPTER 7

WATER TREATMENT AND PUMPING

## 7.1 CRITERIA FOR PUBLIC WATER SUPPLY

Water treatment is necessary at Port Said to provide a safe and acceptable water for public consumption. Water safe for human consumption must be essentially free of toxic substances and pathogenic organisms. Acceptable water is palatable, free from tastes and odors, without excessive turbidity, color, and iron. Chemical and physical standards for drinking water adopted by USEPA, WHO, ARE and SCA are shown in Table 7.1.

Density, or most probable number (MPN), of coliforms in raw and treated water is used most frequently by water supply and health agencies to check the sanitary quality of public water supplies. Because of their complexity the bacteriological standards are not included in Table 7.1. In general, samples for coliform tests should be collected at the El Raswa water plant and points in the distribution system at planned intervals. Sample collecting meets USEPA requirements. The reported results seem satisfactory. It will be necessary to increase the sampling as the population increases. However, the techniques used are not satisfactory and tend to yield incorrect results. The procedure to be followed is described in Standard Methods for Examination of Water and Waste Water or other published procedures. At present the samples are not dechlorinated. The broth used and its method of sterilization is incorrect.

USEPA physical standards, concerned chiefly with aesthetics and palatability of water, are more stringent than those of other agencies. Turbidity is an important standard because of its inhibiting effect on filtered water disinfection with chlorine. Easily determined by operators, turbidity of the finished water provides a ready index to plant performance and to the need for adjustment or modification of chemical dosages.

Raw water turbidity at Port Said is approximately 5 NTU (see Table 6.1). Properly operated treatment facilities should easily yield a turbidity meeting the USEPA standard without additional capital or chemical cost. We recommend the adoption of 1.0 NTU for treated water. Analysis of finished water sampled at El Raswa in July-August 1978 showed turbidities of 0.4 to 0.6 NTU (see Table 7.2).

The phenol levels in the raw water, as shown in Table 6.1, are very high (20 ug/l). Although the presence of phenol does not seem to be a health hazard, high levels can cause an unpleasant taste which could encourage individuals to use a less safe supply. This problem can best be solved by control of oil discharges to the supply canal.

Algae, though not in themselves a standard, play an important role in the treatment process. In addition to affecting taste and causing odor, the bodies of algae can plug the filters. Results of tests made in August, 1978 (Table 7.3) showed that algae control would be desirable.

## 7.2 WATER TREATMENT FACILITIES

The El Raswa Water Treatment Plant (WTP) is located at the northern end of the Port Said Canal, 3 km south of the Port Said business center. As shown on Figure 7-A, the plant consists of water treatment process units, raw and finished water pumps, finished water storage reservoirs, and appurtenances.

Early water works (prior to 1910) apparently included pumps at El Raswa, the end of the canal, and trunk mains to the city. The first slow sand filters were installed in 1919 and extended in 1935. Compressed air cleaning of roughing filters was introduced in 1947. The addition of a Bamag rapid sand filter system in 1965 increased the capacity of the works from 46,000 cu m/d to 81,000 cu m/d. Detailed listing of the facilities and equipment at El Raswa is in Appendix C.

Recommended Program

A continuing program is recommended to improve and expand the water treatment facilities at El Raswa, with parallel programs to modernize and renovate the raw water intakes, pumping stations, electric power system, chlorination facilities, chemical feed and flow metering equipment (Sections 7.3 through 7.8). Equipment specifications for the recommended program are in Appendix D. The proposed scheduling of the improvements through the year 2000 is shown on Figure 7-B.

## 7.3 RAW WATER INTAKES

Existing Facilities

The El Raswa plant has three raw water intakes. A fixed coarse screen is installed across the Port Said Canal ahead of the first intake. Combination fixed coarse and movable fine screens are installed at each of the three raw water inlets to the treatment plant. Cleaning the fixed screens is difficult and time consuming.

Recommended Program

To facilitate cleaning, a fixed coarse screen should be constructed upstream of the New Bamag plant (see Section 7.4, below) across the canal with a locally fabricated bar rack and bridge. At the same time the coarse screens on the three individual raw water inlets should be removed.

As part of the conversion of the existing Bamag Pump Station to raw water (see below), a second intake should be constructed on the Port Said Canal north of the existing Bamag intake. The new intake should be connected to the existing finished water sump when this station is converted to raw water use.

## 7.4 TREATMENT PROCESSES

Existing Facilities

El Raswa water treatment processes at the end of 1977 consisted of 5 slow sand filter trains and a Bamag rapid sand filtration plant. The slow sand filter trains included coagulation and sedimentation tanks, gravel "roughing" filters ahead of the slow sand filters, and filtered water storage tanks. The Bamag plant included coagulation and sedimentation tanks, 8 rapid sand filters, filtered water storage tanks, and raw and filtered water pumps.

The nominal rated capacity of the facilities at the end of 1977 totaled 81,000 cu m m/d, compared with water demands averaging 90,000 cu m/d and maximum day at 113,000 cu m/day. As detailed in Chapter 4, maximum day water demands at Port Said are projected to reach 169,000 cu m/d in 1985, and 326,000 cu m/d in the year 2000.



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Facilities Under Construction

SCA has two projects under construction at El Raswa to improve operations and increase the capacity of the treatment facilities:

(1) CTE conversion of slow sand filter trains #2 and #3 (see Figure 7-A) to rapid sand filtration; elimination of the "roughing" filters; and modification of the chemical feed and coagulation and sedimentation tanks. The unused portion of the slow sand filters will be converted to covered finished water tanks. This work, expected to be complete by the end of 1979, will increase the nominal capacity of filter trains #2 and #3 from 20,000 to 80,000 cu m/d, and provide a total treatment capacity of 141,000 cu m/d.

Allowing 5% of the output for filter washing and other plant uses, this capacity should meet maximum day demands through 1981.

(2) Installation of a second Bamag rapid sand filter system, including two coagulation and sedimentation tanks, 12 rapid sand filters, storage tank, pumps, and other appurtenances. The new units will have a nominal rating of 70,000 cu m/d, or twice as much as the existing Bamag plant, and will raise the total nominal plant capacity to 211,000 cu m/d, adequate through 1987 (see Table 7.4).

Overloading of Facilities

Taking slow sand filter trains #2 and #3 out of service for the CTE conversion project reduced the nominal capacity of the treatment facilities by 20,000 cu m/d, or approximately 25%. This reduction, which prevailed throughout 1978 and is likely to continue through 1979, has compelled overloading the remaining facilities to meet Port Said demands.

Furthermore, and unquestionably more serious, the discharge of "roughing" filter effluent to the finished water storage tanks, without passing through the slow sand filters, has destroyed even the semblance of adequate treatment. "Roughing" filters are used successfully to reduce the load on the slow sand filters, but the gravel media is much too coarse to remove fine turbidity or pathogenic organisms. Although the potential dangers of such practice apparently have not materialized, perhaps because of unusually good raw water or heavy chlorination, steps must be taken promptly to prevent such bypassing in the future.

Rehabilitation of Existing Facilities - Immediate

While the SCA has done an outstanding job of getting the existing facilities operating after the war, much work remains to be done. Most of the recommended measures are relatively simple and could be carried out by staff or locally available mechanics. Principal items are as follows:

Bamag Rapid Filtration Unit

- Rapid Mix is out of service. It should be repaired or replaced.
- Effluent Weirs on clarifier tanks should be leveled by the installation of adjustable weirs. Differential settlement of 7 to 9 cm has reduced the effective weirs to less than one-third of the tank circumference. High velocities and short circuiting in the clarifier tanks and resulting carry-over of suspended



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solids clog filters, shorten filter runs and reduce the plant output. The difficulty can be corrected by adjustable weir plates set carefully to assure equal distribution of the effluent. This will require raising the settling tank flow line by about 10 cm.

- Rate Controllers on the 8 filters have been strapped wide open, letting the filters ride on the clear well. When the filter is clean, the water level in the filter box is barely above the sand, and some 60 cm below the influent gullets. Low water levels on filters cause negative pressures within the bed, air binding, sand and scouring, and a sharp reduction in production. The easiest and simplest way to correct this problem is to repair the rate controllers.

- Instruments and other filter operating equipment in stock should be installed, but restoring the rate controllers to service should have priority.

- Inlet Gullets and Washwater Troughs are not level because of differential ground settlement. With one end of gullets higher than the other, water flows to the lower end and is not distributed uniformly over the filter. Raising the water level on the filters by rate controllers, as recommended, would eliminate this trouble. Washwater gutters, on the other hand, must be level to assure uniform and satisfactory backwash. Non-level influent and washwater gullets should be corrected by installing level metal or wooden weir plates.

- Weir in the Clear Well has been destroyed, allowing air to be forced back through the filter media. This may cause media displacement and air binding. The weir should be restored.

- Manometers should be installed on filters and calibrated to measure headloss through filters and filter backwash rates.

- Cleaning, grading, and replenishment of filter media as needed; repair and replacement of underdrain system where necessary. (To be carried out one filter at a time after CTE slow sand filter #2 and #3 conversion to rapid sand filtration is in service.)

Slow Sand Filter Trains 1, 4 and 5

- Roughing filters, designed and equipped for water and air backwash, have been cleaned just with air for several years because operable washwater pumps are not available. With air wash alone, filtered water is lost after each cleaning by wasting the effluent until it is again acceptable. The procurement and installation of three backwash pumps are recommended. Meanwhile, arrangements should be made locally to temporarily install a backwash pump to permit determination of appropriate backwash rates for roughing filters. The slow filter sand has an effective size of 0.2 mm which is unusually fine. Because of this perhaps also due to clogged or broken drain tiles, the slow sand filters cannot handle the roughing filter output. As much as 75 percent of the water is bypassed around the slow sand filters into the finished water storage tanks. When sand is replaced as part of normal operating procedures, a coarser sand, 0.35 to 0.40 mm, should be used.

- Settling basin baffles should be added to flow train 1. These baffles would consist of concrete block walls constructed near the entrance and exit ports. They would have openings to distribute water evenly across the basin.

- Chemical feeding should be relocated and more carefully regulated to increase its effectiveness and reduce filter clogging.

Initial Upgrade of Slow Sand Flow Trains 4 and 5 (by 1987 and 1990)

Actual construction on converting these slow sand filters to rapid sand filtration system should not start until the current SCA projects are completed and tested.

The cost of conversion has been estimated on the basis of the CTE facilities, but an alternative arrangement, described below, might prove preferable and more economical. Final selection should rest upon completion of the work under construction and a thorough test of its performance. We would preserve the existing three stage roughing filter structures. These are set up to provide an ideal graduation of media (from coarse to fine in direction of filter flow) without the need for special media such as anthracite or garnet. We propose to use sand with effective sizes of 2, 1 and 0.5 mm in the three stages. Initial filter rates would be about 7.5 m/hr in the first stage filters and 2.5 m/hr in the third.

The initial upgrading, under the alternative arrangement, would include:

- New chemical feed facilities for coagulant, coagulant aid, and pre- and post-chlorine.

- Manual and automatic control and monitoring equipment to ensure accurate dosing.

- Rapid mix units.

- Pretreatment (flocculation and settling tank) modifications to increase rates. (The conservatively rated three stage filters will permit high loadings on the pretreatment units).

- New filter bottoms and media in roughing filters.

- New air and water filter wash systems including monitoring equipment.

- Replacement or reinforcement of piping to carry higher flows.

- Conversion of slow sand filters to covered storage for filtered water.

Upgrade of Existing Bamag (by 1995)

The Bamag design is quite conservative. Once the plant has been rehabilitated, the operation should be carefully monitored and test run on individual units to demonstrate that it can run at a higher rate. Preliminary hydraulic analyses indicates that the major piping would not require major changes. Certain changes may be needed:

- Chemical feed; better use of polymers or other filter aids.

- Possible substitution of dual media in the filters for present single media.

- Possible replacement of deteriorating gravel and filter bottoms.

Final Upgrade of Slow Sand Flow Trains 4 and 5 (by 1995 and 1997)

After the initial upgrading, performance of flow trains 4 and 5 should be carefully monitored and recorded. Data on chemical dosages, flow rates, backwash rates, turbidity and coliform removal and filter runs would be analyzed to guide planning for final upgrading.

The final upgrading might include minor improvements to chemical feed, flocculation and settling. The feasibility of operating at rates yielding 50,000 cu m/d for each train by the final upgrading would be demonstrated by full scale tests after the initial upgrading.

Final Upgrade of Slow Sand Flow Trains 2 and 3 (by 1998)

The CTE converted flow trains 2 and 3 are designed to perform effectively at a rating of 40,000 cu m/d each. This is a conservative rating which allows for the inexperience of plant personnel and the lack of operating data needed to modify and adjust facilities for best performance.

Once such operating experience and data are obtained, we believe these converted flow trains can be modified and adjusted to a capacity of 50,000 cu m/d each. Possible measures to attain the additional capacity include:

- Improvements to chemical feed flocculation and settling.
- Introduction of new filter media, such as dual media with finer sand and coarser anthracite.
- Improved underdrains.
- Improved filter washing.

Costs of these improvements would be minor in comparison with the present conversion which involves major structural and mechanical alterations.

Upgrade Slow Sand Flow Train 1 (by 2000)

This is the oldest section of the plant and the only one still providing slow sand filtration without chemical pretreatment. To meet current demands, flow train 1 is currently operating at 10,000 cu m/d, well above its nominal rating. We believe this higher rating can be safely maintained provided minor improvements are carried out as recommended under Rehabilitation of Existing Facilities.

No increase in this capacity would be needed until the year 2000, when it would be raised to 35,000 cu m/d. At that time these units would be over 80 years old and complete replacement might be justified. This decision should be deferred until the capacity is needed, and should be based on physical condition of the units and on expected demand growth at that time. For present planning we have based costs on replacement of the flow train with new units.



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## 7.5 CHEMICAL FEED

### Existing Facilities

Two chemicals are presently used at Port Said for coagulation: aluminum sulfate and polymer, NALCO 600 SSI.

The alum feed equipment for the existing Bamag system consists of dissolving tanks, a constant head tank, and flow meters with regulating valves. The equipment is in reasonably good condition and operable. It is not properly operated for best results but is adequate for present needs. The polymer feeder fashioned by a member of the H&S staff consists of a constant head tank discharging through an adjustable rubber siphon.

For slow sand streams #4 and #5, the chemical feed equipment consists simply of tanks and siphons. As presently operated, the equipment is not suitable for regulating properly chemical dosages. The situation is aggravated by improper location of the alum and polymer feeds.

### Recommended Program

Centralized chemical feed is recommended. The facilities now being constructed by CTE for the converted slow sand filter streams #2 and #3 should be expanded to provide alum and polymer capacity for streams #4 and #5, and eventually for stream #1.

Two alternatives should be considered for feeding the alum and polymer at the existing Bamag plant:

- Continue to feed the chemicals from the Bamag chemical room.
- Centralize the feeding and control for both units in the new Bamag plant.

We also recommend the following immediate corrections for proper regulation of chemical doses for streams #4 and #5:

- Install simple, easily constructed constant head feeders similar to the one installed for the Bamag system.
- To take advantage of hydraulic mixing, feed the polymer at the inlet end of the head box. Feed alum just upstream of the weir.
- In the absence of flow meters, use the "feed rate vs. flow" table to regulate dosages.

We recommend the use of copper sulfate at a rate of 0.2 mg/l for algae control. This method was shown to be simple and effective in controlling algae growth within the basins of the water plant. Copper sulfate can be introduced by adding a fixed weight of crystals to a perforated pail in each flow stream.

## 7.6 CHLORINATION

The purpose of chlorination at Port Said is to disinfect the filtered water and destroy as far as possible pathogenic or harmful organisms. Equally important, chlorination is used to diminish or prevent contamination of the distribution system by infiltration of polluted water through cross connections, leaky joints, or broken pipe.

Although prechlorination is used elsewhere to improve water treatment and will be provided in the CTE conversion of slow sand filter trains #2 and #3 and the new Bamag units, its value at Port Said is questionable.

Existing Facilities

Chlorination facilities at El Raswa are as follows:

- One English Port-a-Cell unit (0 to 3.5 kg/hr), feeding chlorine into the Annex Pump Station discharge.

- Two Egyptian chlorinators in the existing Bamag system: one feeding the Bamag filter effluent ahead of the storage reservoir; the other feeding the high service pump discharge.

- One chlorinator in the Main Pump Station, presently out of service, has not been used for several years.

The existing chlorine facilities at El Raswa do not provide the continuous disinfection needed to ensure a safe supply of water at Port Said. This is evident from the variations in chlorine in parts of the water distribution system.

Some of the deficiency is due to chlorinator failures, usually from lack of maintenance, and occasionally from delayed delivery of chlorine. Some is due to faulty points of chlorine application, causing inadequate dispersement and mixing and little time for chlorine to act. Much of the deficiency, however, is due to untrained or careless operation of the equipment and improper control of chlorine dosages.

Facilities Under Construction

Under the CTE conversion of slow sand filter trains #2 and #3, one chlorinator will be installed on the filter effluent, and the new Bamag unit will include two pre filter and two intermediate chlorinators, and two chlorinators on the filter effluents.

Recommended Program

Consolidation of chlorination facilities in one place, or possibly not more than two locations, would simplify operations and should improve control (Figure 7-E). We recommend that following conversion of the Bamag pumping to raw water and completion of the new finished water pumping station (see Section 7.7, below), one of two alternatives for long term control chlorination be adopted:

- Convert the present Main Pump Station to a central chlorine facility, serving the existing Bamag plant and slow sand streams 1, 4, & 5. The new Bamag plant would use its own facilities and converted slow sand streams #2 and #3 would use the proposed CTE chemical building.

- Increase the chlorination capacity of the new Bamag Plant to serve all units or increase the CTE chlorination facilities to handle all 5 slow sand streams.

A central chlorination facility is recommended. Until the central chlorination facility is constructed, the following recommendations are made:

- Use the two new Port-a-Cell chlorinators now in storage at the water plant. Install one in the Main Pump Station to chlorinate present discharges from the station and slow sand filter train #1 effluent; the other at or near Annex Station, to chlorinate the effluent from filter trains #4 and #5.

- Repair the presently inoperative Port-a-Cell unit in the Main Pump Station and hold as back-up for other chlorinators in the plant.

We suggest also ihe feasibility and desirability of applying chlorine ahead of finished water reservoirs to obtain time for chlorine contact and mixing.

## 7.7 PUMPING STATIONS

### Exisiting Facilities

There are four separate pumping stations at El Raswa:

- Main Station, located north of the Bamag installation, with both raw and finished water pumps, installed in 1924.

- Bamag Station, located within the Bamag building, with both raw and finished water pumps (1964).

- Auxiliary Raw Water Station, located on the west side of the Port Said Canal (1946).

- Annex Finished Water Station, located in the northwest corner of the property near the elevated tank (1946).

Assuming that the largest pump at each of these stations is out of service, the firm raw water capacity is presently 5,160 cu m/hr or 124,000 cu m/d; the finished water capacity is 5,000 cu m/hr or 120,000 cu m/d. The nominal capacity and motor horse power of the 22 raw water and finished water pumps are summarized in Table 7.5.

The age, variety of makes and models, and the unavailability of spare parts for pumps and motors, have prevented adequate maintenance and repair of the pumps for several years.

### Recommended Program

Immediate replacement of nearly all pumps and electrical equipment is needed for satisfactory performance.

To meet immediate and long term water needs and to permit full utilization of existing and proposed treatment facilities, a complete rearrangement of pumping and the installation of new machinery throughout is recommended.

The present Bamag Station should be converted to raw water service exclusively. A new filtered water pumping station should be built north of the finished water storage tanks (see Figures 7-A and 7-D). Pumps to be included in the new Bamag project will be installed adjacent to the filters as provided in the present SCA project. The Auxiliary Raw Water Station and the Annex Finished Water Station should be abandoned, and the Main Pumping Station should be stripped and refurbished to house chlorination facilities (see Section 7.6).

The program would be carried out in steps paralleling increased demand forecasting. Scheduling of the replacement and addition of water pumps is shown on Figure 7-C. Raw water pumping capacity must meet maximum day demand plus 10% for losses at the plant, such as for backwash water. Finished water pumping capacity must meet the entire peak hour demands through 1985. After that, storage in the city would meet a portion of the peak hour demand. The replacement program outlined below shows all pumps being replaced by 1,000 cu m/hr pumps in the first stage. Some of these are to be replaced later with 2,000 cu m/hr pumps. Larger pumps installed in the first stage would have longer useful lives. However, almost as many 2000 cu m/h pumps would be needed in the first stage, since each station would require a standby for the largest pump. The final decision regarding size should depend upon uniformity of model and size for all three canal cities.

1. Raw Water Pumping

Stage 1 - 1980

- Replace the four raw water pumps in the Main Station with four new 1,000 cu m/hr pumps.

- Replace two of the Bamag raw water pumps with new 1,000 cu m/hr pumps. One of the existing 1,080 cu m/hr pumps could be retained in service.

- Retain the Auxiliary Raw Water Station until conversion of the Bamag Station to raw water pump station is completed; however, two additional pumps for the converted station should be purchased without delay for ultimate installation in the converted station. (A total of eight raw water pumps would be purchased initially.)

The raw water pumping capacity then available would be as follows:

| | Total | Firm* |
|---|---|---|
| Main Station | | |
| 4 new pumps @ 1,000 cu m/hr | 4,000 cu m/hr | 3,000 cu m/hr |
| Aux. Raw Water Station | 2,200 | 1,500 |
| Bamag Station | | |
| 2 new pumps @ 1,000 cu m/hr | 2,000 | 2,000 |
| Existing pump @ 1,080 cu m/hr | 1,080 | 1,080 |
| TOTAL | 9,280 cu m/hr | 7,580 cu m/hr |

*With one new pump plus one existing large unit in the Auxiliary Raw Water Station out of service.

Stage 2 - 1981

Upon completion of the new Finished Water Pumping Station, the new raw water pumps installed in the Main Station and the two additional pumps purchased initially would

be moved to the Bamag Station. This would give a firm pumping capacity of 7,000 cu m/hr. With the pumps in the new Bamag Plant, capacity will be sufficient to meet installed WTP capacity through 1987. Replacement of these pumps by 2,000 cu m/hr pumps would be scheduled as follows: 1989 - 3 units; 1994 - 2 units; 1998 - 2 units.

2. Finished Water Pumping

Stage 1 - 1980

- Replace the four finished water pumps in the Main Station with four new pumps of 1,000 cu m/hr capacity.

- Replace the pumps in the existing Bamag Station with three new pumps of 1,000 cu m/hr capacity.

- Retain the Annex Finished Water Station in service until completion of the Finished Water Pumping Station, but purchase three pumps now for ultimate installation in the new station. (A total of ten finished water pumps would be purchased initially.)

The finished water pumping capacity then available would be as follows:

| | Total | Firm* |
|---|---|---|
| Main Station | | |
| 4 new pumps @ 1,000 cu m/hr | 4,000 cu m/hr | 4,000 cu m/hr |
| Annex Station | 2,900 | 1,900 |
| Bamag Station | | |
| 3 new pumps @ 1,000 cu m/hr | 3,000 | 2,000 |
| TOTAL | 9,900 cu m/hr | 7,900 cu m/hr (189,600 cu m/d) |

*With one large new unit in the Bamag Station, plus one large existing unit in the Annex Station out of service.

The firm capacity will easily handle peak hour of the entire plant output after the completion of the CTE modifications.

Stage 2 - 1981

The seven new 1,000 cu m/hr finished water pumps installed in the Main and Bamag Stations under Stage 1 plus the three additional pumps purchased initially would be moved to the new Finished Water Pumping Station. This would provide a firm capacity of 9,000 cu m/hr.



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Final Stage

Five of the 1,000 cu m/hr finished water pumps in the new Finished Water Pumping Station would be replaced with new 2,000 cu m/hr pumps as follows: 3 units in 1988, and 2 units in 1991.

## 7.8 YARD PIPING

In combination with the new pumping facilities, new raw and finished water piping will be constructed to interconnect the several treatment streams and to provide additional hydraulic capacity. For the High Priority program, approximately 600 m of 800 mm raw water and 1,300 m of 800 mm finished water piping will be required. For Staged Development, a new 800 mm header line along the Junction Canal should be constructed around 1990 to handle the increased finished water output from the converted slow sand filters. See Figure 7-A for the location of the new piping.

## 7.9 FLOW METERING

Existing Facilities

For proper chemical feed control, each flow train should be metered and its flow indicated in the chemical feed area. For proper backwash control, the washwater flow rate should be indicated at the rapid sand filter operating floors. To provide an overall record of plant production, the discharges from the finished water pumping stations should be metered, recorded and "totalized" individually.

The El Raswa plant was equipped with many of the needed meters, but at present none are in use. The metering devices (venturi tubes) in the locations listed below are serviceable:

| Primary Meter Location | Required Read-out Devices | Readout Location | Maximum Reading cu m/d |
|---|---|---|---|
| Finished Water Discharge, Main Station | Indicator/ Recorder | Main Operating Floor | 75,000 |
| Finished Water Discharge, Bamag Station | Indicator/ Recorder | Main Operating Floor | 75,000 |
| Bamag Raw Water | Indicator | Chemical Feed Room | 60,000 |
| Bamag Filter Effluent | Indicator | Laboratory | 60,000 |
| Bamag Washwater | Indicator | Filter Gallery | 25,000 |

Facilities Under Construction

In the slow sand section, new raw water and washwater metering for flow trains #2 and #3 is to be provided in the CTE conversion. Flow indicators will be located in the chemical feed and filter control area.



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Recommended Program

- Provide the metering devices listed above with flow transmitters and indicators, or indicator recorders.

- Equip the Annex Pump Station with complete finished water flow metering (75,000 cu m/d), including primary metering device, transmitter and indicator/recorder. The new metering equipment should be selected and planned, as far as feasible, for ultimate use in the new Finished Water Pumping Station and in the Bamag Raw Water Station.

- Install Parshall flumes with transmitters and readout devices in flow trains #1, #4 and #5 to measure the flow of raw water to the chemical feed points. Initially, the maximum readout to each train should be 25,000 cu m/d, designed and arranged for doubling in the future. Measurement of roughing filter backwash rates are not necessary.

## 7.10 WASHWATER AND SLUDGE DISPOSAL

Both rapid and slow sand sections of the plant have gravity drains to carry washwater and settling tank sludge to the Junction Canal in front of the plant. The Bamag flocculator/clarifiers are equipped with scrapers. Sludge can be discharged without dewatering the tank. Settling tanks in flow trains #1, #4 and #5 are periodically dewatered and sludge is hosed to the drains.

The tanks in the CTE conversion have multiple port-drawoff pipes that are intended to remove sludge. The drawoff system covers only a portion of the basin and is placed about 30 cm above the floor. The floor slopes toward the center but is not steep enough to move sludge. The system relies on the differential head between the settling basin water level and the water level in the Junction Canal.

The CTE system has been modified considerably during construction and design data and details have not been made available; therefore, hydraulic analyses and/or recommendations for sludge and washwater disposal have not been made.

## 7.11 ELECTRIC POWER

Electric power for operating the water treatment plant and pumping stations is drawn from the SCA generating stations at El Raswa and at Port Fouad. The two interconnected, oil fired steam generating stations have a total capacity of 7140 KVA.

As shown in Figure 7-F, power is delivered at 5.5 KV through 3 substations at the water plant:

| | | Maximum Demand Feb. 1978 |
|---|---|---|
| (1) | Main Pumping Station and Auxiliary Raw Water Pumping Station | 236 KW |
| (2) | Annex Pumping Station | 207 KW |
| (3) | Bamag Pumping Station | 552 KW |
| | Total | 995 KW |

Under the proposed rearrangement of pumps, the Main, Auxiliary, Raw Water, and Annex Pumping Stations will be eliminated, and the Bamag Pumping Station converted to raw water pumping exclusively. In this service the initial connected load is estimated at 1300 KVA and ultimate at 1700 KVA. At the proposed new finished water pumping station, the connected load will be 3150 KV initially, 4150 KV ultimately. Total connected loads, ranging from 3000 KVA initially to 5850 ultimately, would be several times the present requirements, and in themselves would tax heavily the two SCA stations.

The SCA system is adequate today and has proved reliable. As the sole source supply, however, it exposes the water plant to the risk of extended power outages. To correct this deficiency and hazards, and to meet increased loads in the immediate future a connection to the Port Said municipal system must be made. The municipal system presently obtains power from in-town generators, and a 220 KV line to the national power grid is planned in the near future. It is assumed that the municipal system would pay for service lines to new 11 KV switchgear water plant.

The electric power system at the water plant is deficient in many respects. The existing power circuit breakers do not have published interrupting ratings. As main power system short-circuit values increase (particularly if supply is from the municipal system), the breakers will not safely interrupt short-circuit currents. The breakers are oil-filled, endangering plant personnel. Failure could result in serious fires. The disconnect switches are single pole, hookstick-operated, bare knife type. Opening such switches, one phase at a time, causes severe arcing and is hazardous to operating personnel. These switches cannot be opened safely until the load has been removed. The switchgear is protected by expanded metal screens, not solid steel boxes. The screens are likely to fall into the live parts of the switchgear when being removed. Bare live parts in the basement could cause short circuits in the event of flooding or rodent intrusion.

Installation is recommended of the new switchgear, transformers and motor control centers described in Table 7.6 and Appendix D. Equipment has been sized to carry the ultimate loads expected at the converted Bamag Pumping Station and at the proposed new Finished Water Pumping Station. (Part of the equipment ultimately installed in the new station will be placed in the Main Pumping Station and Bamag Pumping Station to drive the new finished water pumps temporarily installed there.)

Proposed final disposition of the proposed new electrical equipment and interconnections is shown in Figures 7-G and 7-H. When the new electric power system is complete and machinery hooked up, the existing SCA 5.5 KV services and transformers would be retained for standby service, but the 380/190 volt switchgear, wiring, and controllers would be removed from the plant.

## 7.12 COSTS

Costs for the program to upgrade and enlarge the El Raswa WTP, as described in this chapter, are summarized in Table 7.7. The costs of additional treatment capacity were estimated on the following basis:

| | |
|---|---|
| New Facilities | LE 55 per cu m/d |
| Initial Upgrading Flow Trains 4, 5 | LE 38.5 per cu m/d of capacity increase (70% of cost of new facilities) |



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| | |
|---|---|
| Final Upgrading Flow Trains 4, 5 | LE 5.50 per cu m/d of capacity increase (10% of cost of new facilities) |
| Existing Bamag and Flow Trains 2, 3 | LE 11 per cu m/d of capacity increase (20% of cost of new facilities) |

These costs are substantially higher than those reported for the current CTE and Bamag work at El Raswa. The higher figures properly reflect 1978-level costs for flexible, conservatively designed facilities with equipment imported from the U.S. and with U.S. supervised construction. We see no basis for expecting comparable civil works construction to cost significantly less in Egypt than in the U.S. under these conditions. As noted earlier, some major savings may be realized through imaginative design. We feel it is premature to assume these savings at this early date. Costs of pumping stations and miscellaneous work at El Raswa were estimated individually, using the basis for delivered equipment prices and unit construction costs presented in Chapter 5 and Appendix B.

## 7.13 ALTERNATIVE ARRANGEMENT FOR PUMPING AND CHLORINATION FACILITIES

During review of the final report draft, SCA suggested an alternative arrangement for pumping and chlorination facilities at the El Raswa water treatment plant. The principal features would be:

- Extension of the proposed Finished Water Pumping Station structure to house the proposed central chlorination facility (see Figure 7-1).

- Use the raw and finished water pumps purchased under AID/CIP* to reequip the Main Pumping Station as a permanent standby facility and the Bamag station. (The pumps in the Main Station would operate on the existing electrical system which is being improved and enlarged by SCA under AID/CIP)

The 1981 installed capacity of the new Finished Water Pumping Station and of the Bamag station (converted to raw water pumping) would remain the same, but none of the new pumps for these stations would be installed temporarily at the Main station. In all other respects the programs for chlorination and pumping facilities would remain as outlined in Sections 7.6 and 7.7. (The three new SCA finished water pumps, installed temporarily in the Bamag station, would later be moved to the new Finished Water Station.)

The alternative arrangement would entail added costs of L.E. 45,000 for the new structure of the chlorine facility. These costs would be more than offset by some LE 200,000 already allocated in the AID/CIP for electrical equipment at the Main Station and for the six new SCA pumps to be installed in the Bamag station. In any case, overall WWFMP costs and system financing would not change significantly if the alternative arrangement were used.

The decision whether to reequip the Main pump station, either temporarily or permanently, should be kept open until the inception of design work. The decision should then take into account the following:

---

*AID/Commodity Import Program

- suitability of SCA pumps
- actual delivery schedule for SCA pumps
- actual construction schedule for new finished water pumping station
- actual increases in demand.

## TABLE 7.1

## DRINKING WATER STANDARDS

### CHEMICAL PROPERTIES
(mg/l except for pH)

| PARAMETER | USEPA | WHO | ARE | SCA | WWFMP RECOMMENDATI |
|---|---|---|---|---|---|
| pH (range) | 6.5-8.5 | 6.5-9.2 | 6.5-9.2 | 6.8-8.5 | 6.8-8.5 |
| Total Dissolved Solids | --- | 1500 | 1500 | 1000 | 1000 |
| Hardness, $CaCO_3$ | --- | 500 | 500 | 400 | 400 |
| Calcium | --- | 200 | 200 | 125 | 125 |
| Iron | 0.3 | 1.0 | 1.0 | 1.0 | 1.0 |
| Manganese | 0.05 | 0.5 | 0.5 | 0.5 | 0.5 |
| Chromium ($Cr\ 6^+$) | 0.05 | --- | --- | 0.05 | 0.05 |
| Chloride | 250 | 600 | 600 | 400 | 400 |
| Sulfate | 250 | 400 | 400 | 300 | 300 |
| Nitrate | 45 | 45 | 45 | 45 | 45 |
| Arsenic | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Copper | 1.0 | 1.5 | 1.5 | 1.5 | 1.5 |
| Lead | 0.05 | 0.1 | 0.1 | 0.05 | 0.02 |
| Cyanide | --- | 0.05 | 0.05 | 0.02 | 0.02 |
| Magnesium | --- | 150 | 150 | 75 | 75 |
| Mercury | 0.002 | 0.002 | 0.001 | --- | 0.001 |
| Selenium | 0.01 | 0.01 | 0.01 | --- | 0.01 |
| Zinc | 5 | 15 | 15 | 15 | 15 |
| Phenol | --- | 0.002 | 0.002 | --- | 0.002 |

### PHYSICAL PROPERTIES

| | | | | | |
|---|---|---|---|---|---|
| Color(1) | 15 | 50 | 50 | 5 | 5 |
| Turbidity(2) | 1 | 5 | 5 | 5 | 1 |
| Taste | --- | U | A | --- | A |
| Odor(3) | 3 | U | A | --- | A |

(1) Platinum - Cobalt Color Units
(2) Nephelometric Turbidity Units
(3) Threshold Odor Number
--- Not indicated
U Unobjectionable
A Acceptable

## TABLE 7.2

## FINISHED WATER QUALITY

| | El Raswa WTP July-August, 1978 | |
|---|---|---|
| pH | 7.4 | 7.3 |
| Electroconductivity, u mhos/cm | 405 | 405 |
| Total Dissolved Solids, mg/l | 230 | 230 |
| Suspended Solids, mg/l | 0.5 | 0.2 |
| Color, Cobalt Units | 5 | 5 |
| Turbidity, NTU | 0.4 | 0.6 |
| Alkalinity, mg/l as $CaCO_3$ | 92 | 96 |
| Hardness, mg/l as $CaCO_3$ | 120 | 115 |
| Calcium, mg/l as Ca | 29 | 26 |
| Total Iron, mg/l | 0.2 | 0.2 |
| Manganese, mg/l | nd | nd |
| Hexavalent Chromium ug/l | nd | nd |
| Chloride, mg/l | 32 | 30 |
| Silica, mg/l $SiO_2$ | 8 | 10 |
| Sulfate, mg/l | 30 | 35 |
| Ammonia Nitrogen, mg/l | - | - |
| Nitrate, mg/l as $NO_3$ | 0.1 | 0.2 |
| BOD, mg/l | 0 | 0 |
| COD, mg/l | - | - |
| Total Phosphorus, mg/l | 0.22 | trace |

Analyses performed by Hazen and Sawyer.
nd - not detected

TABLE 7.3

EL RASWA WTP WATER ALGAE COUNT (1978)
(Algae per ml)

| | Filaments | Colonies | Non-Filamentous Green | Diatoms | Total |
|---|---|---|---|---|---|
| Aug. 15 | | | | | |
| Raw | 22 | 18 | 37 | 554 | 631 |
| Stream 1* | 0 | 4 | 20 | 38 | 62 |
| Bamag* | 7 | 9 | 11 | 51 | 78 |
| Aug. 16 | | | | | |
| Raw | 29 | 6 | 13 | 631 | 679 |
| Stream 4* | 29 | 6 | 13 | 631 | 679 |
| Bamag* | 2 | 7 | 18 | 524 | 551 |
| Aug. 17 | | | | | |
| Raw | 13 | 9 | 22 | 375 | 419 |
| Stream 5* | 4 | 7 | 20 | 56 | 87 |
| Bamag* | 16 | 7 | 18 | 120 | 161 |

*Samples obtained from settled water before entering filters. Examination of filters showed round worms plus the same Anacystis Sp. colonies, filamentous green algae and deleterious material seen in the settled water. In addition, large clumps of a filamentous green algae, probably Ulothrix, not observed in the raw or settled water, were floating on some of the Stream 1 filters.

## TABLE 7.4

## EL RASWA WTP CAPACITIES VS. SUPPLY REQUIREMENTS

| Flow Trains | With CTE Modifications and New Bamag Plant | | With Initial System Upgrading | | Possible Ultimate Capacities | |
|---|---|---|---|---|---|---|
| | cu m/d | cu m/hr | cu m/d | cu m/hr | cu m/d | cu m/hr |
| 1 | 6,000 | 250 | 10,000 | 415 | 35,000 | 1,460 |
| 2 | 40,000 | 1,670 | 40,000 | 1,670 | 50,000 | 2,085 |
| 3 | 40,000 | 1,670 | 40,000 | 1,670 | 50,000 | 2,085 |
| 4 | 10,000 | 415 | 35,000 | 1,460 | 50,000 | 2,085 |
| 5 | 10,000 | 415 | 35,000 | 1,460 | 50,000 | 2,085 |
| SUBTOTAL | 106,000 | 4,420 | 160,000 | 6,675 | 235,000 | 9,800 |
| Existing Bamag | 35,000 | 1,460 | 50,000 | 2,085 | 50,000 | 2,085 |
| SUBTOTAL | 141,000 | 5,880 | 210,000 | 8,760 | 285,000 | 11,885 |
| New Bamag | 70,000 | 2,915 | 70,000 | 2,915 | 70,000 | 2,915 |
| TOTAL | 211,000 | 8,795 | 280,000 | 11,675 | 355,000 | 14,800 |

| | | 1978 | 1982 | 1985 | 1990 | 1995 | 2000 | For 750,000 Population(3) |
|---|---|---|---|---|---|---|---|---|
| Average Day Demand | cu m/d | 90,000 | 116,000 | 138,000 | 178,000 | 216,000 | 258,000 | 290,000 |
| Maximum Day Demand(1) | cu m/d | 113,000 | 145,000 | 173,000 | 223,000 | 270,000 | 323,000 | 364,000 |
| Peak Hour Demand(2) | cu m/d | 153,000 | 197,000 | 235,000 | 303,000 | 367,000 | 439,000 | 495,000 |
| Peak Hour Demand | cu m/hr | 6,375 | 8,210 | 9,790 | 12,620 | 15,290 | 18,290 | 20,600 |

(1) 1.25 times average day demand
(2) 1.7 times average day demand
(3) At year 2000 per capita flows

TABLE 7.5

WATER PUMPS AT EL RASWA WTP

| Location | Pump No. | Capacity cu m/hr | Motor HP | Year Station Installed |
|---|---|---|---|---|
| | | Raw Water Pumps | | |
| Main Station | 1 | 400 | 22 | 1924 |
| | 2 | 400 | 41 | |
| | 3 | 700 | 41 | |
| | 4 | 700 | 40 | |
| Auxiliary Station | 5 | 700 | 45 | 1946 |
| | 6 | 400 | 22 | |
| | 7 | 400 | 22 | |
| | 8 | 700 | 50 | |
| Rapid (Bamag) | 9 | 1080 | 46 | 1964 |
| | 10 | 1080 | 46 | |
| | 11 | 1080 | 46 | |
| | | Finished Water Pumps | | |
| Main Station | 1 | 400 | 90 | 1924 |
| | 2 | 500 | 90 | |
| | 3 | 500 | 90 | |
| | 4 | 400 | 90 | |
| Annex | 5 | 400 | 90 | 1946 |
| | 6 | 1000 | 190 | |
| | 7 | 500 | 90 | |
| | 8 | 1000 | 170 | |
| Rapid (Bamag) | 9 | 900 | 175 | 1964 |
| | 10 | 900 | 175 | |
| | 11 | 900 | 175 | |

## TABLE 7.6

## RECOMMENDED ELECTRICAL EQUIPMENT
## EL RASWA WTP

| Location | Item | No. | Capacity | Characteristics | Specifications Reference (See Appendix D) |
|---|---|---|---|---|---|
| | | | KVA Rating | Voltage Ratio | |
| Bamag P.S. | 3-Phase Transformer | 2 | 1500 | 11 KV 380-220V | G |
| New F.W.P.S.(1) | 3-Phase Transformer | 2 | 2500/3125 | 11 KV 3300V | G |
| | | | | No. Mains/Feeders | |
| Bamag P.S. | Switchgear | | | 2/3(5) | H |
| New F.W.P.S. | Switchgear | | | 2/4(5) | H |
| Bamag P.S. | Motor Control Center | 1 | | | I |
| New F.W.P.S. | Motor Control Center | 1 | | | I |
| Flow Trains 1, 4 & 5(2) | M.C.C., Starters, Wiring, Misc. | | | | I |
| Main Station A(3) | | | | | |
| Bamag P.S.(4) | | | | | |

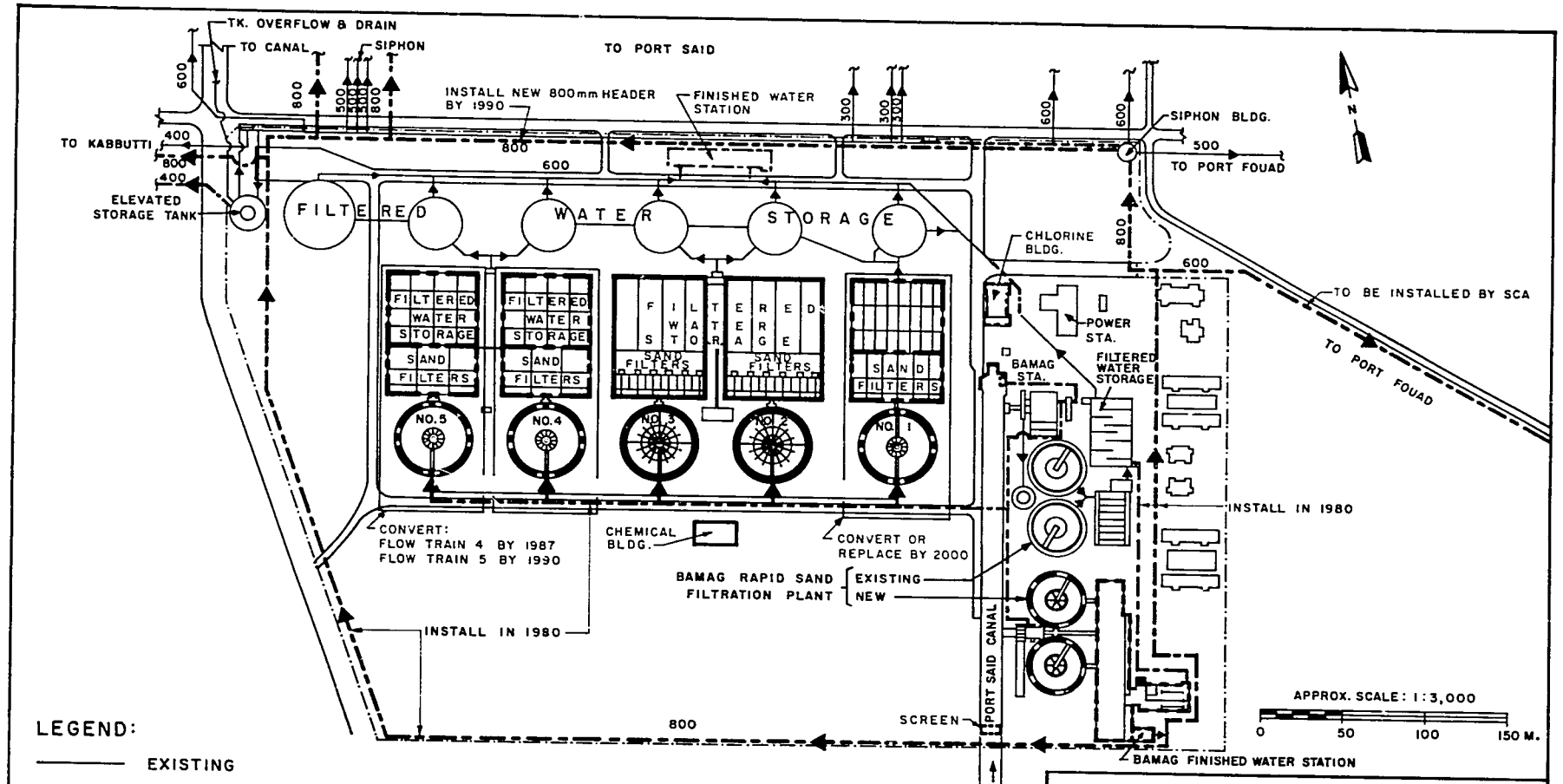
(1) Finished Water Pumping Station
(2) Washwater pumps and new flow meters
(3) Chlorination Facilities
(4) Flow meters
(5) Includes alternate supply circuit breakers.
Costs include temporary and permanent installation.

TABLE 7.7

RECOMMENDED PROGRAM
EL RASWA WTP COSTS
(Thousands of 1978 LE)

| | Civil/ Pipe | Mechanical | TOTAL | Foreign | Local |
|---|---|---|---|---|---|
| **HIGH PRIORITY** | | | | | |
| Local Measures | 14 | 4 | 18 | - | 18 |
| Equipment Procurement | - | 1962 | 1962 | 1424 | 538 |
| Major Capital Projects | 1683 | 470 | 2153 | 1273 | 880 |
| Subtotal | 1697 | 2436 | 4133 | 2697 | 1436 |
| **IMMEDIATE PHASE** | | | | | |
| Major Capital Projects | 101 | 136 | 237 | 134 | 103 |
| **STAGED DEVELOPMENT** | | | | | |
| Initial Upgrade-Unit 4 | 464 | 696 | 1160 | 635 | 525 |
| Initial Upgrade-Unit 5 | 464 | 696 | 1160 | 635 | 525 |
| Upgrade Existing Bamag | 100 | 150 | 250 | 137 | 113 |
| Final Upgrade-Unit 4 | 50 | 76 | 126 | 69 | 57 |
| Final Upgrade-Unit 5 | 50 | 76 | 126 | 69 | 57 |
| Final Upgrade-Units 2+3 | 133 | 200 | 333 | 182 | 151 |
| Final Upgrade-Unit 1 | 1166 | 1750 | 2916 | 1598 | 1318 |
| Purchase & Install New Pumps | - | 643 | 643 | 529 | 114 |
| Reinforce Header Pipe | 239 | - | 239 | 167 | 72 |
| Subtotal | 2666 | 4287 | 6953 | 4021 | 2932 |
| TOTAL | 4464 | 6859 | 11323 | 6852 | 4471 |

All figures include 20% contingencies and 31.5% support services except for local measures where not required. See Tables 9.1, 9.2, and 9.3 for a detailed breakdown of High Priority and Immediate Phase projects.

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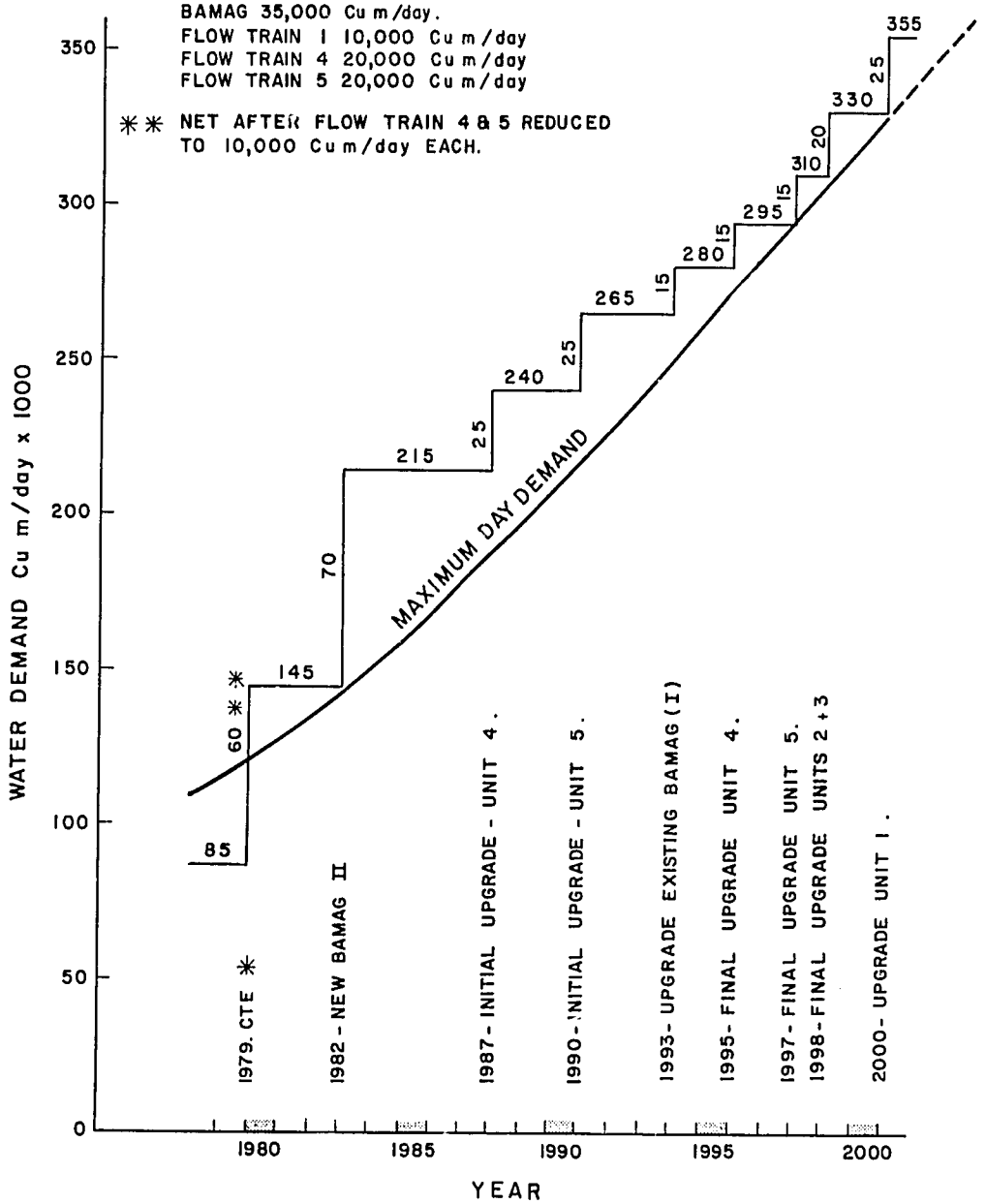
PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

**EL RASWA WTP**
**PROPOSED LAYOUT**

VOL.2
FIG.
7-A

22

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SCHEDULE OF EL RASWA PLANT IMPROVEMENTS

VOL.2
FIG. 7-B

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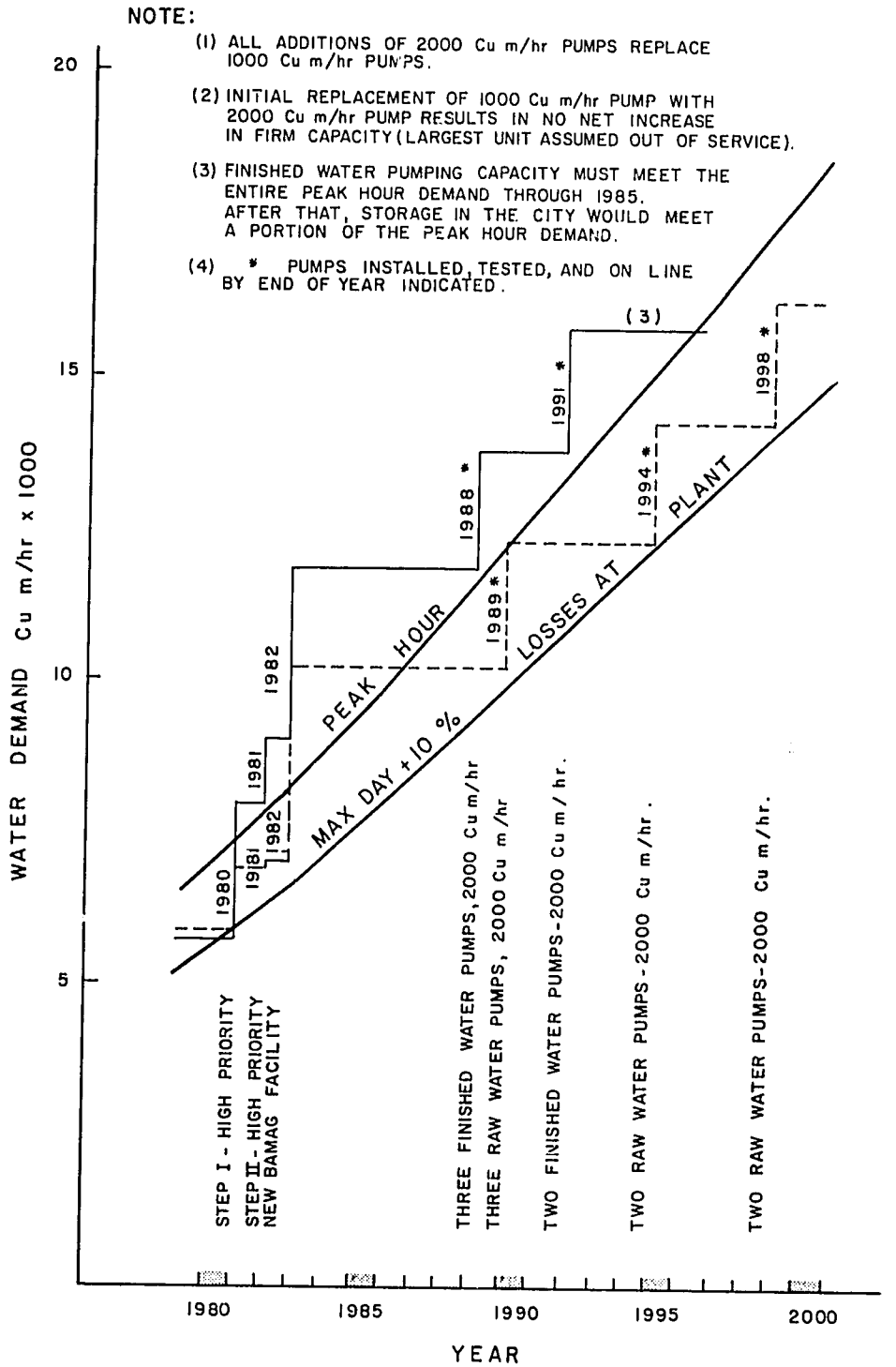
N52321

123

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SCHEDULE OF WATER PUMP ADDITIONS

VOL. 2
FIG. 7-C

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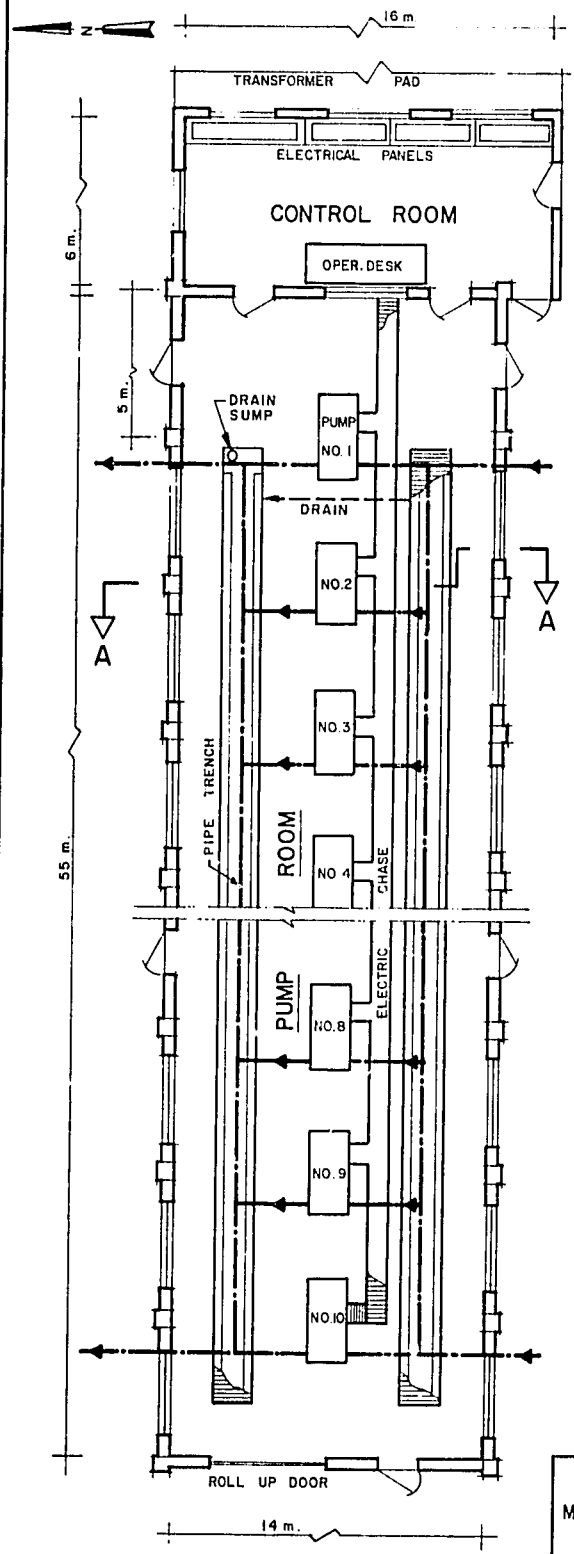
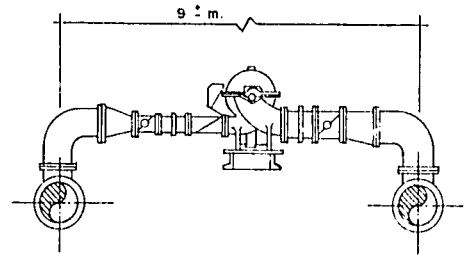
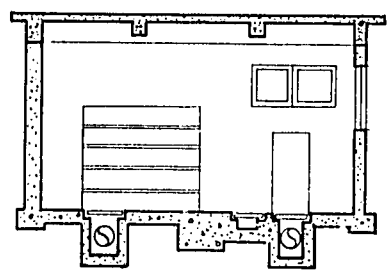



PLAN




TYPICAL SECTION AT PUMP



SECTION A-A

NOT TO SCALE

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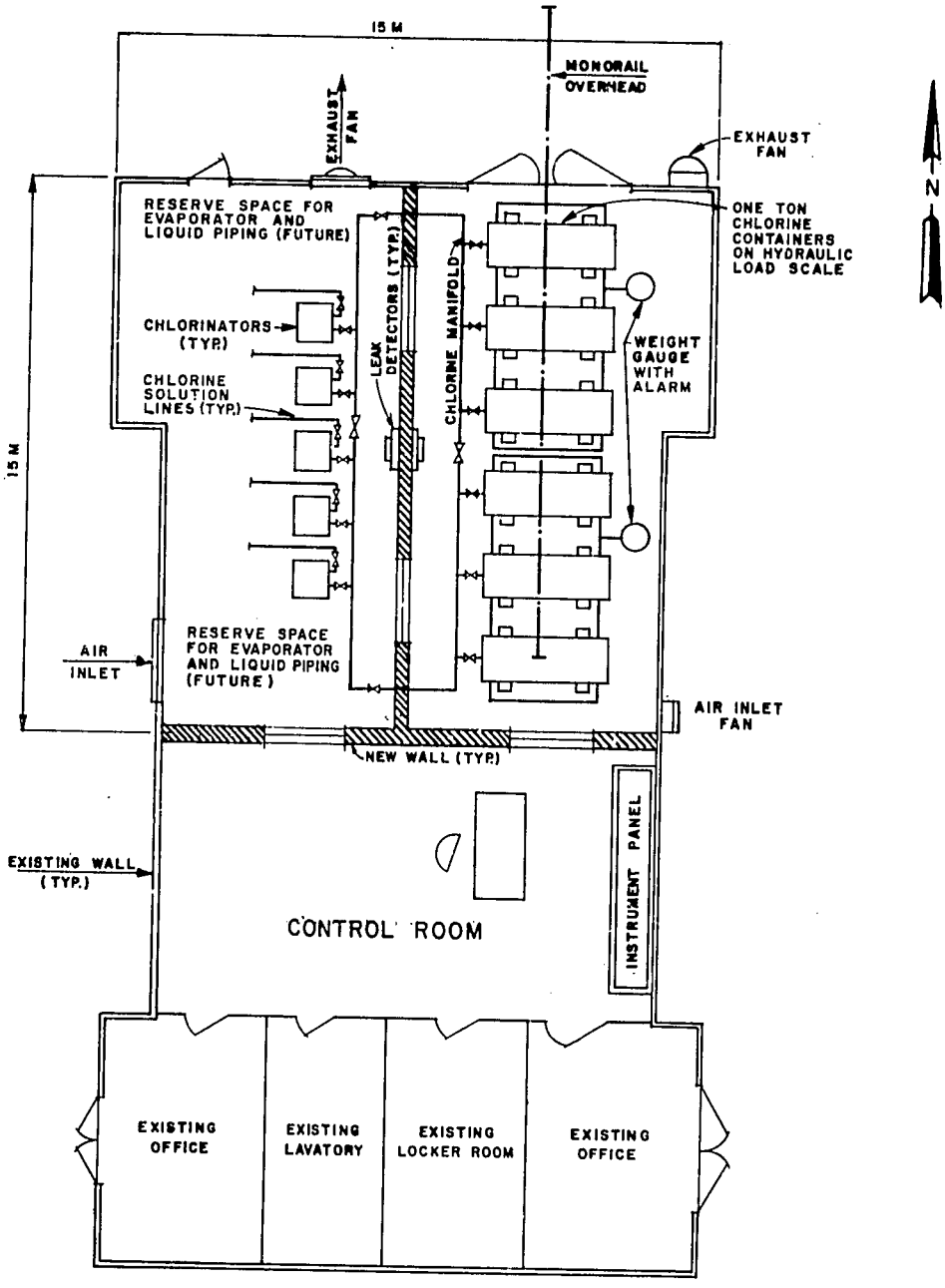
EL RASWA
PROPOSED FINISHED WATER
PUMP STATION

VOL. 2
FIG.
7-D

125




PLAN

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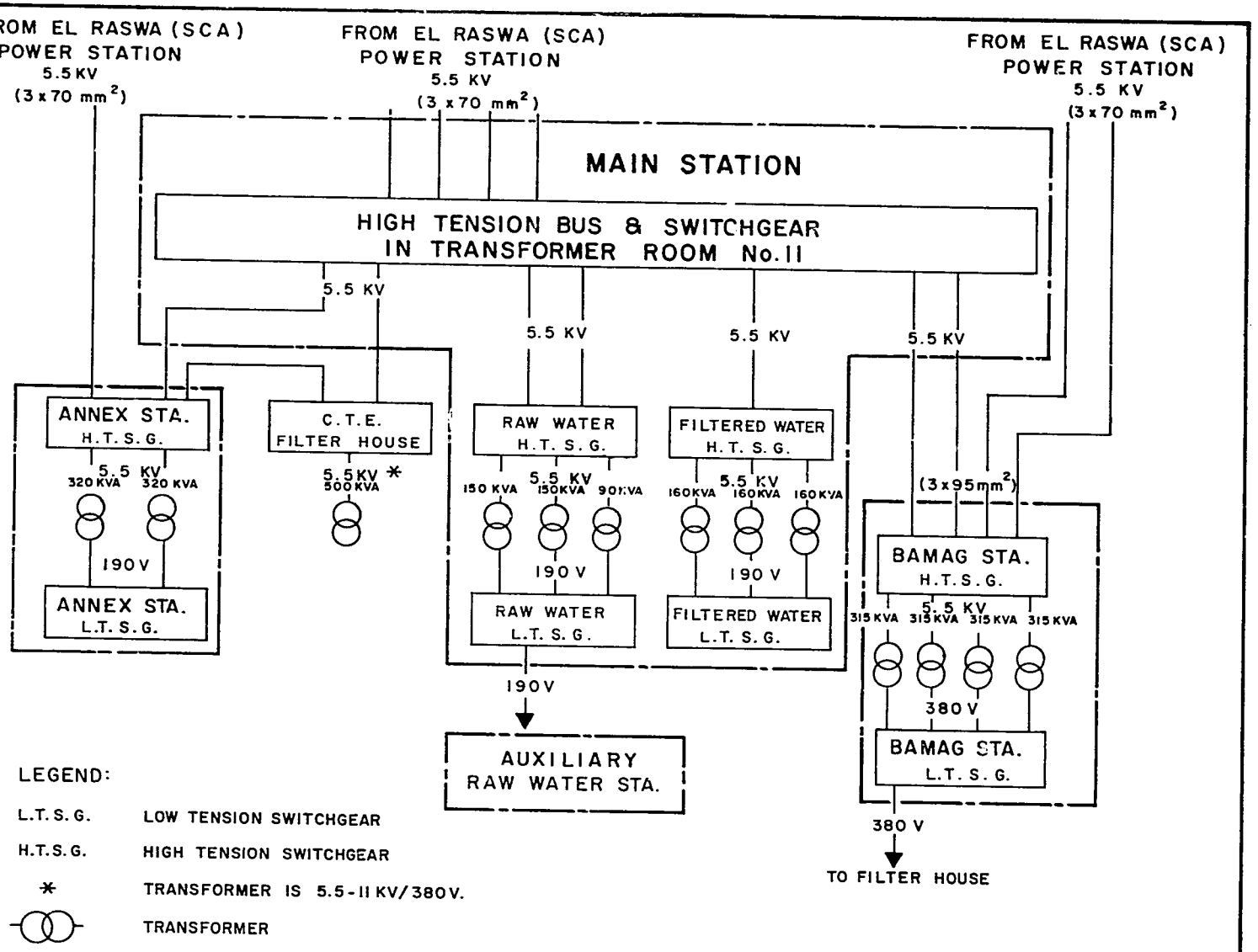
PROPOSED CHLORINATION FACILITIES AT EL. RASWA

VOL. 2
FIG. 7-E

126

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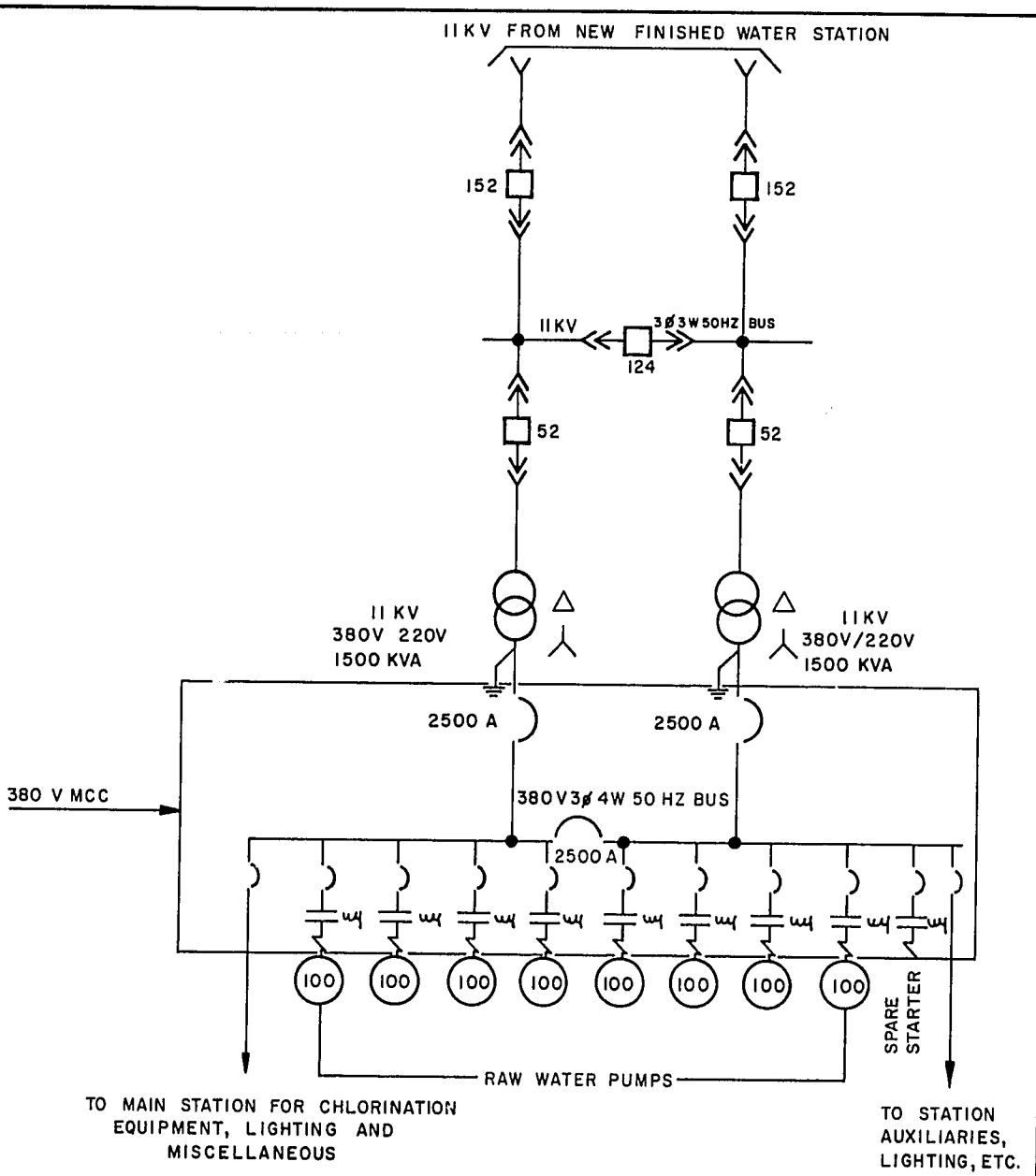
EL RASWA EXISTING WATER TREATMENT PLANT
ELECTRICAL BLOCK DIAGRAM

VOL. 2
FIG. 7-F




## SYMBOLS

152 — DRAWOUT TYPE POWER CIRCUIT BREAKER MAIN

124 — DRAWOUT TYPE POWER CIRCUIT BREAKER BUS TIE

52 — DRAWOUT TYPE POWER CIRCUIT BREAKER FEEDER

LOW VOLTAGE 3 POLE CIRCUIT BREAKER

100 — MOTOR HORSEPOWER AS NOTED

MCC — MOTOR CONTROL CENTER

STARTER & CONTACTOR

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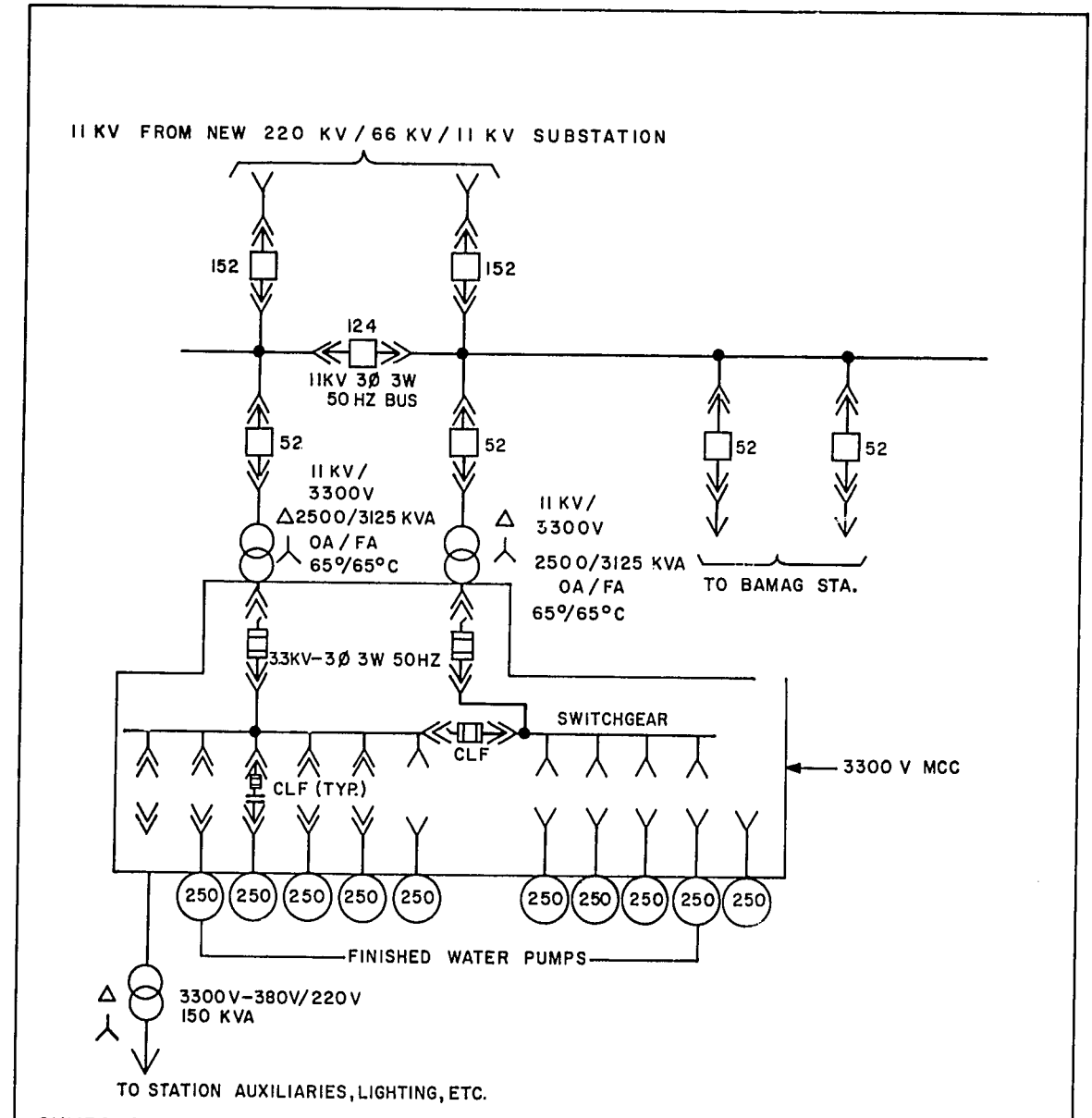
**EL RASWA BAMAG PUMPING STATION PROPOSED SUBSTATION SINGLE LINE DIAGRAM**

VOL. 2
FIG. 7-G




SYMBOLS:

TRANSFORMER

250 MOTOR HORSEPOWER AS NOTED

CLF DRAWOUT TYPE LOAD-BREAK SWITCH WITH CURRENT-LIMITING FUSES.

CURRENT-LIMITING FUSES

CLF CONTROLLER (DRAWOUT TYPE)

MCC MOTOR CONTROL CENTER

NOTE:

NUMBER OF MAIN FEEDERS SUBJECT TO CHANGE AFTER OPTIMIZATION STUDY.

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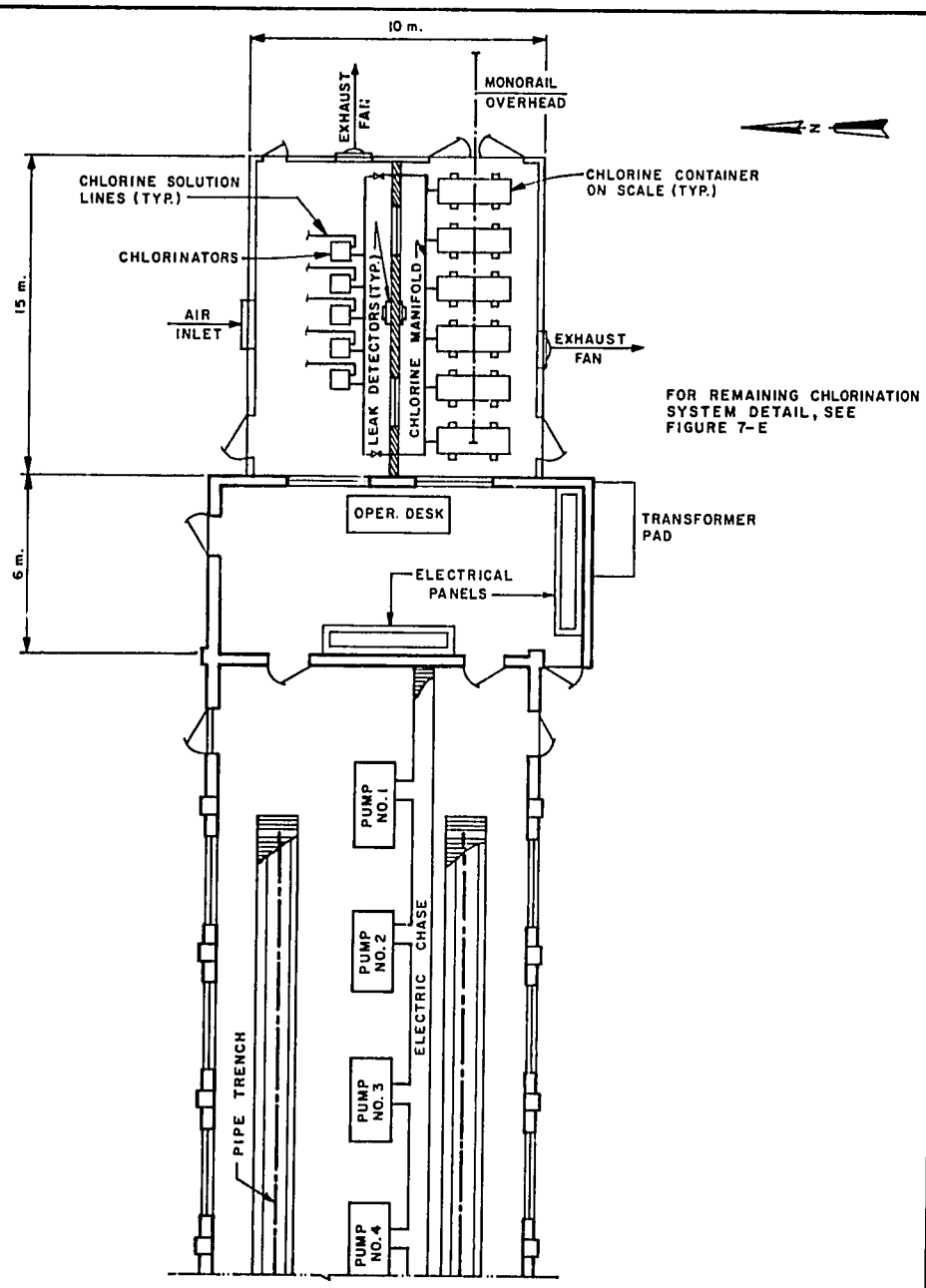
EL RASWA NEW FINISHED WATER STATION PROPOSED SUBSTATION SINGLE LINE DIAGRAM

VOL.2
FIG.
7-H

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ALTERNATIVE FINISHED WATER PUMPING STATION WITH CHLORINATION FACILITIES

VOL.2 FIG. 7-I

CHAPTER 8

WATER DISTRIBUTION

## 8.1 GENERAL DESCRIPTION

The Port Said water distribution system draws its supply from the El Raswa Water Treatment Plant. Plate 1 shows the general layout of the system, which includes some 67 km of primary water mains, 200 to 800 mm in diameter.

Pressure is maintained by the finished water pumps, with a portion of the peak hour demand met by a small elevated storage tank at the plant. The distribution system is relatively strong and capable of meeting normal and peak demands over most of the city. Serious city-wide pressure problems have generally been due to reduced pumping at El Raswa or shutdowns because of inadequate raw water. Chronic low water pressures throughout the city during the early phases of the studies were subsequently improved when one of the siphons to Port Fouad, found by pitometer measurements to be leaking 16,000 cu m/d, was closed off (see Section 4.1).

With normal operation at El Raswa after isolation of the leaking siphon, pressures are near or above 20 m during maximum demand periods (Table 8.1). Problem areas, shown on Figure 8-A, are in the northwest part of the city where the pressure drops to less than 10 m during periods of high demand and in areas where isolating valves may be partially closed.

### Distribution System Contamination

In addition to identifying areas of inadequate water supply, low distribution system pressures increase the hazards of water main contamination through cross connections or leaky mains. To gage the sanitary quality of water distributed in Port Said, and to check SCA laboratory procedures at the same time, a parallel bacteriological testing program was made. Standard coliform MPN tests were used. Of 53 samples collected over a 10-day period in April and May 1978, 18 samples, all taken in the western part of Port Said (see Figure 8-B), showed positive. These samples indicated severe contamination of this part of the distribution system, or inadequate chlorination of water at El Raswa, and perhaps both. Since the western part of Port Said was subject to low pressure much of the time, and undoubtedly zero pressure on occasion, the positive results there were not surprising. Subsequent testing in August showed an improvement in the sanitary quality of the water. Of 50 sampling points, five yielded positive results. The restoration of continuous pressure following closure of the leaky siphon was probably the major cause of the better quality, but the proportion of positive samples, 10 percent, is still higher than desirable. The test results differed substantially from those obtained by the SCA laboratory, some of which may be due to deficiencies in existing SCA procedures.

Surveys have been made to identify possible sources of contamination. Fire hydrant pits have been observed to be full of water due to leaks. Residual chlorine has been found to be insufficient in some areas shown on Figure 8-B where coliforms are present. Water sampling August 7-9, 1978 indicated chlorine residuals ranging between 0.1 and 1.5 mg/l, as shown in Figure 8-C. The chlorine dose applied to water leaving the slow sand filters and pumped by the Annex Station should be increased from 1.0 mg/l currently used to 1.5 or 2 mg/l. Roof tanks, as used in Port Said, do not seem to be a source of contamination.

Distribution System Leakage

Field testing in Port Said from April to September, 1978 indicated more than 24,000 cu m/d leakage from the distribution system, or approximately 1/4 of the pumping at El Raswa. Leaks identified, but not all measured, included the following:

| Locations | Estimated Quantity |
|---|---|
| - El Raswa near Annex Pumping Station | 400 cu m/d |
| - Line on north side of Junction Canal | 2,000 cu m/d |
| - Valve on Port Fouad side of No. 16 Siphon | 2,000 cu m/d |
| - South Port Fouad siphon (No. 9) on island | 16,000 cu m/d |
| - Old Damietta line after Siphon No. 5 | 1,500 cu m/d |
| - Transmission main near No. 11 Siphon | 1,500 cu m/d |
| - Three open 25 mm taps in military area northwest of city | 1,500 cu m/d |
| - Water main leak in Port area near SCA Headquarters | unknown |

The 16,000 cu m/d leak in the Port Fouad siphon, detected and confirmed by pitometer measurements, was dramatic. Closure of the siphon had a marked effect on distribution system pressures and water service. While other leaks as large as this are not likely to be found, the cost of treatment and pumping of the estimated total leakage compels immediate attention and correction.

## 8.2 PRIMARY DISTRIBUTION PIPES/STORAGE

### Existing Facilities

#### Water Mains

The distribution system is divided into two sections, Port Said and Port Fouad. The primary distribution system is shown on Plate I. The Port Said system is connected to the El Raswa Treatment Plant by four siphons: two 600 mm siphons meeting an 800 mm line in El Raswa Road; one 600 mm siphon meeting an 800 mm line in El Nasr Road; one 400 mm siphon at El Kabbutti Road. Major loops go to the center of the city with most of the city fed through 300 and 400 mm mains.

The Port Fouad system is connected to the Port Said system by the 500 mm north siphon. The three other siphons serving Port Fouad, one from Port Said and two from the El Raswa plant, are out of service. Figure 8-D shows all known siphons, and Table 8.2 the physical condition of the siphons.

Table 8.3 is an inventory of the principal transmission and distribution mains 200 mm and larger in diameter. Hazen and Williams "C" factors were estimated chiefly on the basis of age. Most mains are cast iron, with recent additions cement-lined ductile iron or asbestos-cement pipe. Pipe is generally in good condition except for several old steel pipe siphons and steel pipes laid in the corrosive groundwater. Flows through the siphons were measured by pitometers installed at each end of the siphon, with pressure measurements taken half hourly over a 24 hour period. On the basis of this investigation it was concluded that the seven abandoned siphons should be physically detached and plugged. This should



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eliminate an estimated 700 cu m/day leakage. An additional 1500 cu m/day could be eliminated by replacing Siphon No. 5. Siphon No. 9, with a measured leakage of 16,000 cu m/day, has been closed and is being inspected to determine the cause of the leak. Except for these problems, the siphons are considered to be in fair condition.

Reservoirs

Existing distribution storage totals 15,000 cu m, all located at El Raswa. Except for one 1000 cu m elevated tank, the reservoirs are ground storage tanks, feeding the El Raswa finished water pumps for delivery to Port Said.

Facilities Under Construction

Water Mains

One new 600 mm fiberglass siphon is under construction near El Raswa to replace the abandoned southern siphons to Port Fouad, and installation of a second 600 mm siphon is planned in the future. Two new 800 mm siphons will be installed across the Junction Canal to serve Port Said. Pipe is on the ground ready to be laid along Nasr Road to provide a third 800 mm transmission line from El Raswa to the center of Port Said. These improvements are part of the first stage of an on-going SCA program to reinforce the existing system.

Reservoirs

The CTE conversion of slow sand filter trains #2 and #3, will increase the ground storage at El Raswa by 12,000 cu m, and completion of the second Bamag unit will add another 5,000 cu m.

Recommended Program

Improvements to the primary distribution system are aimed at maintaining a minimum of 20 meters pressure throughout the system at all times. A three part program is recommended: 1) leak survey and repairs; 2) continued reinforcement of the water mains; and 3) addition of distribution storage.

## 8.3 LEAK SURVEY AND REPAIRS

The objective of a leak survey is to find where water is being lost between the water treatment plant and the customer's meter. Two levels of leak surveying are recommended:

(1) Sound and Visual Survey

Many of the distribution leaks are easily found as they are surrounded by high green grass or water can be seen flowing on the surface of the ground. Service pipe leaks may be apparent from the continuous discharge of water onto sidewalks and streets. Leaks in pipes under water are more difficult to find unless they are large enough to cause bubbles floating to the surface. Water escaping through cracked pipe or fittings can be heard with sounding equipment. Sound detection can be started at once, presumably carried out by Port Said personnel after a two month training period. This survey should locate the large leaks not evident from the surface.

(2) Velocity Surveys

Velocity surveys, capable of identifying much smaller leaks, depends upon tight gate valves for dividing the system into sections. Replacing valves and leaky hydrants as recommended in this report is expected to require one to two years and perhaps longer. Until then velocity surveys are not feasible. The methods and procedures for such surveys are outlined in Appendix E.

## 8.4 REINFORCEMENT OF PRIMARY DISTRIBUTION MAINS AND ADDITIONAL STORAGE

### Distribution Mains

Computer models were used to analyze the distribution system based on programs developed for this specific purpose. The project scope requires that such a program be furnished to SCA and that assistance be given to adapt it for use on SCA computer systems. To meet this requirement, we developed a fully documented new program able to model primary distribution networks of the size expected in Port Said, including projects in progress. The program used the Newton-Raphson technique and matrix algebra to solve iteratively the non-linear simultaneous equations describing network flow and headloss. For simplicity the method does not take into account ground elevation differences, which are negligible in Port Said. The program is not included in this report and will be submitted separately, with documentation as to modifications needed for use on other systems.

Analysis of a number of designs was required before the above program was completed. For these analyses we used a similar program available from ES-Parsons. Although this latter program has a larger capacity and wider applicability, its documentation is proprietary. Both programs gave identical results when used to model the same system.

Distribution system reinforcement was developed to meet year 2000 demands under various conditions as outlined below. The analyses were based upon elevated storage away from El Raswa in order to determine the proper heights for elevated storage tanks to assure filling and emptying as required. Ground storage is more flexible than elevated storage, but the information developed is useful in determining pumping requirements.

Program conditions were as follows:

1. At maximum day demand (1.25 x average day demand) we checked overall pressures with the entire demand met from El Raswa. Pipe sizes were adjusted to assure pressures of at least 20 m without any flow from storage tanks. Areas of minimum pressure were selected as locations for tanks remote from El Raswa.

2. At the typical demand condition while tanks are emptying (1.28 x maximum day demand - see "Storage", below), we determined water elevations at the selected tank locations assuming the tanks feeding at an average rate for their emptying in 13 hr. Assuming elevated tanks, 8 m deep, we set the tank mid-depths at the determined water elevations.

3. At peak hourly demand of 1.4 x maximum day and with tanks 84 percent full, we checked that all system pressures were above 20 m and that no headlosses exceeded 4 m/1,000 m.



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4. At the typical demand condition when the tanks are filling (0.67 x maximum day demand) and with flow into the tanks at an average rate based on filling them in 11 hr, we checked water elevations at the tanks and at El Raswa. Where water elevations at the tanks based on filling were 1.2 meters higher than those computed for emptying (see 2 above), the elevations found in 2 above are proper.

5. At minimum hourly demand (0.54 x maximum day demand), with tanks 60 percent full, we checked that pipe friction losses did not exceed 4 m/1,000 m. (This condition approximates the maximum fill rate.)

After the proposed water main layout for 2000 was fully analyzed, intermediate stages were selected and analyzed to meet earlier demands. The system was checked under condition 3 above to assure that pressures were accurate and headlosses reasonable.

Demands of individual districts (Table 4.10) were allocated to the system nodes shown in Figure 8-E. Current SCA projects-in-progress were assumed to be completed in 1979. Further reinforcements and extensions needed by the end of 1980 were classified as High Priority, while those needed by the end of 1982 were included as Immediate Phase Projects.

Plate I shows the location and schedule of recommended extensions and reinforcements to the primary system and of recommended additions to distribution storage. The schedule of water storage additions is shown graphically on Figure 8-F and the lengths and sizes of mains to be added in each design period in Table 8.4.

The High Priority Program would reinforce capacity to the north and west from the terminus of the two 800 mm mains near the head of the Interior Canal; this will raise pressures in the northwest part of the city. The system will also be extended into a newly developed area south of the New Hourria District. Immediate Phase mains would provide water for further development of the area between the Manzala Canal and Interior Canal, south from the New Hourria District to the Junction Canal. The principal main would be a new 1000 mm line from El Raswa Canal, parallel to the Junction Canal.

Mains to be added by 1985 would reinforce the extensions made under the Immediate Phase, and provide service to the new fishing village at El Gamil. A 3000 cu m tank would be added near the head of the Interior Canal. Mains to be added by 1990 would supply the two new reclaimed areas: the first, west of Manzala Canal; the second, southwest of El Raswa; and reinforce the line to El Gamil and the mains feeding Port Fouad.

Projects to be completed by 1995 would include a loop around newly developed areas to the east of Port Fouad; a new 400 mm main in Nasr Street reinforcing capacity to the system west of Manzala Canal; and a 500 mm main to feed the newly developed residential area south of the Junction Canal. Projects to complete the system to meet year 2000 demands would include a loop around the newly developed residential area south of the Junction Canal, plus two 3000 cu m tanks in this area and in Port Fouad. A final 6000 cu m storage tank would be added in the year 2000, taking into account the direction of further growth expected at that time.

Storage

Figure 8-G is a typical diurnal demand curve for a reasonably tight municipal system, serving largely residential demands. Night flows, or base flows resulting from leakage and wastage, are low. In Port Said lower peaks may be expected because of waste and



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distribution system leakage, and the curve shown can be safely used to determine equalization storage.

The equalization volume shown graphically on the curve amounts to 15 percent of the maximum day demand. This volume empties in 13 hr and fills in 11 hr. The average demand during the emptying period is 12.8 percent of the average demand over the day (maximum day demand) and the average demand during the 11 hr fill period is 67 percent of the maximum day demand. At the time of maximum hourly demand (1.36 x maximum day demand) the tanks are 84 percent full and at the time of minimum demand (0.54 x maximum day demand) they are 60 percent full. (At minimum demand the fill rate is maximum.)

In estimating future storage needs, the goal is to have 15 percent of maximum day demand, plus a fire reserve of 5,000 cu m. The proposed conversion of slow sand filter trains #4 and #5 at El Raswa would add 10,000 cu m of ground storage. Such storage should be utilized before new storage is built, and when new storage is built it should be located away from the plant, near the centers of demand. This will reduce peak flows from El Raswa and permit smaller pipelines between El Raswa and the demand centers. The first new storage away from El Raswa should not be needed until 1985, and from 1994 on, all further required storage should be located near demand centers.

A decision remains whether new storage should be in elevated tanks or in ground tanks. Ground storage using concrete tanks, which appears the better choice at this time, is the basis for project cost estimates. Since relative costs may change, however, this selection should be reviewed before actual commitment to design.

If storage is properly located, the year 2000 distribution system would meet peak demands for a population of 750,000. Placing 6000 cu m of storage near Mazrah as shown in Figure 8-D would permit the population beyond 684,000 to locate in the northwest part of the City, at the longest distance from El Raswa.

Table 8.5 compares the cost of elevated and ground storage reservoirs for various sizes and construction materials. The basis for estimating is that used for other projects as described in Appendix B. Ground storage has a lower capital cost and present worth. The ground storage present worth will be lower even after adjustments for shadow pricing of power required for repumping and for various discharge rates. Ground storage is less disruptive of the urban environment and roofs can be adapted for community use - such as for parks.

## 8.5 VALVES AND HYDRANTS

### Existing Facilities

The distribution system contains valves at most pipe junctions which permit some isolation of sections needing attention. Some valves open counterclockwise; others open clockwise. In several instances, it is not known whether individual valves are open or shut. Many valves are leaking excessively through valve stem packing. Other inoperable valves cannot be repaired for lack of spare parts. Some crosses and tees do not have enough valves to allow isolation of small sections. Under such conditions, effective and intelligent operation of the distribution system is almost impossible.

At present, SCA's responsibility is limited to providing adequate capacity in the distribution piping for fire fighting. The Governorate has the responsibility for installation and maintenance of hydrants. There are about 580 fire hydrants in Port Said. Those in

Port Said are British (counterclockwise); those in Port Fouad are French (clockwise). Each type has its own thread. Hydrants are installed flush with the ground where they are exposed to potential back siphonage of polluted surface water. Nearly half of the hydrants are leaking or inoperative, and a number are used for vehicle washing and other local needs. Many new areas have no hydrants.

Recommended Program

Many valves cannot be repaired for lack of spare parts. Replacement of some 125 valves in sizes from 200 to 800 mm is needed to assure better utilization of the existing piping and to allow isolation of leaks without shutting down large sections of the system. A gradual program should be instituted to add sectionalizing valves so that each cross has three valves and each tee has two. Each fire hydrant should also have a shutoff valve at the curb. Valves 400 mm and larger should be of the gear-operated butterfly design with mechanical stops and a bypass line. Gradual replacement of the pit type hydrant is recommended, using the simple design shown in Figure 8-H. All valves should open counterclockwise and hose connections should utilize English system threads. Existing French hydrants should be the first replaced. Connections should be made to 200 mm mains or larger with 150 mm connecting pipes. In some areas without house services, illegal use of hydrants and the attendant waste of water can be reduced by the installation of small public taps.

Hydrants should be installed in all new areas, and additional hydrants in the older areas: 2.5 hydrants per hectare in residential areas, and twelve hydrants per hectare in industrial areas.

## 8.6 SECONDARY PIPING, BUILDING CONNECTIONS, AND METERS

Existing Facilities

Approximately 40 km of secondary piping smaller than 400 mm presently serve most of the Port Said area satisfactorily. In several parts of the city currently under redevelopment, higher population densities may require replacement of existing mains. Some of the smaller steel piping should be replaced. The newer piping is chiefly asbestos cement. Some service connections are threaded, others are not.

Lead pipe is used for building service lines with service connections made to lines 300 mm or less. Service connections are made by shutting down the main, using hand tools and tapping collars frequently without corporation stops and curb stops. For some buildings, services are much too small and house connections are a general source of leaks.

As noted in Section 4.1, of the approximately 12,000 water connections in Port Said, 8000 services are metered. About 40 percent of the meters examined were found to be damaged or missing. The use of 11 different makes of meters makes spare part inventory and maintenance difficult.

Most meters are poorly located. Many open meter pits are used as trash receptacles and for rubbish burning. Other pits are filled with dirt and, if covered, the covers are too heavy for removal by one person. Some meter pits are inaccessible because of permanent structures built over them. Strict rules and regulations regarding pit installation and maintenance are needed if this type of setting is used.

Buried meters are inaccessible and subject to groundwater and traffic damage. The meters set in open areas, accessible to the public, are vulnerable to theft and vandalism. (Several of the meters reset by the SCA, especially for the water consumption and

wastage studies described in Section 4.1, were damaged, requiring replacement during the tests.) Meters in doorways and hallways have some physical protection, are accessible to meter readers and service personnel, and are relatively inaccessible to the general public.

Facilities Under Construction

New secondary mains are being laid in the Port Fouad area. Asbestos-cement pipe with some threaded and some collar service connections is being used.

Recommended Program

The use of asbestos-cement pipe should continue. To avoid unnecessary leaks in building connections, threaded corporation stops should be used for all new and replacement taps, and "wet taps" should be used wherever possible to avoid shutting down the distribution main. Although lead service pipe can be used with corporation stops, plastic service lines are recommended as better able to resist adverse soil and water conditions. House service lines should be laid perpendicular to the water main from the water meter setting to facilitate locating a buried curb box or corporation stop in the water main. To avoid having to change meters under pressure, all services should be equipped with a house shut-off (stop and waste) valve ahead of the meter. Old or substandard service lines should be replaced prior to any major street repair or area reconstruction.

A standardization program should be initiated to phase out the large variety of old, difficult-to-repair meters. This would also reduce the volume and cost of the spare parts inventory and decrease storage space for parts; increase efficient use of personnel and equipment in the repair area; and facilitate standardization of meter settings as to fittings and spacing.

Included in the recommendations for the Immediate Phase work are 9,500 meters, to be used for non-metered government housing (4,000), to replace broken or missing meters (3,000), and to provide meters for new construction (2,500). Of the approximately 10,000 operational meters now either in stock or installed in the system, it is estimated that approximately 5,000 could be retained and the other 5,000 be scrapped under the standardization program. Plastic meters, connections and meter boxes are recommended. Plastic has the advantage of not being attractive to theft and vandalism and is durable and corrosion resistant.

Care must be taken in the selection of meter sizes. Meters too large may miss low flows and underregister. Small meters on flows exceeding manufacturer's rated capacities may cause excessive wear, high maintenance costs, and underregistration. Compound meters should be used on services with a wide range of usage. The use of a battery of smaller meters is practical for some larger installations. Sealed bypasses on large meters may be desirable to provide service to the consumer if the meter must be removed for maintenance.

As a guide, it is recommended that single family dwellings have 16 x 20 mm meters, two-family dwellings have 20 mm meters, buildings with up to 10 families have 25 mm meters, and larger housing have 40 mm meters.

For a successful metering program, a policy of property owner accountability should be initiated. The meters should be placed in protected areas and the property owner should be held accountable for loss or damage to the meter.

The meter repair and replacement program should be increased to eliminate the backlog of broken meters. The meter shop has in stock approximately 4,700 repaired and calibrated meters. Most of these meters are for residential services. Although many industrial and institutional meters are inoperative or missing, only a few are in stock for replacement. The meter shop, although staffed with ten technicians, is able to repair and calibrate only about 200 meters per month. Current meter testing facilities are not adequate for complete tests even on small meters. A new test bench with appurtenant equipment is needed for in-shop testing. Field test equipment is also needed to test the larger meters in place. Once adequate, modern equipment is available, personnel must be trained in its use.

## 8.7 ESTIMATED COSTS

The costs for improving the water distribution system as recommended in this report are summarized in Table 8.6. In addition to primary system reinforcement and extensions, the costs include the following:

- Procurement (High Priority) of replacement valves and hydrants, vehicles, construction equipment and tools needed to overcome the current backlog of deferred maintenance.

- Special procurement of meters (Immediate Phase) to permit full metering of the system, to eliminate obsolete meters, and to standardize on equipment for easier repair operations.

- Extension of the secondary distribution system (150 mm or less) to serve individual buildings.

- Installation of service connections to new buildings.

- Purchase and installation of meters for new services.

- Purchase of the following vehicles, construction equipment, and tools needed for maintenance of the water treatment and distribution systems:

  20 - Chlorine (1 ton) Cylinders
  (Storage to be provided out of doors with provisions for protection from sunlight)
  2 - 3/4 Ton Pickup Truck
  1 - Backhoe
  1 - Front-end Loader
  1 - Air Compressor
  2 - Concrete Mixers
  2 - Vibrators
  Miscellaneous Tools & Shop Equipment

Requirements for secondary distribution lines, service connections and meters for new dwelling units were based on the development expected under the Port Said Master Plan (PSMP) typified in detailed layouts prepared by the consultants for the Demonstration Projects under the PSMP.

Project estimates do not include the cost of land for reservoirs because it is assumed the reservoirs would be built on public land.

TABLE 8.1

WATER DISTRIBUTION SYSTEM PRESSURES

September 11, 1978

| Location (Node) | Pressure (m) 0700 to 0830 hours(1) | Pressure (m) 1900 to 2000 hours(2) |
|---|---|---|
| Port Said | | |
| 22 | 13.4 | 16.2 |
| 27 | 14.1 | 16.9 |
| 33 | 23.2 | 26.0 |
| 35 | 23.9 | 26.7 |
| 43 | 17.6 | 21.8 |
| 45 | 12.0 | 12.0 |
| 47 | 8.4 | 8.4 |
| 47+ | 6.3 | 7.7 |
| 58 | 21.7 | 23.2 |
| 60 | 20.4 | 21.1 |
| Port Fouad | | |
| 16 | 16.2 | 21.8 |
| 38 | 17.6 | 23.2 |

(1) El Raswa discharge pressure 31.5 m
(2) El Raswa discharge pressure 31.8 m

## TABLE 8.2

## PHYSICAL CONDITION OF SIPHONS (1978)

| Siphon Number[1] | Size & Material | Status | Leakage | Canal Crossing | Condition |
|---|---|---|---|---|---|
| 1 | 600 mm CIP | In use | Negligible | Junction | Good |
| 2 | 600 mm CIP | In use | Negligible | Junction | Good |
| 3 | 300 mm steel | Abandoned | Leaking but negligible | Junction | Damaged |
| 4 | 300 mm steel | Abandoned | Leaking but negligible | Junction | Damaged, Siphon #5 attached |
| 5 | 300 mm steel | In use (Former line from Damietta) | Leaking 1500 $m^3/d$ | Junction | Surface leakage reparable |
| 6 | 500 mm steel | Abandoned | Leaking but negligible | Junction | Damaged. Not fully tested. |
| 7 | 500 mm steel | Abandoned | Leaking but negligible | Junction | Damaged. Not fully tested. |
| 8 | 500 mm steel | In use | Negligible | Junction | Good |
| 9 | 500 mm CIP | Closed July 9, 1978. Repairs in Progress. | Leaking 16,000 $m^3/d$ | Suez South Siphon | Canal leak - reparable |
| 10 | 500 mm CIP | In use | Negligible | Suez North Siphon | Good |
| 11 | 200 mm steel | Abandoned | Leaking but negligible | Interior | Damaged |
| 12 | 400 mm steel | In use | Negligible | Junction near Lake Manzala | Good |
| 13 | 600 mm steel | In use | - | Junction Railroad Bridge | Good. Not fully tested. |
| 14 | 400 mm | In use | Negligible | Suez Tributary | Good. Not fully tested. |
| 15 | 500 mm CIP | Abandoned | Leaking but negligible | Suez North #3 | Damaged |
| 16 | 500 mm CIP | Abandoned. Being replaced. | Leaking | Suez South #2 | Damaged. |

(1) See Figure 8-D for location.

TABLE 8.3

INVENTORY
WATER DISTRIBUTION SYSTEM

| Pipe Size (mm) | Material | Installation Date | Length (m) | Hazen & Williams "C" Factor |
|---|---|---|---|---|
| 200 | CI/steel/AC | 1910 - 1978 | 22,650 | - |
| 300 | CI | 1960 - 1970 | 6,925 | 110 |
| | CI | 1950 - 1960 | 4,825 | 85 |
| | CI | 1940 - 1950 | 1,975 | 75 |
| | CI | 1930 - 1940 | 350 | 65 |
| | CI | 1920 - 1930 | 1,700 | 60 |
| | CI | 1910 - 1920 | 1,800 | 55 |
| | | Sub-total | 17,575 | |
| 400 | CI | 1960 - 1970 | 2,700 | 115 |
| | CI | 1950 - 1960 | 1,200 | 95 |
| | CI | 1930 - 1940 | 550 | 75 |
| | CI | 1910 - 1920 | 500 | 65 |
| | AC | 1970 - 1980 | 5,500 | 140 |
| | AC | 1960 - 1970 | 2,250 | 130 |
| | | Sub-total | 12,700 | |
| 500 | CI | 1960 - 1970 | 750 | 120 |
| | CI | 1950 - 1960 | 2,500 | 105 |
| | CI | 1930 - 1940 | 175 | 85 |
| | | Sub-total | 3,425 | |
| 550 | CI | 1950 - 1960 | 1,150 | 110 |
| | | Sub-total | 1,150 | |
| 600 | CI | 1960 - 1970 | 1,225 | 130 |
| | CI | 1920 - 1930 | 2,100 | 90 |
| | | Sub-total | 3,325 | |
| 800 | CI | 1960 - 1970 | 850 | 135 |
| | CI | 1950 - 1960 | 2,350 | 120 |
| | CI | 1930 - 1940 | 3,400 | 110 |
| | | Sub-total | 6,600 | |
| | | TOTAL | 67,425 | |

## TABLE 8.4

## ADDITIONS TO PROPOSED PRIMARY DISTRIBUTION SYSTEM

| | | | | Length in meters | | | |
|---|---|---|---|---|---|---|---|
| | | High Priority | Immediate Phase | | Staged Development | | |
| Size mm | SCA(1) | 1980 | 1982 | 1985 | 1990 | 1995 | 2000 |
| 200 | - | 1290 | - | - | 315 | 1680 | - |
| 300 | - | 800 | 1000 | - | 3600 | 550 | 1380 |
| 400 | 3540 | 780 | 2680 | - | 4420 | 1740 | 6340 |
| 500 | - | 410 | - | 7350 | 8920 | 1280 | - |
| 600 | - | 2010 | 1100 | - | 580 | - | - |
| 800 | 4490 | - | 1150 | - | - | 240 | - |
| 1000 | - | - | 1940 | - | - | - | - |
| TOTAL | 8030 | 5290 | 7870 | 7350 | 17835 | 5490 | 7720 |

Note: See Plate I for location of mains.
(1) SCA Projects-in-Progress

TABLE 8.5

PRESENT WORTH COMPARISON OF STORAGE TANK ALTERNATIVES
(Thousands of 1978 LE)

| | 2,500 cu m Capacity | | | | 5,000 cu m Capacity | | | |
|---|---|---|---|---|---|---|---|---|
| | Concrete Ground | Steel Ground | Concrete Elevated | Steel Elevated | Concrete Ground | Steel Ground | Concrete Elevated | Steel Elevated |
| **Capital Cost** | | | | | | | | |
| Tanks | 83 | 69 | 330 | 299 | 165 | 138 | 660 | 598 |
| Pump Station Equipment | 40 | 40 | - | - | 60 | 60 | - | - |
| Pump Station Structure | 16 | 16 | - | - | 24 | 24 | - | - |
| Total Capital Cost | 139 | 125 | 330 | 299 | 249 | 222 | 660 | 598 |
| Salvage Value | -49 | -43 | -165 | -150 | -95 | -81 | -330 | -299 |
| **Annual Cost** | | | | | | | | |
| Tank Maintenance | 0.8 | 1.4 | 3.3 | 3.0 | 1.7 | 2.8 | 6.6 | 6.0 |
| Pump Station Maintenance | 2.4 | 2.4 | - | - | 3.6 | 3.6 | - | - |
| Electricity-Commercial Price | 2.2 | 2.2 | - | - | 4.4 | 4.4 | - | - |
| Total Annual Cost | 5.4 | 6.0 | 3.3 | 3.0 | 9.7 | 10.8 | 6.6 | 6.0 |
| **Present Worth at 8% Discount Rate** | | | | | | | | |
| Salvage Value | -11 | -9 | -35 | -32 | -20 | -17 | -71 | -64 |
| Operation and Maintenance | 55 | 61 | 32 | 30 | 127 | 138 | 65 | 59 |
| Total Cost | 183 | 177 | 327 | 297 | 356 | 343 | 654 | 593 |
| **Present Worth at 10% Discount Rate** | | | | | | | | |
| Salvage Value | -7 | -6 | -25 | -22 | -14 | -12 | -49 | -45 |
| Operation and Maintenance | 48 | 53 | 28 | 26 | 110 | 119 | 56 | 51 |
| Total Cost | 180 | 172 | 333 | 303 | 345 | 329 | 667 | 604 |
| **Present Worth at 15% Discount Rate** | | | | | | | | |
| Salvage Value | -3 | -3 | -10 | -9 | -6 | -5 | -20 | -18 |
| Operation and Maintenance | 35 | 39 | 21 | 18 | 81 | 88 | 41 | 38 |
| Total Cost | 171 | 161 | 341 | 308 | 324 | 305 | 681 | 618 |

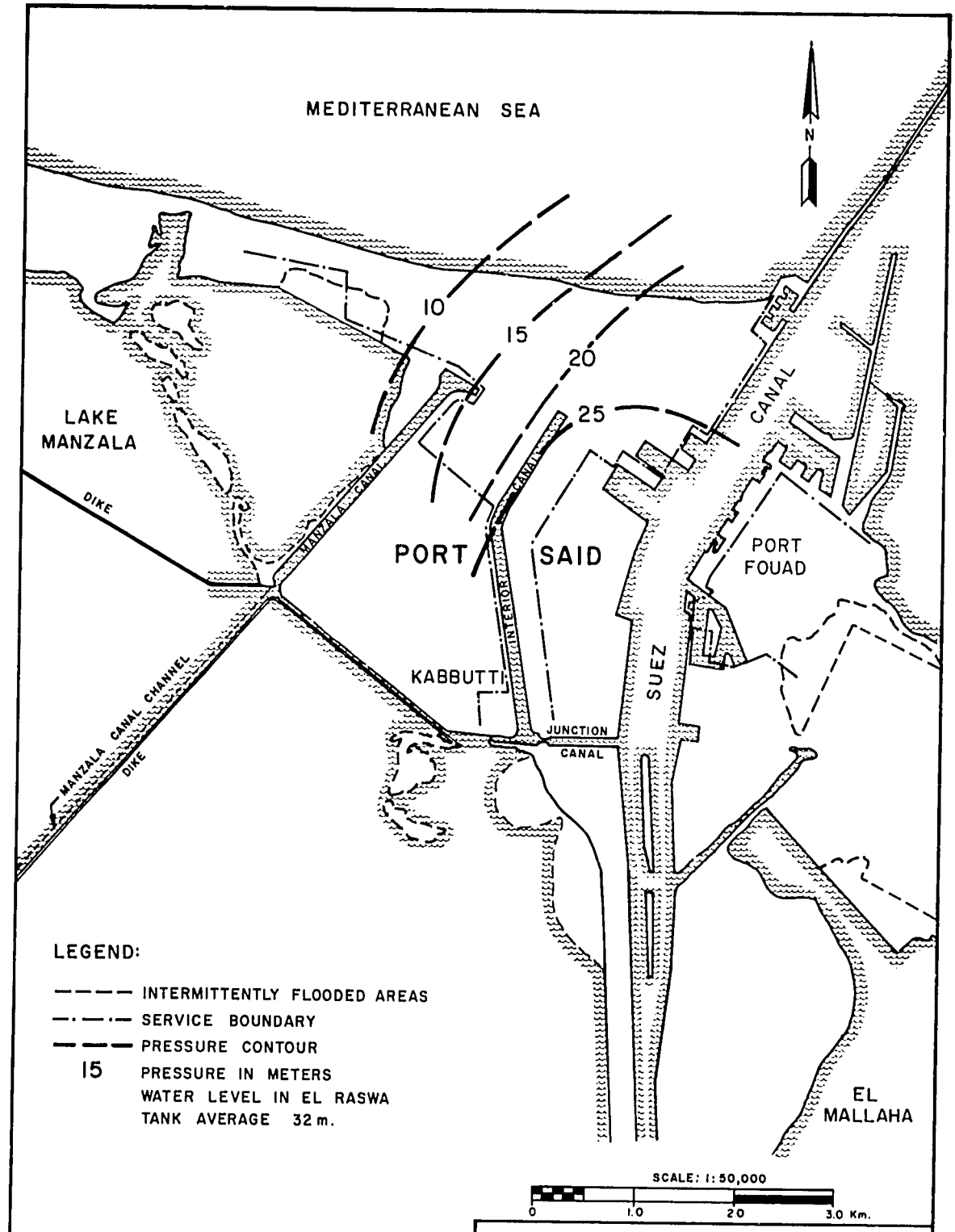
TABLE 8.6

RECOMMENDED PROGRAM

DISTRIBUTION SYSTEM COSTS(1)
(Thousands of 1978 LE)

| | Civil/ Pipe | Mechanical | TOTAL | Foreign | Local |
|---|---|---|---|---|---|
| HIGH PRIORITY | | | | | |
| Local Measures - Leak Repairs | 40 | - | 40 | | 40 |
| Procurement/Installation of Materials & Equipment | 516 | 180(2) | 696 | 559 | 137 |
| Major Capital Projects (1979-80) | | | | | |
| Primary Distribution System(3) | 1032 | - | 1032 | 574 | 458 |
| Secondary Distribution System(4) | 774 | - | 774 | 39 | 735 |
| Service Connections(5) | 323 | - | 323 | 17 | 306 |
| Leak Survey - Equipment and Services(6) | - | 2 | 17 | 12 | 5 |
| Subtotal High Priority | 2685 | 182 | 2882 | 1201 | 1681 |
| IMMEDIATE PHASE | | | | | |
| Water Meter Procurement/Installation(7) | | 1108 | 1108 | 958 | 150 |
| Major Capital Projects (1981-82) | | | | | |
| Primary Distribution System(3) | 3023 | - | 3023 | 2064 | 959 |
| Secondary Distribution System(4) | 1042 | - | 1042 | 53 | 989 |
| Service Connections(5) | 438 | - | 438 | 22 | 416 |
| Leak Survey - Equipment and Services(6) | - | 40 | 166 | 116 | 50 |
| Subtotal Immediate Phase | 4503 | 1148 | 5777 | 3213 | 2564 |
| STAGED DEVELOPMENT | | | | | |
| 1983-1985 | | | | | |
| Primary Distribution Lines | 1929 | - | 1929 | 1121 | 808 |
| Secondary Distribution Lines(4) | 1544 | - | 1544 | 77 | 1467 |
| Service Connections(5) | 648 | - | 648 | 33 | 615 |
| Meters(8) | - | 29 | 29 | 26 | 3 |
| 1986-1990 | | | | | |
| Primary Distribution Lines | 3623 | - | 3623 | | |
| Secondary Distribution System(4) | 3164 | - | 3164 | 159 | 3005 |
| Service Connections(5) | 1315 | - | 1315 | 65 | 1250 |
| Meters(8) | | 436 | 436 | 374 | 62 |
| 1991-1995 | | | | | |
| Primary Distribution System | 904 | - | 904 | 508 | 396 |
| Secondary Distribution System(4) | 2805 | - | 2805 | 140 | 2665 |
| Service Connections(5) | 1179 | - | 1179 | 59 | 1120 |
| Meters(8) | - | 412 | 412 | 352 | 60 |
| 1996-2000 | | | | | |
| Primary Distribution System | 1236 | - | 1236 | 750 | 486 |
| Secondary Distribution System(4) | 2795 | - | 2795 | 140 | 2655 |
| Service Connections(5) | 1174 | - | 1174 | 59 | 1115 |
| Meters(8) | - | 424 | 424 | 363 | 61 |
| Vehicles and Construction Equipment(9) | - | 150 | 150 | 150 | - |
| Distribution Storage(10) | 804 | 102 | 906 | 102 | 804 |
| Subtotal Staged Development | 23120 | 1553 | 24673 | 6531 | 18142 |
| TOTAL | 30308 | 2883 | 33332 | 10945 | 22387 |
| REHABILITATION | - | - | 141 | 86 | 55 |
| COSTS NOT INCLUDING REHABILITATION | 30308 | 2883 | 33191 | 10859 | 22332 |

(1) Including contingencies and support services (see Table B-5). See Tables 9.1 through 9.5 for detailed cost breakdown of High Priority and Immediate Phase programs.
(2) Includes 173,000 for vehicles and maintenance equipment (10 yr life). (Other equipment 20 yr life.)
(3) Does not include costs for SCA additions to distribution system.
(4) Based on LE 98/added dwelling unit (du) 1 per 4.75 added population (average for 1980-2000) plus LE 6,500 per gross ha of industrial or institutional area added. (5% foreign costs.)
(5) Based on LE 42/added du plus LE 2,600 per gross ha of industrial or institutional area added (5% foreign costs).
(6) Costs of rehabilitation items are not shown in Civil/Pipe and Mechanical columns (total: LE 15,000 High Priority, LE 126,000 Immediate Phase). Amounts shown under Civil/Pipe and Maintenance are for vehicles and maintenance equipment.
(7) Includes meters needed for new services through late 1985.
(8) One residential meter per 5 du. Two industrial/institutional meters per net ha of industrial or institutional area added. Individual meter costs: residential LE 62 (6% of local cost), industrial/institutional LE 160 (6% of local cost).
(9) Allowance for additional purchases (not replacement) LE 10,000/yr. Assumed 10 yr life.
(10) For timing see Figure 8-E.

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PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

**WATER DISTRIBUTION SYSTEM**
**EXISTING PRESSURE CONTOURS**

VOL. 2
FIG.
**8-A**

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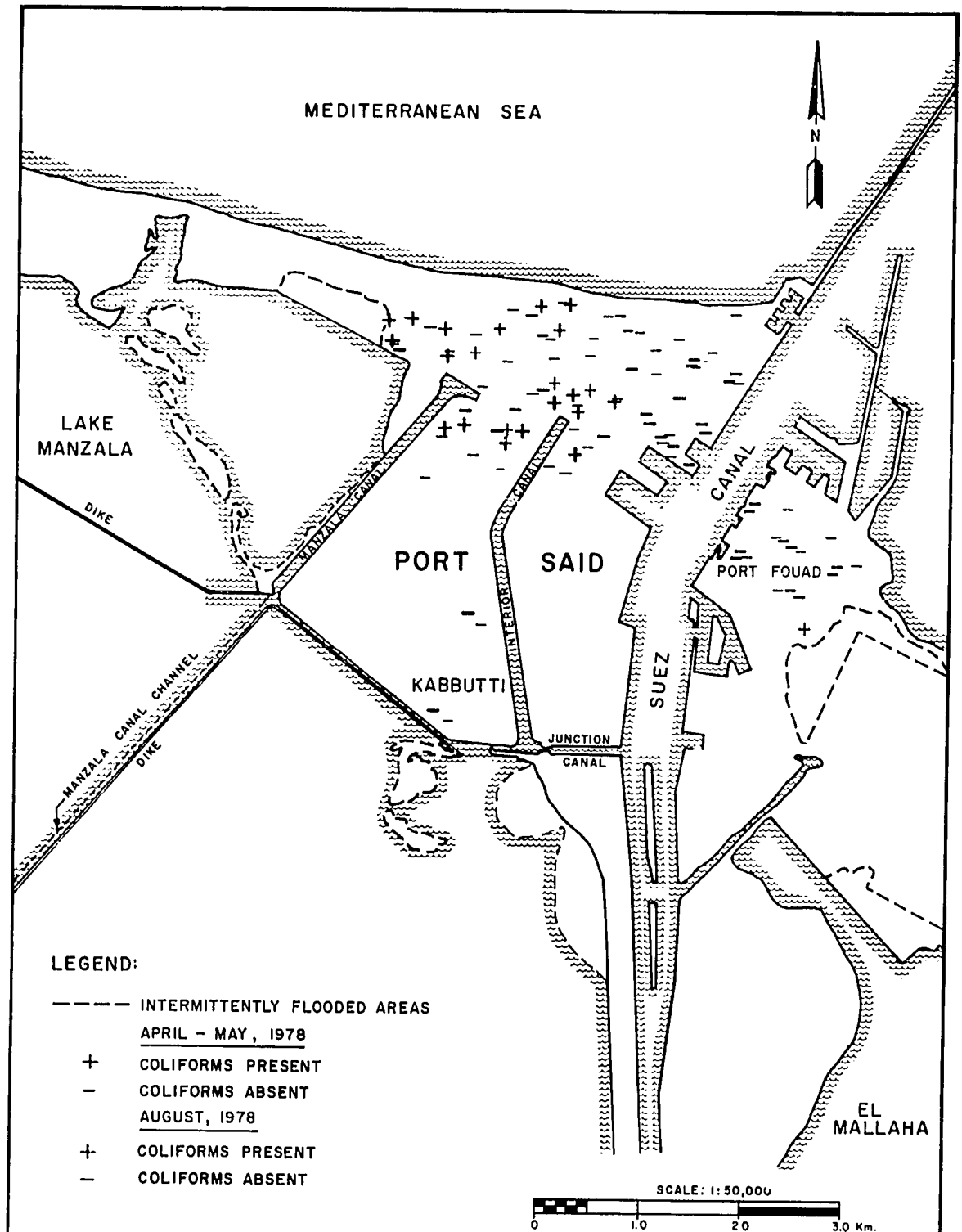


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**BACTERIOLOGICAL TESTING RESULTS**

VOL.2
FIG.
8-B

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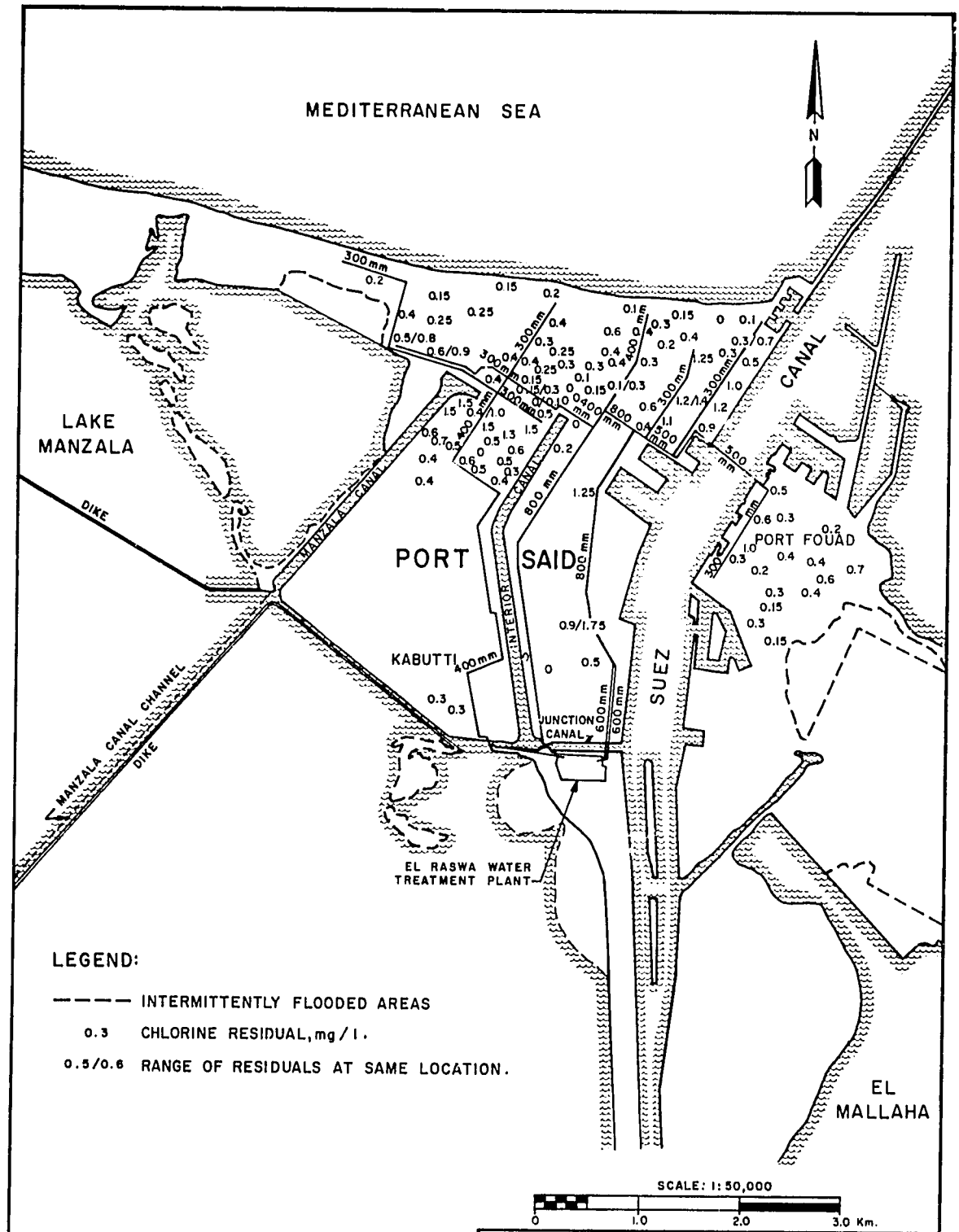


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CHLORINE RESIDUALS
7-9, AUGUST 1978

VOL.2
FIG.
8-C

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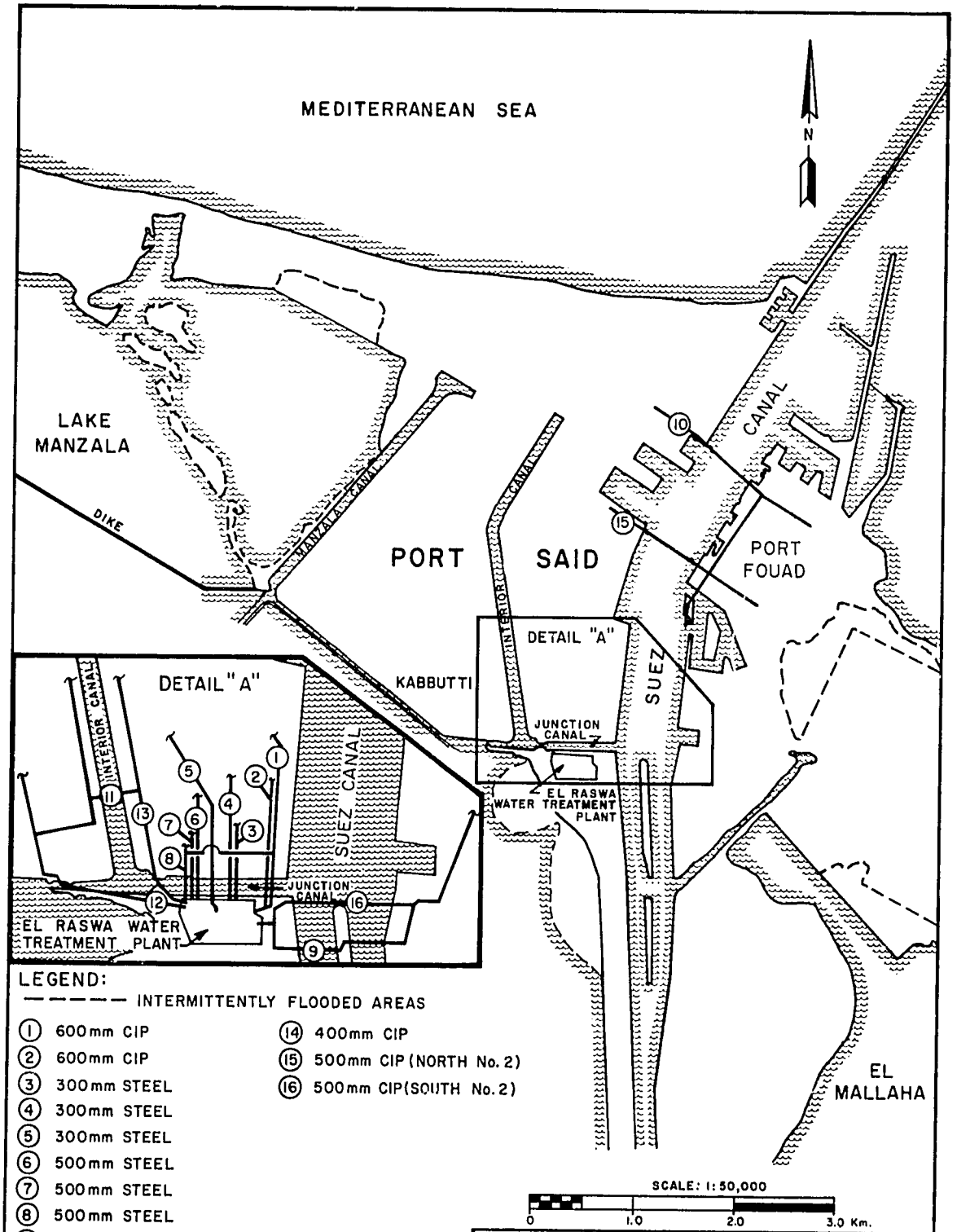


LEGEND:

- — — — — INTERMITTENTLY FLOODED AREAS

1. 600mm CIP
2. 600mm CIP
3. 300mm STEEL
4. 300mm STEEL
5. 300mm STEEL
6. 500mm STEEL
7. 500mm STEEL
8. 500mm STEEL
9. 500mm CIP (SOUTH SIPHON)
10. 500mm CIP (NORTH SIPHON)
11. 200mm STEEL
12. 400mm CIP
13. 600mm STEEL
14. 400mm CIP
15. 500mm CIP (NORTH No. 2)
16. 500mm CIP (SOUTH No. 2)

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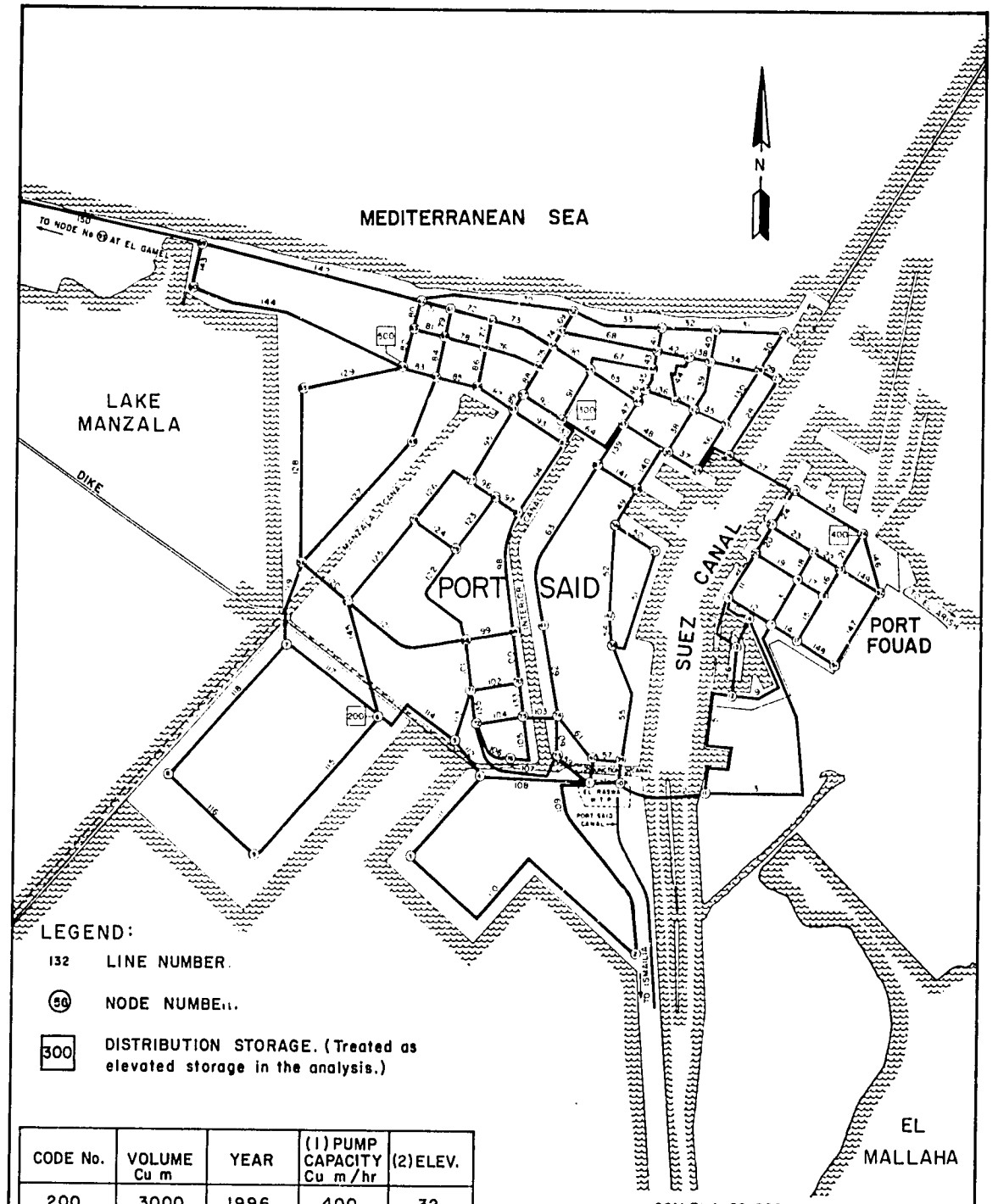
## LOCATION OF SIPHONS

VOL. 2
FIG.
8-D




| CODE No. | VOLUME Cu m | YEAR | (1) PUMP CAPACITY Cu m/hr | (2) ELEV. |
|---|---|---|---|---|
| 200 | 3000 | 1996 | 400 | 32 |
| 300 | 3000<br>3000 | 1985<br>1996 | 400<br>400 | 32<br>32 |
| 400 | 3000 | 1996 | 400 | 28 |
| 500 | 6000 | 2000 | 800 | 26 |

(1) FOR GROUND STORAGE.

(2) ℄ OF ELEVATED TANK OR STATIC LIFT OF PUMPS IF GROUND STORAGE.

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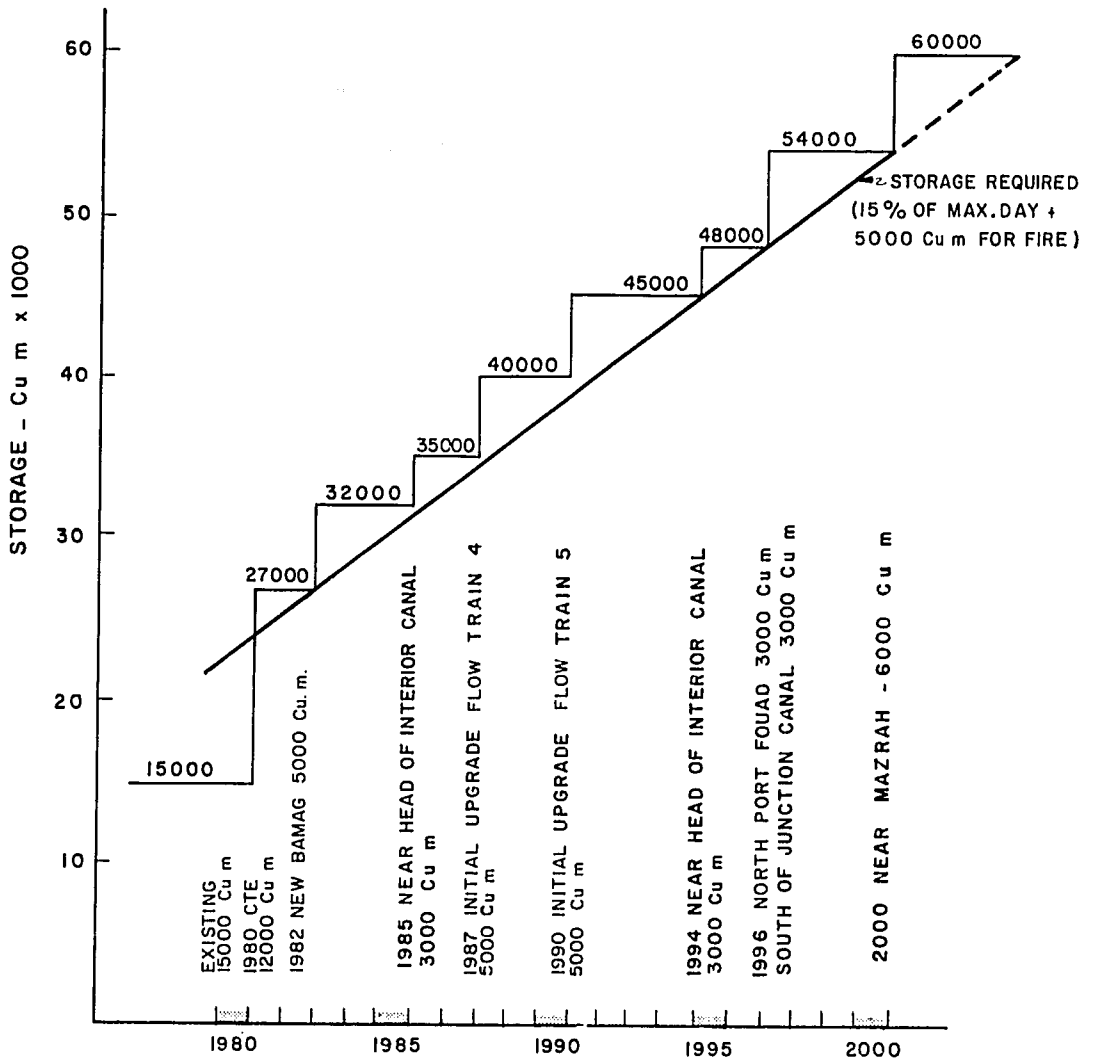
DISTRIBUTION SYSTEM NODE MAP

VOL. 2
FIG. 8-E




NOTE:

STORAGE CONSTRUCTED, TESTED, AND ON LINE BY END OF YEAR INDICATED.

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SCHEDULE OF WATER STORAGE ADDITIONS

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FIG.
8-F

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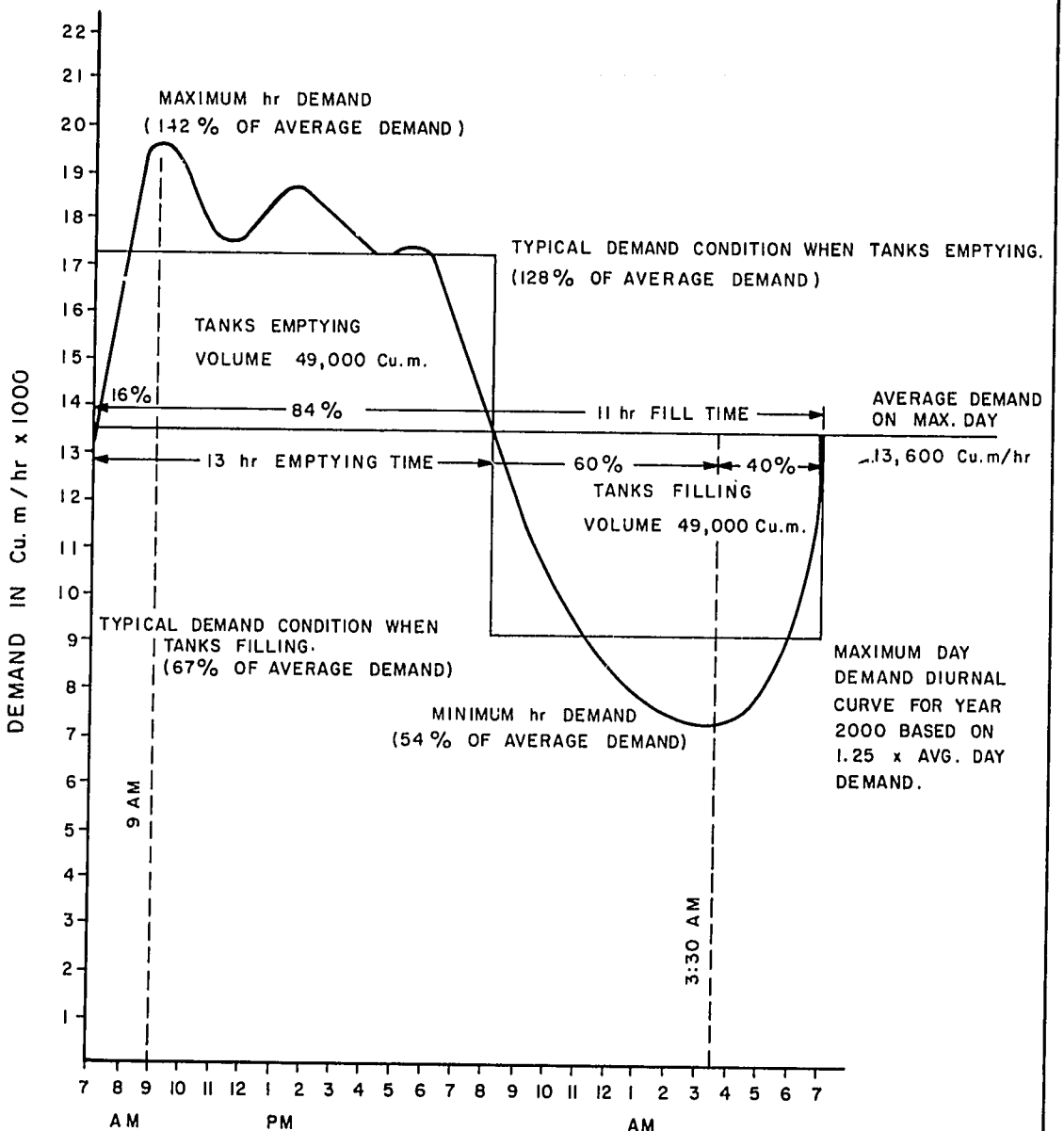


NOTE: FLOW VARIATIONS ON MAXIMUM DAY DEMAND CURVE PROJECTED FROM ACTUAL FLOW MEASURES FIG. No. C-5 PART I REPORT.

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MAXIMUM DAY DIURNAL STORAGE CURVE YEAR 2000

VOL.2 FIG. 8-G

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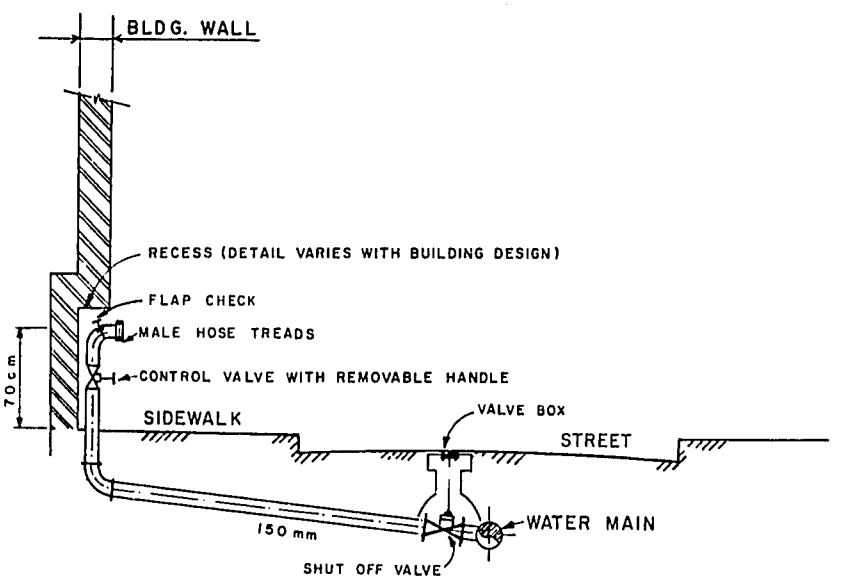


NOT TO SCALE

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RECOMMENDED
HYDRANT INSTALLATION

VOL.2
FIG.
8-H

CHAPTER 9

# ANALYSIS AND COSTS OF RECOMMENDED PROGRAM

## 9.1 ANALYSIS

Alternative proposals for source of supply, treatment and distribution of water are compared in their respective chapters (6, 7 and 8). Since there is no inter-relationship between alternatives for source of supply, treatment and distribution, no overall analysis is needed.

Each recommended project has been assessed and found to be technically sound and in conformance with accepted engineering standards and practices.

## 9.2 COSTS

The costs of recommended projects are as low as or lower than costs of other reasonably available alternatives. Recommended projects are summarized and their costs shown in Chapters 6, 7 and 8. Tables 9.1 through 9.5 summarize the High Priority and Immediate Phase measures of the program by the following categories:

- Local Measures
- Procurement of Equipment
- Major Capital Projects
- Procurement of Services

Table 9.6 summarizes the costs shown in Tables 9.1 through 9.5 and adds the cost of allowances for contingencies and support services such as engineering, legal and administrative. Total cost of the High Priority and Immediate Phase of the recommended programs is LE 13.8 million.

Table 9.7 summarizes capital costs, including contingencies and support services, for the water supply, treatment, and distribution system improvements for the Staged Development period (LE 53.9). Table 9.8 lists costs under the High Priority, Immediate Phase, and Staged Development programs. The total cost of all projects is estimated at LE 67.7 million.



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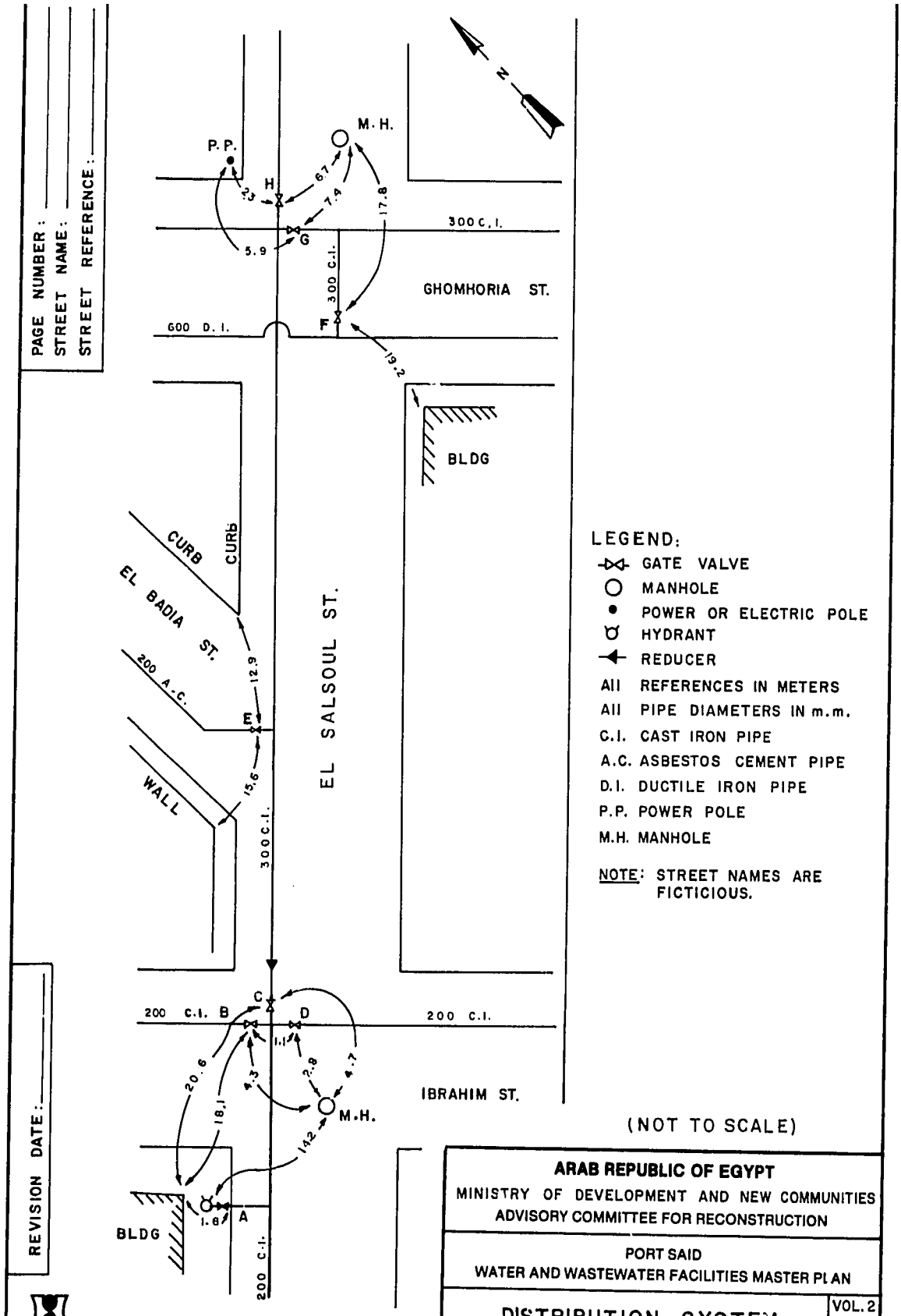
PAGE NUMBER:
STREET NAME:
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N
M.H.
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H
G
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E
C
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D
A
6.7
7.4
17.8
2.3
5.9
300 C.I.
300 C.I.
GHOMHORIA ST.
600 D.I.
19.2
BLDG
CURB
CURB
EL BADIA ST.
200 A.C.
12.9
15.6
WALL
EL SALSOUL ST.
300 C.I.
200 C.I.
200 C.I.
1.1
20.6
18.1
4.3
2.8
4.7
IBRAHIM ST.
M.H.
14.2
1.6
BLDG
200 C.I.
LEGEND:
GATE VALVE
MANHOLE
POWER OR ELECTRIC POLE
HYDRANT
REDUCER
All REFERENCES IN METERS
All PIPE DIAMETERS IN m.m.
C.I. CAST IRON PIPE
A.C. ASBESTOS CEMENT PIPE
D.I. DUCTILE IRON PIPE
P.P. POWER POLE
M.H. MANHOLE
NOTE: STREET NAMES ARE FICTICIOUS.
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WATER AND WASTEWATER FACILITIES MASTER PLAN
DISTRIBUTION SYSTEM
STRIP MAP EXAMPLE
VOL. 2
FIG.
10-B
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TABLE 9.1

HIGH PRIORITY LOCAL MEASURE COSTS

| Measure | Purpose/Remarks | Estimated Local Cost (LE 1,000)(1) |
|---|---|---|
| **Water Treatment Plant** | | |
| Construct raw water coarse screen bar rack | Reduce loss of head in PSC and simplify plant raw water intake structures. | 5 |
| Install adjustable weirs on Bamag I clarifiers | Greatly reduce floc carry over of solids and lengthen filter runs. | 3 |
| Repair rate controllers on Bamag I filters | Introduce sufficient headloss into effluent piping so filter boxes will operate full at all times. | - |
| Install and calibrate manometers on filters and on washwater pumps in Bamag I | Measure headloss through filters and estimate pump deliveries. | - |
| Install adjustable weir plates to level washwater through weirs in Bamag I filters | Improve distribution of washwater flows. (Present unbalance due in part to weirs out of level because of differential settlement.) Install plates on one filter and test before work done on others. | 5 |
| Install on-hand replacement equipment for Bamag I filters | Facilitate operation of filters. Provide indications of individual filter flows. | - |
| Uncover underdrains in one of the Bamag I rapid sand filters for inspection | Determine structural and hydraulic conditions. (Work will be done after flow train 3 is on line as rapid sand.) | 1 |
| Arrange temporary washwater pumps for roughing filters in flow trains No. 1, 4 and 5 | Permit testing to determine appropriate backwash rates for roughing filters. | 1 |
| Uncover sections of underdrains in slow sand filters No. 1, 4 and 5 for inspection | Determine structural condition and whether sand clogged. This work will supplement complete inspection of filters in flow train 2 during their conversion to storage reservoirs, which will begin after flow train 3 goes on line as rapid sand. Work in flow trains 1, 4 and 5 will be coordinated with regular sand scraping. | 1 |
| Change chemical feed points in flow trains No. 4 and 5 as follows: Move polyelectrolyte feed point upstream from inlet structure. Move alum feed point to inlet structure | Take advantage of available head to improve mixing. At present, alum is at a location where turbulence is low. Poor mixing results. | 1 |
| Install flow baffle in settling tank - flow train No. 1 | Reduce short circuiting and eliminate dead space. (Tank is circular with single inlet and outlet port) | 1 |
| **Distribution System** | | |
| Locate and repair major leaks | Reduce water consumption up to 10,000 cu m/d | 30 |
| Repair leaking valve and hydrant packing | Reduce water consumption up to 2,000 cu m/d | 10 |
| | Subtotal Treatment Plant | 18 |
| | Subtotal Distribution System | 40 |
| | TOTAL LOCAL MEASURE COSTS | 58 |

(1) Based on August 1978 costs. Does not include allowances for contingencies and support services such as engineering, legal and administrative.

TABLE 9.2

PROCUREMENT OF EQUIPMENT COSTS
HIGH PRIORITY AND IMMEDIATE PHASE

| HIGH PRIORITY WATER TREATMENT PLANT<br>Item | Quantity | Characteristics<br>Flow (cu m/hr) | TDH (m) | HP | Specifications Reference (See Appendix D) | Estimated Costs(3)<br>Foreign(1) LE (1,000) | Local(2) LE (1,000) | Total LE (1,000) |
|---|---|---|---|---|---|---|---|---|
| Pumps: | | | | | | | | |
| Raw Water | 8 | 1000 | 15 | 100 | A | 179 | 52 | 231 |
| Finished Water(4) | 10 | 1000 | 45 | 250 | A | 224 | 47 | 271 |
| Backwash (Flow Trains 1, 4 & 5) | 3 | 1000 | 15 | 100 | A | 67 | 20 | 87 |
| | | | | | Subtotal | 470 | 119 | 589 |
| Rapid Mix Bamag 1 | 1 | 1.5 HP Impeller Mix | | | B | 21 | 1 | 22 |
| Flow Meters | | | | | | | | |
| Flow Trains No. 1, 4 and 5 in Raw Water Inlet Line | 2 | Insert Parshall Flume capacity to 25,000 cu m/d, with transmitter, and indicator, before settling basins | | | D | 15 | 5 | 20 |
| Bamag Raw, Filter & Finished Water in Discharge Lines | 3 | New transmitter for each existing venturi meter, two with indicator, one with indicator/recorder. Capacity to 60,000 cu m/d. | | | E | 10 | 5 | 15 |
| Annex Finished Water Station Discharge Line | 1 | Venturi tube with transmitter and indicator/recorder. Capacity to 75,000 cu m/d. | | | F | 6 | 4 | 10 |
| Main Pumping Station Finished Water Discharge Line | 1 | New transmitter and indicator/recorder for existing venturi. Capacity to 75,000 cu m/d. | | | E | 4 | 2 | 6 |
| | | | | | Subtotal | 35 | 16 | 51 |
| Electrical Equipment | | KVA Rating | Voltage | | | | | |
| 3-Phase Transformers | | | | | | | | |
| @ Bamag Pumping Station | 2 | 1500 | 11 KV/380V | | G | 21 | 7 | 28 |
| @ New Finished Water Pumping Station (F.W.P.S.) | 2 | 2500/3125 | 11 KV/3300V | | | 35 | 13 | 48 |
| | | No. of Feeders/Mains | | | | | | |
| Switchgear | | | | | | | | |
| @ Bamag P.S. | | 2/2 1 Bus Coupler | | | H | 179 | 45 | 224 |
| @ New F.W.P.S. | | 2/4 1 Bus Coupler | | | H | 179 | 45 | 224 |
| Motor Control Center (M.C.C.) | | | | | | | | |
| @ Bamag P.S. | 1 | 380 Volt | | | I | 115 | 30 | 145 |
| @ New F.W.P.S. | 1 | 3300 Volt | | | I | 140 | 35 | 175 |
| Panels, Switches, Conduit and related equipment | | | | | I | 70 | 32 | 120 |
| | | | | | Subtotal | 739 | 207 | 946 |

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TABLE 9.2 (Cont.)

PROCUREMENT OF EQUIPMENT COSTS
HIGH PRIORITY AND IMMEDIATE PHASE

| HIGH PRIORITY WATER DISTRIBUTION SYSTEM<br>Item | Quantity | Characteristics, Capacity<br>Size mm | Specifications Reference (See Appendix D) | Estimated Costs(3) Foreign(1) LE (1,000) | Local(2) LE (1,000) | Total LE (1,000) |
|---|---|---|---|---|---|---|
| Valves | 12 | 800 | J | 126 | 5 | 131 |
| | 6 | 600 | J | 43 | 2 | 45 |
| | 6 | 500 | J | 31 | 2 | 33 |
| | 26 | 400 | J | 91 | 7 | 98 |
| | 31 | 300 | J | 23 | 6 | 29 |
| | 44 | 200 | J | 18 | 7 | 25 |
| | | | Subtotal | 332 | 29 | 361 |
| Meter Test Equipment | - | | - | 4 | 1 | 5 |
| Operations Equipment | | | | | | |
| Chlorine cylinders | 20 | 1 ton | | 14 | | 14 |
| Pickup truck | 2 | 3/4 ton | | 22 | | 22 |
| Backhoe | 1 | | | 19 | | 19 |
| Front-end Loader | 1 | | | 27 | | 27 |
| Air Compressor | 1 | | | 10 | | 10 |
| Miscellaneous Tools & Shop Equipment | - | | | 50 | | 50 |
| | | | Subtotal | 142 | | 142 |
| Hydrant Replacement and Additions | 100 | 15 lps | K | 21 | 40 | 61 |
| | | TOTAL HIGH PRIORITY PROCUREMENT COSTS: | | 1,764 | 413 | 2,177 |
| IMMEDIATE PHASE WATER DISTRIBUTION SYSTEM | | Size mm | | | | |
| Meters | 1,768 | 15 | L | 48 | 8 | 56 |
| | 4,295 | 20 | L | 181 | 16 | 197 |
| | 4,800 | 30 | L | 453 | 19 | 472 |
| | 1,137 | 40 | L | 178 | 5 | 183 |
| | 12,000 | | Subtotal | 860 | 48 | 908 |
| | | Subtotal Immediate Phase Procurement: | | 860 | 48 | 908 |
| | | Subtotal High Priority Procurement: | | 1,764 | 413 | 2,177 |
| | | | TOTAL: | 2,624 | 461 | 3,085 |

(1) Includes delivery to Port Said.
(2) Includes installation.
(3) Based on August 1978 costs. Does not include allowances for contingencies and support services such as engineering, legal and administrative.
(4) Only installing seven (7) pumps out of ten (10) under High Priority and Immediate Phase.

TABLE 9.3

MAJOR CAPITAL PROJECTS
ESTIMATED CONSTRUCTION COSTS(1)
HIGH PRIORITY AND IMMEDIATE PHASE
(Thousands of 1978 LE)

| | Design Period (Months) | Foreign Cost | Local Cost | Total Cost |
|---|---|---|---|---|
| HIGH PRIORITY: | | | | |
| SOURCE OF SUPPLY | | | | |
| Seepage and Weed Control of Port Said Canal | 4 | 50 | 7 | 57 |
| WATER TREATMENT PLANT | | | | |
| New Finished Water Pump Station | 12 | | | |
| Mechanical Equipment and Piping(2) | | 274 | 60 | 334 |
| Civil Construction of Structure & Site Work(3) | | 76 | 97 | 173 |
| Electrical & Instrumentation(2) | | 24 | 121 | 145 |
| Subtotal | | 374 | 278 | 652 |
| Raw Water Pump Station (Bamag I) Modifications | 6 | | | |
| Mechanical Equipment and Piping(2) | | 15 | 41 | 56 |
| Civil Modification to Building & Site Work(3) | | 11 | 17 | 28 |
| Electrical & Instrumentation(2) | | 17 | 19 | 36 |
| Subtotal | | 43 | 77 | 120 |
| Yard Piping | | | | |
| Raw Water (1300 m of 80 mm) | 4 | 515 | 134 | 649 |
| Finished Water (600 m of 800 mm) | | 932 | 489 | 1,421 |
| Subtotal Water Treatment Plant | | | | |
| DISTRIBUTION SYSTEM (Existing Areas) | | | | |
| Primary Pipe Reinforcing(4) | | | | |
| Purchase and Installation | 6 | 415 | 266 | 681 |
| Secondary Distribution | | | | |
| Purchase and Installation | 12 | 11 | 500 | 511 |
| Service Connections | 6 | 5 | 208 | 213 |
| Subtotal Distribution System | | 431 | 974 | 1,405 |
| Subtotal High Priority Projects | | 1,413 | 1,470 | 2,883 |
| IMMEDIATE PHASE: | | | | |
| SOURCE OF SUPPLY | | | | |
| Dredging and Sealing of Port Said Canal | 6 | 183 | 234 | 417 |
| WATER TREATMENT PLANT | | | | |
| Centralized Chlorination Facilities | 4 | | | |
| Mechanical Equipment and Piping | | 52 | 18 | 70 |
| Civil Building Modifications and Site Work | | 18 | 30 | 48 |
| Electrical and Instrumentation | | 17 | 6 | 23 |
| Subtotal | | 87 | 54 | 141 |
| Centralized Chemical Feed Facilities | 2 | | | |
| Purchase and Installation of New Equipment and Piping | | 10 | 5 | 15 |
| Subtotal Water Treatment | | 97 | 59 | 156 |
| DISTRIBUTION SYSTEM (New Areas) | | | | |
| Primary Piping(4) | 6 | | | |
| Purchase and Installation | | 1,537 | 458 | 1,995 |
| Secondary Piping | 6 | | | |
| Purchase and Installation | | 15 | 673 | 688 |
| Service Connections | 2 | 7 | 283 | 290 |
| Subtotal Distribution System | | 1,559 | 1,414 | 2,973 |
| Subtotal Immediate Phase | | 1,839 | 1,707 | 3,546 |
| TOTAL MAJOR CAPITAL PROJECTS | | 3,252 | 3,177 | 6,429 |

(1) Based on August 1978 costs. Not including allowances for contingencies and support services such as engineering, legal and administrative.
(2) Equipment costs (pumps, electronic and portion of instrumentation) included in High Priority Equipment Procurement (see Table 9.2).
(3) Includes allowances for plumbing and ventilation.
(4) Pipe lengths and diameters required for primary distribution system are summarized on Table 8.4, Additions to Proposed Primary Distribution System. Figure B-1 presents water main unit construction costs.

TABLE 9.4

WATER DISTRIBUTION SOUND LEAK SURVEY

PROCUREMENT OF SERVICES

ESTIMATED EQUIPMENT COSTS(1)
(Thousands of 1978 LE)

| | Foreign | Local | TOTAL |
|---|---|---|---|
| **Personnel** | | | |
| Engineer (specialist) | 9.4 | 1.4 | 10.8 |
| Record Keeper (local) | - | .4 | .4 |
| Two laborers to open valve boxes, hydrants and curb stops | - | .4 | .4 |
| Two laborers to serve as traffic guards | - | .4 | .4 |
| Subtotal | 9.4 | 2.6 | 12.0 |
| **Equipment** | | | |
| Sound equipment(2) | 1.6 | - | 1.6 |
| Supplies and expendables | - | .6 | .6 |
| Transportation | - | .8 | .8 |
| Subtotal | 1.6 | 1.4 | 3.0 |
| TOTAL | 11.0 | 4.0 | 15.0 |

(1) Based on August 1978 costs. Does not include allowances for support services such as engineering, administrative and legal.
(2) Son-O-Phones and geophones. Treated as equipment procurement for determining allowances for contingencies and support services.

TABLE 9.5

WATER DISTRIBUTION VELOCITY LEAK SURVEY

PROCUREMENT OF SERVICES

ESTIMATED PERSONNEL - EQUIPMENT COSTS(1)
(Thousands of 1978 LE)

| | Foreign | Local | TOTAL |
|---|---|---|---|
| **Personnel** | | | |
| Contractor | | | |
| Project Manager (6 months) | 25 | 4 | 29 |
| Resident Engineer (12 months) | 42 | 8 | 50 |
| Local Technical Assistants(2) | | | |
| Assistant Project Manager | - | 5 | 5 |
| 2 Technicians | - | 4 | 4 |
| Education Training Supervisor | - | 3 | 3 |
| Local Labor(2) | | | |
| 2 Drivers | - | 2 | 2 |
| 4 Laborers | - | 2 | 2 |
| 1 Clerk/typist | - | 3 | 3 |
| Subtotal | 67 | 31 | 98 |
| **Equipment** | | | |
| Major Items(3) | | | |
| Van-type Vehicle | 8 | - | 8 |
| Pick-up Truck, 1/2 T | 7 | - | 7 |
| Test Equipment(4) | 18 | - | 18 |
| Supplies and Expendables | | | |
| Spare Parts | 4 | - | 4 |
| Expendables (corporation stops, clamps, tubing) | 4 | - | 4 |
| Office Expendables | - | 1 | 1 |
| Operating Expendables (gasoline, oil) | - | 2 | 2 |
| Subtotal | 41 | 3 | 44 |
| General Support | | | |
| Machine Shop | - | 2 | 2 |
| Office | - | 1 | 1 |
| Subtotal | - | 3 | 3 |
| TOTAL | 108 | 37 | 145 |

(1) Based on August 1978 costs. Does not include allowances for support services such as engineering, legal and administrative.
(2) Costs assume that technical and manual labor assistance is not supplied by Suez Canal Authority.
(3) Treated as equipment procurement for determining allowances for contingencies and support services.
(4) Includes: M scope detector, aqua locator, pipe locator, three sets of pitometers (with manometers), pressure gauges (direct reading and recording), new tapping machine (complete with accessories), 50 corporation stops, hand tools, spare parts and supplies such as clamps, tubing, tape.

## TABLE 9.6

## RECOMMENDED PROGRAM ESTIMATED COSTS[1]

### HIGH PRIORITY AND IMMEDIATE PHASE
(Thousands of 1978 LE)

| | | |
|---|---|---|
| Local Measures Table 9.1 | | 58.00 |
| Equipment Procurement | | |
| Table 9.2 | 3,085 | |
| Sound Leak Survey Table 9.4 | 2 | |
| Velocity Leak Survey Table 9.5 | 33 | |
| | 3,120 | |
| Contingencies and Support Cost Factor | x 1.22 | |
| Subtotal | | 3,806.40 |
| Major Capital Projects Table 9.3 | 6,429 | |
| Contingencies and Support Cost Factor | x 1.515 | |
| Subtotal | | 9,739.94 |
| Procurement of Services | | |
| Sound Leak Survey Table 9.4 | 13 | |
| Velocity Leak Survey Table 9.5 | 112 | |
| | 125 | |
| Contingencies and Support Cost Factor | x 1.13 | |
| Subtotal | | 141.25 |
| TOTAL | | 13,745.59 |

(1) Including allowances for contingencies and support services such as engineering, legal and administrative.

TABLE 9.7

RECOMMENDED PROGRAM ESTIMATED COSTS
STAGED DEVELOPMENT
(Thousands of 1978 LE)[1]

| | Civil/ Pipe | Mechanical | TOTAL | Foreign | Local |
|---|---|---|---|---|---|
| RAW WATER SUPPLY[2] | | | | | |
| Concrete Lining | 10405 | - | 10405 | 2076 | 8329 |
| Raw Water Storage (1.5 million cu m) | 3776 | 124 | 3990 | 1209 | 2691 |
| Contribution to MOI Improvements Upstream of Rayah Barrage: | | | | | |
| Initial Stage (1985) | 1000 | - | 1000 | - | 1000 |
| Final Stage (1990) | 7000 | - | 7000 | - | 7000 |
| Subtotal - Raw Water Supply | 22181 | 124 | 22305 | 3285 | 19020 |
| EL RASWA WTP[3] | | | | | |
| Initial Upgrade-Unit 4 | 464 | 696 | 1160 | 635 | 525 |
| Initial Upgrade-Unit 5 | 464 | 696 | 1160 | 635 | 525 |
| Upgrade Existing Bamag | 100 | 150 | 250 | 137 | 113 |
| Final Upgrade-Unit 4 | 50 | 76 | 126 | 69 | 57 |
| Final Upgrade-Unit 5 | 50 | 76 | 126 | 69 | 57 |
| Final Upgrade-Units 2+3 | 133 | 200 | 333 | 182 | 151 |
| Final Upgrade-Unit 1 | 1166 | 1750 | 2916 | 1598 | 1318 |
| Purchase & Install New Pumps | - | 643 | 643 | 529 | 115 |
| Reinforce Header Pipe | 239 | - | 239 | 167 | 72 |
| Subtotal - El Raswa WTP | 2666 | 4287 | 6953 | 4021 | 2932 |
| DISTRIBUTION SYSTEM[4] | | | | | |
| 1983-1985 | | | | | |
| Primary Distribution Lines | 1929 | - | 1929 | 1121 | 808 |
| Secondary Distribution Lines | 1544 | - | 1544 | 77 | 1467 |
| Service Connections | 648 | - | 648 | 33 | 615 |
| Meters | - | 436 | 436 | 374 | 62 |
| 1986-1990 | | | | | |
| Primary Distribution System | 3623 | - | 3623 | | |
| Secondary Distribution System | 3164 | - | 3164 | 159 | 3005 |
| Service Connections | 1179 | - | 1179 | 59 | 1120 |
| Meters | - | 412 | 412 | 352 | 60 |
| 1996-2000 | | | | | |
| Primary Distribution System | 1236 | - | 1236 | 750 | 486 |
| Secondary Distribution System | 2795 | - | 2795 | 140 | 2655 |
| Service Connections | 1174 | - | 1174 | 59 | 1115 |
| Meters | - | 424 | 424 | 363 | 61 |
| Vehicles and Construction Equipment | - | 150 | 150 | 150 | - |
| Distribution and Storage | 804 | 102 | 906 | 102 | 804 |
| Subtotal - Distribution System | 23120 | 1553 | 24673 | 6531 | 18142 |
| TOTAL - STAGED DEVELOPMENT | 47967 | 5964 | 53931 | 13837 | 40094 |

(1) Includes contingencies and support allowance costs.
(2) See Table 6.4.
(3) See Table 7.7.
(4) See Table 8.6.

TABLE 9.8

TOTAL RECOMMENDED PROGRAM-ESTIMATED COSTS
(Thousands of 1978 LE)[1]

| | Civil/Pipe[2] | Mechanical[2] | TOTAL | Foreign | Local |
|---|---|---|---|---|---|
| **HIGH PRIORITY** | | | | | |
| Raw Water Supply[2] | - | - | 86 | 66 | 20 |
| El Raswa WTP | 1697 | 2436 | 4133 | 2697 | 1436 |
| Distribution System[2] | 2685 | 182 | 2882 | 1201 | 1681 |
| Subtotal High Priority | 4382 | 2618 | 7101 | 3964 | 3137 |
| **IMMEDIATE PHASE** | | | | | |
| Raw Water Supply[2] | 200 | - | 631 | 266 | 365 |
| El Raswa WTP | 101 | 136 | 237 | 134 | 103 |
| Distribution System[2] | 4503 | 1148 | 5777 | 3213 | 2564 |
| Subtotal Immediate Phase | 4804 | 1284 | 6645 | 3613 | 3032 |
| **STAGED DEVELOPMENT** | | | | | |
| Raw Water Supply | 22181 | 124 | 22305 | 3285 | 19020 |
| El Raswa WTP | 2666 | 4287 | 6953 | 4021 | 2932 |
| Distribution System | 23120 | 1553 | 24673 | 6531 | 18142 |
| Subtotal Staged Development | 47967 | 5964 | 53931 | 13837 | 40094 |
| TOTAL - RECOMMENDED PROGRAM | 57153 | 9866 | 67677 | 21414 | 46263 |
| REHABILITATION[2] | - | - | 658 | 334 | 324 |
| COSTS NOT INCLUDING REHABILITATION | 57153 | 9866 | 67019 | 21080 | 45939 |

(1) Includes contingencies and support allowance costs.
(2) Costs for rehabilitation are not included under civil and mechanical classification. Rehabilitation work included in both High Priority, LE 101,000, and Immediate Phase, LE 557,000. See Chapters 6 and 8 for details.

CHAPTER 10

# ORGANIZATION AND OPERATIONS

The water treatment and distribution system for Port Said is under the control of the Suez Canal Authority (SCA). The basic organizational structure is sound and generally adequate to accomplish the task of supplying Port Said with sufficient amounts of good quality water. The work accomplished to restore service after an almost complete shutdown from 1967 to 1973 is to be highly commended.

A number of operating deficiencies were noted. Specific measures recommended to overcome these deficiencies include:

- Provision of adequate tools and replacement parts.
- Use of modern-type service connections.
- Improvement of record keeping.
- Training programs to increase skills.
- Strengthening of supervision - especially for water treatment operations.

This chapter reviews in detail overall and functional organization and staffing for water system operations for both near and long term. Included is the integration of some services (e.g., billing of accounts) for the wastewater system. Special consideration is given to personnel qualifications, training and salaries.

## 10.1 ORGANIZATIONAL STRUCTURE

### Overall Structure

At present the water system is operated within the overall SCA organizational structure. The local water organization reports to the Vice-Director of the SCA, who is responsible for Works Department activities in Port Said. All the normal operations and maintenance functions of a typical municipal water department, including preparation and collection of bills, are handled by the local organization. The Works Department headquarters or other SCA departments provide certain support functions such as personnel, procurement. finance and project planning.

Several alternative organizational structures are being considered for the water utilities in the canal cities:

- The consultants for the national Management and Tariff Studies Relative to Water/Sewerage recommended (December, 1978) a combined regional water and sewerage company, or general organization, to serve the canal cities.
- An alternative recommendation in the report was formation by the SCA of a regional water company and separate formation of a regional sewerage utility, either as a public company or as a general organization. The ultimate goal would be eventually to combine the two organizations.

- On the other hand, we understand that present national policy favors giving governorates increasing responsibility for public services.

Integrating water and wastewater operations at the local or regional level would:

- Simplify levying user charges for water and wastewater service. (The charges would be based on metered water use in any case).

- Avoid unnecessary duplication of equipment and staff for basically similar activities, including:

  - Pipeline construction and maintenance
  - Pumping station operation and maintenance
  - Treatment plant operations
  - Shops
  - Laboratories
  - Engineering and construction management
  - Customer services contacts
  - Procurements
  - Financial management
  - Personnel and training
  - Facilitate coordination of service extensions and street openings.

A major effort would be needed to establish a basis for such integration, taking into account the interests of all present parties concerned. We believe that the potential benefits would justify the effort.

Whatever the organizational structures selected to provide water and sewer service to Port Said in the years ahead, the choice is likely to be made in a wider context than that of Port Said alone. The selection of overall structures should take these factors into account:

- The line organization in Port Said should be responsible for providing service.
- The overall structure should be judged by how well it supports the line organization in the basic job of providing good water service.
- The organization with responsibility for service must have the authority and independence to discharge this responsibility.
- The present overall structure is serving quite well and should not be altered until a demonstrably better alternative is developed.

## Departmental Structure

The departmental organization shown on Figure 10-A would fit readily into different overall structures supplying support services. A completely autonomous organization, whether at the governorate or regional level, would have separate departments to handle such functions as finances, personnel, engineering, and procurement. In such a structure, the local organization at Port Said would serve as the operations and maintenance department or the local branch of each department in an overall structure.

The proposed organization in Port Said would be closely patterned on the present one. At present the department is organized into New Projects, Treatment, Distribution and Administrative Divisions, with the following responsibilities:

- New Projects Division - develop, design and inspect new work; maintain records and drawings.
- Treatment Division - operate and maintain El Raswa WTP, including laboratory facilities.
- Water Distribution Division - repair leaks, install new services, replace meters. Division personnel are supplemented by contract laborers when needed.
- Administrative Division - read and repair meters, prepare billings.

To transform the present departmental organization to that shown on Figure 10-A, the following specific revisions are recommended:

- Create a Customers Services Division, including sections for meter reading, customer accounting, collection, and meter installation and repair. (Meter installation would be moved from the Distribution Division).
- Establish a Stores and Equipment Section to support the Treatment and Distribution Divisions.
- Add five shift managers in the Treatment Division.
- Institute a records section in the Distribution Division.

The recommended local-level water organization could be readily adapted to a combined water-wastewater utility. We would suggest the following:

- Water Distribution Division to become a Pipeline Division responsible for installation and repair of all types of lines.
- Treatment Division to become an Operations Division responsible for water treatment and pumping facilities.
- Maintenance of all plants and pumping stations to be centralized in one division, including sections for stores and equipment.



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- New Projects Division to incorporate the new projects/facility records for water and wastewater. The records section in the Water Distribution Division would be transferred to this division.

- Customer Services Division to remain as shown.

## 10.2 NEW PROJECTS DIVISION

The SCA has assigned 17 technicians from the Treatment and Distribution Divisions to assist in the design and construction of new facilities. Included are surveyors, draftsmen and personnel versed in equipment operation and instrumentation. An engineering supervisor position, established but still vacant, should be filled as soon as possible.

The New Projects staff would be available to assist the contractors and engineering consultants responsible for construction. The staff's knowledge of local problems and conditions should be most valuable both to the resident staff supervising construction and to the staff of the construction contractors. Local personnel should, in turn, benefit from training during their participation in these major projects.

## 10.3 TREATMENT DIVISION

### Supervisory Staff

At El Raswa Water Treatment Plant (WTP), overall responsibility for operation and maintenance should rest with an engineer well-trained in water processes and chemistry. The five shift managers would be scheduled to provide round-the-clock supervision of chemical feed/flocculation, filtration, backwashing, pump operation, plant production and electrical/mechanical maintenance.

Each shift manager would be responsible for activities of the entire plant staff on duty during his shift, and for proper preparation of all operations and maintenance records for the shift.

### Operations Section

At the present time, seven locations at the plant are staffed with 38 operators around-the-clock. Full time staffing of these locations, based on eight hour shifts and a six-day week with allowances for vacation and sick leave, would require only 35 operators. We understand that the present staff is working 12-hour shifts, six days a week.

The proposed increases in plant capacity are to be met by upgrading the existing streams; therefore, the total operating staff need increase only moderately. There will be one less pumping station than at present: the new finished water and new Bamag stations will be added; but the Main Auxiliary Raw Water and Annex Stations will be eliminated.

Proposed staffing would be based on eight operating locations manned as follows in the year 2000:

| Operating Locations | Operators Per Shift |
|---|---|
| Raw Water Pumping Station | 1 |
| New Bamag Pumping Station | 1 |
| Finished Water Pumping Station | 1 |
| Chemical Feed and Flocculation | 2 |
| Existing Bamag - Filtration | 1 |
| New Bamag - Filtration | 1 |
| Converted Slow Sand Filters - Filtration | 2 |
| Additional Crew for Chemical Handling | 1 |
| | 10 |

Round-the-clock staffing would require 5 operators for each position, based on a 6 day, 48 hr work week, with allowances for vacations, holidays and sick time. Two foremen per shift would be provided - one specialized in pumping and one in treatment operations. Up to 20 percent of the staff would be trainees or laborers.

For the near term, until the conversion of flow trains 4 and 5, all eight operating locations will still be needed. Chemical feed, flocculation and chemical handling, and operation of the converted slow sand filters could probably be covered by 2 to 3 men per shift. Hence the present staffing of 38 operators/laborers should be adequate for this period.

At present, on a daily average, about 20 contract laborers are hired for scraping and refilling slow sand filters. As the slow sand filters are converted, these positions would be eliminated - the last before the year 2000. Through 1987, one extra foreman would be provided to oversee this work.

The operations of the plant were evaluated and water analyses made (see Table 10.1). Several of the recommendations presented in Chapter 7 could be implemented at virtually no cost and with available personnel to enable the plant to produce consistently high quality water. For example, although control of the algae problem in the slow sand filters (Table 7.3) by a low dose of copper sulfate was demonstrated, no interest has been shown to date in continuing or expanding the treatment. The practice of operating pumps against almost closed discharge valves still continues, though it has repeatedly been pointed out to be unnecessary and poor practice.

Accurate feeding of coagulant and coagulant aids has been stressed in past reports and is again mentioned in this report. The coagulant feed (alum) to the Bamag has been set at a constant rate (400 l/hr) for several months, even though the flow rate varies through a range of 10,000 to 45,000 cu m/day. Proper feed rates could save money. Overfeeding wastes alum and polymer and causes early plugging of slow and rapid sand filters, resulting in a reduced plant output.

Several simple adjustable constant rate chemical feeders have been built and installed by Hazen and Sawyer personnel. Several more, which would greatly improve the chemical feeding accuracy and consistency, are required. A proper operation of the filter valves was recommended in a written backwash procedure. At present there does not appear to be any uniform backwash procedure. Filters are washed from 2 to 10 or 15 minutes with air only, water only, or air and water, at the option of the operator. In addition, the filter influent valve normally was left open and one of the drain valves was not opened during the wash. (Leaving the influent valve open floods the pipe gallery, which in turn could contaminate the filter and water.)

Proper chlorination is not given the priority it should have. More than occasionally, flow streams from one or another part of the plant leave without any chlorination. (Tests indicated that this dose should be about 2 mg/l to overcome the 1 mg/l demand and maintain adequate residual throughout the system.)

Supervisory personnel appear to have no interest in carrying out or expanding any of the above projects. In fact, even those that have been installed are not operating properly due, in large part, to a lack of care.

An immediate need is for an experienced operations engineer to effectively supervise the plant. There can be no hope of improving operating conditions and water quality until improved supervision and control is established and maintained. This must include the adequate supply of parts and hand tools, plus on-site supervision by a qualified, interested supervisor, and interest and financial support at all levels of management.

Plant Maintenance Section

The maintenance of the treatment facilities is to be commended. The fact that the city is now furnished a reasonably good quality water 24 hours a day attests to the diligence and hard work of the personnel.

Maintenance of the pumps and pumping stations is excellent. Through the skill and ability of the SCA maintenance personnel, pumps over fifty years old have been rebuilt, even when it required the complete manufacture of a new impeller or the rewinding of a motor. On the other hand, other equipment such as all of the flow measurement equipment and the Bamag rapid mixer and flocculators have gone unrepaired.

The El Raswa WTP maintenance staff appears adequate to perform the required routine work at this time. When the new Bamag plant and the CTE conversions are completed, additional personnel and skills will be required, including electricians and control-and-instrumentation mechanics, if the additional electronic control and monitoring equipment is to remain operational. Plans should be made by SCA to obtain technicians immediately and train them for this work.

The 36-man maintenance staff assigned to the water plant handles only routine preventive maintenance, minor repairs and upkeep of the plant grounds. Major repairs such as rewinding motors are performed by specially qualified personnel in the SCA's well-equipped central workshops. We have assumed that this system would continue and that the staff involved would rise from the equivalent of the present 10 full time people to the equivalent of 20 people by the year 2000. Although not shown on the organization chart, these personnel have been allowed for in estimating labor costs.

Laboratory

The water system has two laboratories - one at El Raswa and a second, for bacteriological work, in the city. As a result, the staff (two chemists and eight assistants) is larger than need be. Once the new Bamag plant is completed, there would be three laboratories.

We recommend that the laboratories be consolidated at El Raswa. On this basis, the laboratory chief, one chemist, three technicians (trained laboratory assistants) and two sample collectors should be able to handle the year 2000 work load. Infrequently needed



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testing, such as for heavy metals (atomic absorption spectroscopy) and organics (gas chromotography), should be sent to the National Research Center or other large laboratory with the required sensitive equipment.

Water Plant Records

The current record keeping system at the WTP is good and includes sufficient information to operate the plant effectively.

Records kept include:

- Raw and finished water quantities
- Pump hours (currently used to estimate water quantities)
- Electrical power consumed
- Chemical feed quantities
  - a) Aluminium Sulfate
  - b) Chlorine
  - c) Polymer
  - d) Copper Sulfate (not currently used)
  - e) Carbon (not currently used)
- Raw ana finished water quality, including algae counts, bacteriological quality and chemical analysis
- Port Said Canal water level
- Water levels in finished water reservoirs
- Distribution system pressure
- Chlorine residual

These records are totaled and summarized on a regular basis and forwarded to higher management.

The record keeping should continue basically as it exists. There is, however, a tendency to duplicate records and create an excess of paper work. Efforts should be made to streamline the system and to eliminate duplication. More time should be spent actually analyzing the data and using the information to improve operations.

## 10.4 STORES AND EQUIPMENT DIVISION

The recommended organization would include a new section to provide these services:



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- Inventory, safeguard, order and record use of supplies and materials in the operations and maintenance of the system.

- Provide field maintenance for construction equipment.

- Prepare and analyze maintenance records to determine spare parts stock and identify equipment that should be replaced because of high maintenance costs.

This section would support both the Treatment and Distribution Divisions. Existing structures at the plant - either the Main Pumping Station (if not converted to a chlorination facility) or the generator buildings - are likely to be available for warehousing.

## 10.5 WATER DISTRIBUTION DIVISION

### Maintenance Mains and Services Section

This section, responsible for repairing leaks, installing new services, and replacing meters, is supplemented by contract laborers as required by the work load. Our studies have shown a large number of broken or non-operating meters and numerous visible leaks in the distribution system that should be repaired immediately. (Meter installation and repair should be moved to a new Customer Service Division; see Section 10.6, below).

The present staff of the Maintenance Mains and Services Section (26 technicians and laborers) is not able to keep up with the work load. However, increasing the number of staff will not solve the problem. Unless work methods, materials and equipment are improved, the backlog of leaks is likely to remain a problem. The work of an ample staff is hampered by outdated practices and lack of proper tools. As an example, a five man crew assigned to repair a leak or to install a new service will usually have only one pick and shovel on the job. The use of lead service piping and hand drilled, lead saddle taps also contribute to excess work. With proper materials, tools and techniques, the staffing shown in Figure 10-A should be adequate to maintain the Port Said distribution system in the year 2000.

### Records Section

One of the greatest weaknesses of the water distribution system, unlike El Raswa WTP, is the lack of records. The system has functioned over the past few years because of the willingness and ability of the engineers, technicians, foremen and laborers to work extremely hard with very limited resources. The knowledge of the older workers at all levels has been invaluable.

To keep pace with the growth of the system and to improve the level of service to all customers, a vastly improved recordkeeping system must be developed.

An engineer (Assistant Division Engineer), two technicians, and three draftsmen would comprise the Records Section for the period through the year 2000. The principal assignment in the early years would be collection and recording of key data on the existing water system, such as detailed in-place drawings showing pipe and valve locations, age and make of system elements, and condition of these materials. Considerable effort would be needed to fill in major gaps in existing records. The section would also be responsible for accurately recording extensions, reinforcements and alterations of the system.



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### Maps

The field crews need detailed maps of the water system. Without such maps, proper procedures cannot be established for isolating breaks, repairing valves and hydrants, adding and changing meters.

An atlas should be available in the engineer's office, the maintenance shop and the top foreman's vehicle. This would be a set of maps on a scale of 1 to 1,000, with page size approximately 80 cm x 65 cm. The maps should show all water mains, all connections between mains, all valves, all hydrants and all street names. A quick view of portions of the system would be provided to see what problems would be caused by any emergency or planned maintenance. The Fire Major would need a set of these maps to use for fire protection planning. An index system must be developed. A system must be established for reporting all changes to the keeper of the master copies so corrections can be made and new pages of the atlas, with revision dates, distributed. (Only the revised pages, not the entire atlas, would be reprinted each time a revision is made.)

A second set of strip maps, including exact locations of all valves and hydrants, need not be to scale but should be schematics, showing each street and giving reference points for each valve. Measurement must be sufficiently accurate to locate valves at night even if pavement has been placed over them. Reference points should be those most likely to remain for a long time, such as building corners, light poles, manhole covers, or wall corners. Measurements should be to the nearest 0.1 m (see Figure 10-B for a strip map example). Every foreman who performs work on valves or mains needs a set of these maps. Field work for the preparation of the maps would require a survey crew plus one long-term employee with knowledge of the locations. A draftsman should be assigned responsibility for drawing the original maps on mylar and then making all revisions.

### Valve Maintenance Records

Once strip maps are available, a valve maintenance program can begin and be controlled. Each valve should be identified by letter, street name and page number. The records should include the condition of valve, valve packing and valve box, and the direction of operation and number of turns to fully close and open. All valves 400 mm and larger should be checked annually, and smaller valves at least every five years.

## 10.6 CUSTOMER SERVICES DIVISION

The present Administrative Section should be reorganized to form this division. Meter installation and replacement functions should be transferred from the Distribution Division and made the responsibility of the Meter Installation and Repair Section. The present meter reading section would be redesignated as the Customer Accounts Section. A separate cashier section (Collection Section) would be set up.

The new name of the division would emphasize the mission of providing service. The division chief or the Customer Accounts Section chief should be available to handle customer problems whenever necessary.

### Meter Installation and Repair Section

Recommendations for improvements in meter installation and repair are presented in Section 8.6.

The meter shop staff, consisting of ten technicians and a shop chief, is adequate to handle the present volume of meter repairs. Only 200 meters are repaired per month in this shop; less than one meter per man per day. This low rate of production should improve, however, with better test equipment, standardization of meter brands and types and elimination of old, difficult-to-repair meters. The year 2000 staffing would consist of two foremen - one shop and one field - and twelve technicians. This differs from the present meter shop staff by only three men - the field foreman added to supervise installation work, and two added technicians.

Meter Shop Records

Existing shop records are good. An additional cross reference file needs to be set up on all meters. The first record should be filed by meter number and should show the address, the meter number and the meter make and size. Space should be provided so that the same card can be used when a repaired meter is installed at a new location. The second record should be filed by street address. Both of these file cards can be printed by the SCA computer from data it has. The shop foreman may have to add the meter make as meters come in for repair. There should be a monthly cost accounting and production accounting for the entire shop and by individual repairmen.

Customer Accounts Section

This section is responsible for reading meters, transferring the information to books and forms, making estimates where meters are broken or missing, and collecting the water revenues. The section is adequate to perform the current work load. Certain efficiencies could be effected by improved bookkeeping procedures, better use of the existing computer and by better methods of bill collecting.

As of May, 1978, the SCA had about 8,000 meters installed in Port Said. Customers without meters were either estimated or billed on a flat rate for water service.

Meter readings, bill preparation and bill collecting is done by eleven technicians and one supervisor. The meter readers enter readings into a field book, and upon returning to the office, transfer these readings to a second meter book. Estimates are then made for the non-read and stopped meters. Orders for meter changes are prepared and sent to the Distribution Section.

The book prepared in the office is sent to Ismailia to be used in the computerized preparation of water bills, which are returned to Port Said and hand carried by the reader technicians to the customers for collection. Customers not at home, or those who do not pay when called upon, are required to pay the bills at the SCA office. Nonpayment of bills is cause for discontinuance of water service.

A computer print-out is returned with the bills from Ismailia. The print-out lists total billings in LE and various charges and taxes. Volumes of water billed for individual accounts are listed but not totaled for the system. Such a total would not be accurate in any case because of the large number of estimates and flat rate bills.

A hand-written ledger and balance sheet is prepared and maintained by the SCA accounting office. Quantities of water distributed to customers are determined by using figures for high service pumping hours from El Raswa WTP but are not presently reconciled with quantities from the water bills.



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Bullen et al[1] state that for the two lower income groups, the per capita consumption of water is 100 lcd. There is a flat charge of 0.20 to 0.30 LE per month for water service for unmetered accounts. Our work shows that the consumption figure for unmetered (flat rate) accounts is greater than 160 lcd. When this figure is applied to the 18,000 government housing units alone, the loss in revenue exceeds 25,000 LE per annum. With the addition of 3,000 housing units without meters per year, the loss in revenue increases with each succeeding year. The metered accounts and other sources of revenue must subsidize these flat rate accounts.

In addition to revenue loss from government housing, there are inconsistencies in billings that could represent further losses. For example, according to Binnie et al[2], the shipyard was billed for 2,300 cu m/d in 1966-67 whereas, in 1977, SCA billed them for only 920 cu m/d. The work force (3,000 employees) and the type of production are the same, yet the volume billed, now largely estimated, has dropped by over 60 percent.

Greater use of the SCA computer in Ismailia can provide more accurate billing and better management data. For each water account a computer "mark sense" card should be generated and sent to Port Said when the meters are to be read. An experienced meter reader supervisor needs to work very closely with the computer people so that each account can be coded in such a way that the reading cards will come from the computer center sorted in piles that represent all meters that are close together. This will allow the meter readers to work most effectively. Where meters have stopped or do not exist consumption estimates must be made. There already exists an office procedure for doing this. The only recommended change would be to enter this data on the computer card. Cards would be returned to the computer center where they can be "read" by the computer. An edited list should be printed showing all accounts that seem to be unusually high or low. These would be manually checked and adjusted and returned to the computer. Bills would be prepared and distributed as at present. Use of the "mark sense" card requires a small amount of training. Errors will be reduced rapidly with experience. The manual transfer of the reading as is presently done is not likely to be error free. Even with the greatest care, the chance for errors increases with each manual transfer of data.

The computer should be used to make up change cards for inoperative meters. This would relieve the meter reader from making the decision as to whether or not a meter has been inoperative long enough to justify replacement.

Collection Section

In spite of efficiency improvements expected from measures outlined above, the section must be expanded to handle the larger number of customers. By the year 2000, 15 readers and 7 account clerks would be needed.

While making their regular rounds the meter readers would also pursue collection of overdue payments. The account clerks would handle billing, orders for new services, meter change orders and routine complaints. The mission of the section should be to account for as much of the water production as possible.

To safeguard handling of receipts, the cashiers would be in a separate section reporting directly to the Division Chief. Cashiers would receive customer payments directly, and also checking moneys collected by meter readers.

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(1) PSMP, Vol. 6, Para 6.5
(2) PSMP, Vol. 6, Table 1-1



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## 10.7 STAFF

### Qualifications

All staff should be able to understand oral and written instructions, be safety-conscious and know the basics of materials and tools used in their work. All except those with strictly desk or light workbench duties must be physically fit for climbing, lifting and walking. All but ordinary laborers should be able to fill out written reports of work activities.

Operators and maintenance technicians must fully understand the functioning of the processes, equipment and controls for which they are responsible. This should extend to recognizing fault conditions and knowing appropriate responses including totally manual operation where necessary.

All staff should receive appropriate training to help them best use their skills in the water system. At a minimum this should include basic orientation to work practices and safety, plus on-the-job training. In many cases formal training programs should be provided to expand employees' skills - both to do their present jobs better and to help them advance to higher positions.

Desirable educational backgrounds for various positions in the organization are shown in Table 10.2.

Supervisors in the water system must provide both the leadership and major portions of the specialized technical knowhow to keep the system functioning properly. A key example is the position of chief of the treatment division; to give proper directions, he should be generally familiar with the duties of all his staff, but must also himself be thoroughly qualified by training and experience in water processes and chemistry. Filling this position with someone of these qualifications is a major problem. To a lesser degree this applies to other positions such as the shift managers.

A program of incentives and of technical and managerial training is needed in to attract, develop and retain supervisory staff for future needs and for replacing present staff who retire.

### Training

Projects now in progress at the water plant involve more complex instrumentation and control than the present staff is familiar with. Future projects are likely to do the same. Higher rate operation will require skillful control. Similarly, new skills will be needed to apply the better materials and techniques recommended for service connections. In all cases, to benefit from upgrading the physical facilities it is necessary to improve the operating and maintenance skills of the staff.

The required upgrading of skills can be accomplished most effectively through formal training programs organized by specialists in such work - drawing upon material available from professional associations such as the American Water Works Association.

Development costs of good programs are high, and once developed they should be used to the maximum. For this reason we suggest that the programs be developed by a regional or even a national agency, which would present them to as many local systems as possible. Presentations should include instructing local supervisors in techniques for on-the-job training to supplement the formal program.

If the training programs are to be undertaken at the regional level, an appropriate agency to develop and present them would be a newly designated Personnel and Training Division within the Administrative Department of SCA.

Compensation

In 1977 the full time water system staff of 163 received average wages of LE 677 per employee. (This excludes contract labor, technical specialists from SCA central shops, and the Works Director for Port Said who has responsibilities beyond the water system.) We understand that social insurance and benefits, such as meals, quarters and transportation furnished, bring total compensation to over 160 percent of wages.

The SCA roster of salaries and positions shows a wide variety of job titles and a wide range of pay levels under the same job title.

Whatever their title, most staff members are at pay levels comparable to that for laborers. We recommend that individuals job titles be reviewed to make them consistent with the organization chart, taking into acount required skills and responsibilities for various positions. Compensation should then relate more closely to job title.

For the projection of labor costs, we have grouped the staff positions shown on the organization chart (Figure 10-A) into five categories. Table 10-3 shows this grouping and the projection of numbers in each staff position through the year 2000.

The assumed compensations for different categories are as follows:

| Category | Average Compensation LE/yr |
|---|---|
| Professional | * |
| Supervisor | 1800 |
| Technical/Operator | 1200 |
| Clerical | 1000 |
| Laborer | 780 |
| Senior Maintenance Technicians | 1800 |

*Average not meaningful since compensation would vary widely with experience and responsibility. For lower level professional positions we have assumed compensation equivalent to that for supervisors.

We believe that SCA is already offering total compensation at these levels for individuals with the requisite skills. For proper future operation of the water system, it will be essential to increase the number of staff members at higher skill levels, with compensation high enough to attract and retain them.

## TABLE 10.1

## COLIFORM AND TURBIDITY CHARACTERISTICS

## EL RASWA WTP

TOTAL COLIFORMS MPN/100 ml (Samples taken in April-May and July, 1978)(1)

| | Raw Water | Settled Water | | | | Gravel | | Filtered Water | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Bamag | Unit 1 | Unit 4 | Unit 5 | Unit 1 | Units 4&5 | Bamag | Unit 1 | Unit 4 | Unit 5 |
| | 8 Samples | 5 Samples | 2 Samples | 2 Samples | 2 Samples | 2 Samples | 6 Samples | 9 Samples | 6 Samples | 6 Samples | 6 Samples |
| Average | 2,800 | 870 | 500 | 1,450 | 800 | 60 | 220 | 120 | 160 | 49 | 47 |
| Maximum | 13,000 | 1,300 | 500 | 2,200 | 1,100 | 70 | 920 | 540 | 540 | 130 | 130 |
| Minimum | 700 | 330 | 500 | 700 | 500 | 50 | 0 | 34 | 5 | 8 | 8 |

TURBIDITY, NTU (Samples taken in July, 1978)(1)

| | Raw Water | Settled Water | | | | Gravel | | Filtered Water | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Bamag | Unit 1 | Unit 4 | Unit 5 | Unit 1 | Units 4&5 | Bamag | Unit 1 | Unit 4 | Unit 5 |
| | 5 Samples | 2 Samples Each | | | | 2 Samples Each | | 4 Samples | 2 Samples Each | | |
| Average | 6.1 | 2.9 | 6.9 | 4.9 | 4.4 | 1.9 | 1.3 | 0.6 | 0.7 | 0.6 | 0.7 |
| Maximum | 6.9 | 3.5 | 7.1 | 5.1 | 5.5 | 2.3 | 1.5 | 0.7 | 0.7 | 0.7 | 0.8 |
| Minimum | 5.5 | 2.4 | 6.6 | 4.6 | 3.3 | 1.4 | 1.1 | 0.5 | 0.6 | 0.5 | 0.5 |

(1) All laboratory analyses by Hazen and Sawyer.

## TABLE 10.2

## STAFFING BASIS FOR LABOR COSTS

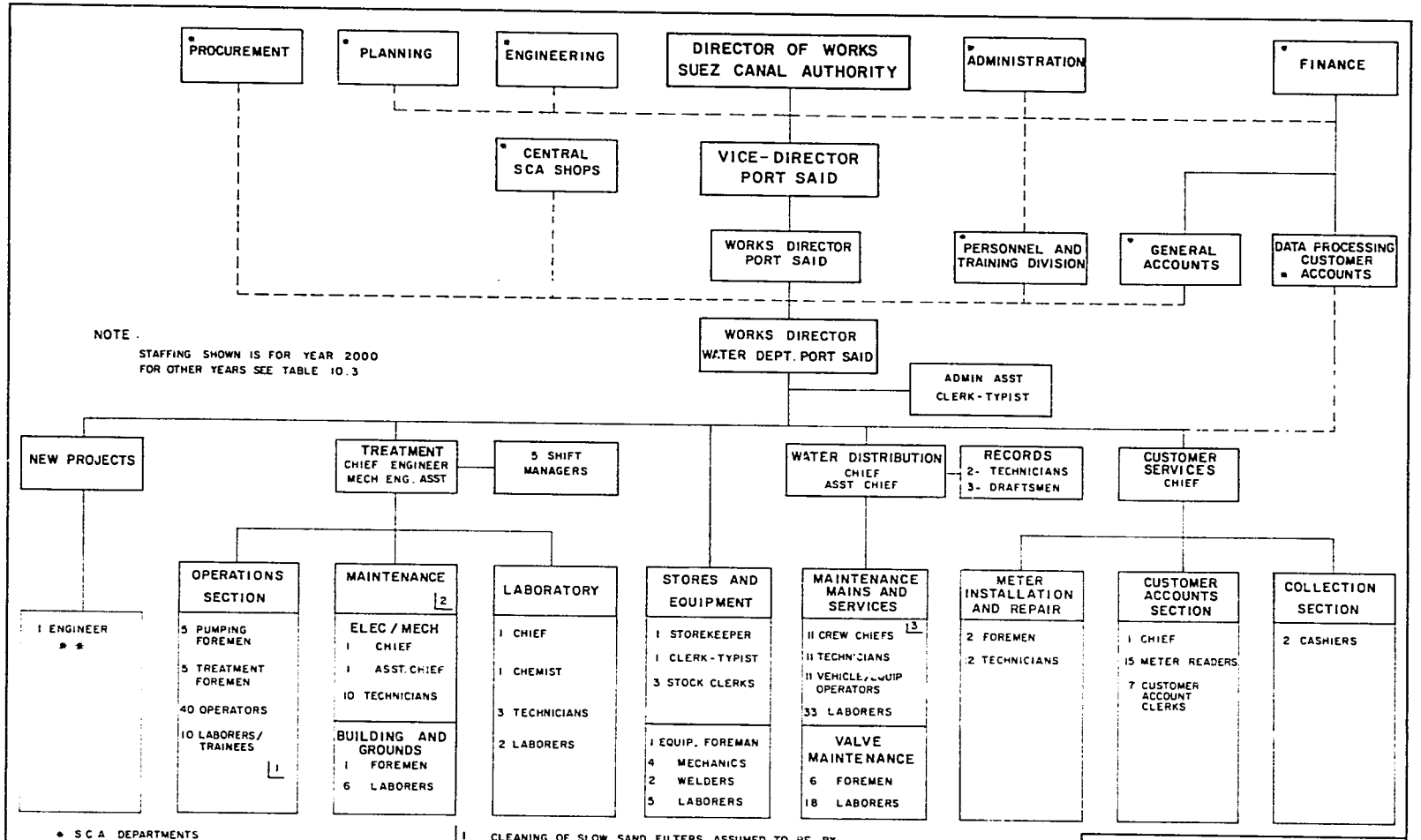
| Position | 1983 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|
| **Professional** | | | | | |
| Director of Department | 1 | 1 | 1 | 1 | 1 |
| Chief Engineer - Operations | 1 | 1 | 1 | 1 | 1 |
| Chief Engineer - Pipelines | 1 | 1 | 1 | 1 | 1 |
| Chief Engineer - Maintenance | 1 | 1 | 1 | 1 | 1 |
| Operations Shift Manager | 5 | 5 | 5 | 5 | 5 |
| Chemist | 1 | 1 | 1 | 1 | 1 |
| Engineer Records | 1 | 1 | 1 | 1 | 1 |
| Engineer New Projects | 1 | 1 | 1 | 1 | 1 |
| Subtotal | 12 | 12 | 12 | 12 | 12 |
| **Supervisor & Senior Technician** | | | | | |
| Service Area Supervisor | 10 | 10 | 10 | 10 | 10 |
| Treatment Plant Supervisor | 10 | 10 | 10 | 10 | 10 |
| Sludge Handling Supervisor | 1 | 1 | 1 | 1 | 1 |
| Pipeline Maintenance Supervisor | 1 | 1 | 1 | 1 | 1 |
| Sewer Cleaning Supervisor | 1 | 1 | 1 | 1 | 1 |
| Sewer Connections Supervisor* | 1 | 1 | 1 | 1 | 1 |
| Maintenance Shop Supervisor | 1 | 1 | 1 | 1 | 1 |
| Field Maintenance Foreman | 1 | 1 | 1 | 1 | 1 |
| Buildings & Grounds Foreman | 1 | 1 | 1 | 1 | 1 |
| Sewer Cleaning Crew Chief | 3 | 4 | 5 | 6 | 7 |
| Sewer Repair Crew Chief | 3 | 3 | 5 | 6 | 6 |
| Sewer Connection Crew Chiefs* | 4 | 6 | 6 | 6 | 6 |
| Senior Mechanic | 3 | 3 | 3 | 3 | 3 |
| Senior Electrician | 3 | 3 | 3 | 3 | 3 |
| Subtotal | 43 | 46 | 49 | 51 | 52 |
| **Technician & Operators** | | | | | |
| Pump Station Operator | 35 | 35 | 50 | 53 | 55 |
| Treatment Plant Operator | 15 | 15 | 15 | 15 | 15 |
| Sludge Pump Station Operator | 1 | 1 | 1 | 1 | 1 |
| Effluent P.S. Operator | 5 | 5 | 5 | 5 | 5 |
| Storekeeper | 1 | 1 | 1 | 1 | 1 |
| Bucket Machine Operator | 6 | 8 | 10 | 12 | 14 |
| Power Rodder Operator | 2 | 2 | 3 | 3 | 4 |
| Jet Rodder Operator | 1 | 1 | 1 | 1 | 1 |
| Sewer & Manhole Mason | 3 | 3 | 5 | 6 | 6 |
| Maintenance Mechanic | 4 | 4 | 4 | 4 | 4 |
| Maintenance Electrician | 3 | 3 | 3 | 3 | 3 |
| Welder | 2 | 2 | 2 | 2 | 2 |
| Carpenter | 2 | 2 | 2 | 2 | 2 |
| Painter/Glazer | 1 | 1 | 1 | 1 | 1 |
| Mason | 1 | 1 | 1 | 1 | 1 |
| Surveyor | 2 | 2 | 2 | 2 | 2 |
| Inspector | 2 | 2 | 2 | 2 | 2 |
| Draftsmen | 2 | 2 | 2 | 2 | 2 |
| Subtotal | 88 | 90 | 110 | 116 | 121 |
| **Equipment Operator** | | | | | |
| Sludge Truck Driver | 8 | 11 | 11 | 14 | 17 |
| Wet Well & Screenings Truck Driver | 2 | 2 | 2 | 4 | 4 |
| Front End Loader Operator | 3 | 3 | 3 | 3 | 3 |
| Sewer Cleaning Collection Truck Driver | 3 | 4 | 5 | 6 | 7 |
| Backhoe Operator (Repair) | 1 | 1 | 1 | 2 | 2 |
| Backhoe Operator (New Connections)* | 1 | 1 | 2 | 2 | 2 |
| Field Maintenance/Transport Driver | 3 | 3 | 3 | 3 | 3 |
| Subtotal | 21 | 25 | 27 | 34 | 38 |
| **Laborer** | | | | | |
| Pump Stations | 40 | 40 | 55 | 58 | 60 |
| Treatment Plants | 25 | 25 | 25 | 25 | 25 |
| Sludge Beds | 17 | 20 | 25 | 29 | 35 |
| Laboratory | 1 | 1 | 1 | 1 | 1 |
| Bucket Machine Crews | 15 | 20 | 25 | 30 | 35 |
| Power & Jet Rodder Crews | 7 | 7 | 10 | 10 | 13 |
| Sewer & MH Repair Crews | 9 | 9 | 15 | 18 | 18 |
| Field Maintenance | 6 | 6 | 6 | 6 | 6 |
| Buildings & Grounds | 6 | 6 | 6 | 6 | 6 |
| Shops & Stores | 9 | 9 | 9 | 9 | 9 |
| Service Connection Crews | 16 | 24 | 24 | 24 | 24 |
| Subtotal | 151 | 167 | 201 | 216 | 232 |
| **Clerical** | | | | | |
| Administrative Section | 3 | 3 | 3 | 3 | 3 |
| Shops & Stores | 3 | 3 | 3 | 3 | 3 |
| Subtotal | 6 | 6 | 6 | 6 | 6 |
| TOTAL STAFF | 321 | 346 | 405 | 435 | 461 |

*All labor costs of new connections are included in Capital Cost of New Service Connections in Table 8.9.

TABLE 10.3
STAFFING BASIS FOR LABOR COSTS

| Position | 1977 | 1982 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|---|
| **Professional** | | | | | | |
| Works Director - Port Said (Half-time) | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Works Director - Water Department | 1 | 1 | 1 | 1 | 1 | 1 |
| Treatment - Chief Engineer | 1 | 1 | 1 | 1 | 1 | 1 |
| - Mech. Engineer | 1 | 1 | 1 | 1 | 1 | 1 |
| - Shift Manager | - | 5 | 5 | 5 | 5 | 5 |
| Distribution - Chief Engineer | - | 1 | 1 | 1 | 1 | 1 |
| - Asst. Engineer | - | 1 | 1 | 1 | 1 | 1 |
| Laboratory - Chief Chemist | 1 | 1 | 1 | 1 | 1 | 1 |
| - Chemist | 1 | 1 | 1 | 1 | 1 | 1 |
| Customer Service Chief | - | 1 | 1 | 1 | 1 | 1 |
| New Projects - Engineer | - | 1 | 1 | 1 | 1 | 1 |
| | 5.5 | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 |
| **Supervisor** | | | | | | |
| Pumping Foreman | 7 | 5 | 5 | 5 | 5 | 5 |
| Treatment Foreman | | 6 | 6 | 5 | 5 | 5 |
| Electrical/Mechanical - Chief | 1 | 1 | 1 | 1 | 1 | 1 |
| - Asst. Chief | 1 | 1 | 1 | 1 | 1 | 1 |
| Building & Grounds - Foreman | 1 | 1 | 1 | 1 | 1 | 1 |
| Storekeeper | 1 | 1 | 1 | 1 | 1 | 1 |
| Equipment Foreman | 1 | 1 | 1 | 1 | 1 | 1 |
| Mains and Service Crew Chief | | 8 | 10 | 10 | 11 | 11 |
| Valve Maint. Foreman | 9 | 4 | 4 | 5 | 5 | 6 |
| Meter Installation Foreman | | 1 | 1 | 1 | 1 | 1 |
| Meter Repair Foreman | 1 | 1 | 1 | 1 | 1 | 1 |
| Customer Accounts Chief | 1 | 1 | 1 | 1 | 1 | 1 |
| Administrative Assistant to Director | 1 | 1 | 1 | 1 | 1 | 1 |
| | 24 | 32 | 34 | 34 | 35 | 36 |
| **Technician/Operator** | | | | | | |
| Treatment Operator | 8 | 30 | 30 | 40 | 40 | 40 |
| Electrical/Mechanical Maintenance | 10 | 10 | 10 | 10 | 10 | 10 |
| Laboratory | 2 | 2 | 2 | 3 | 3 | 3 |
| Equipment Mechanic | 2 | 2 | 2 | 3 | 3 | 4 |
| Welder | 1 | 1 | 1 | 1 | 2 | 2 |
| Mains and Services | 4 | 8 | 10 | 10 | 11 | 11 |
| Vehicles/Equipment Operator | 4 | 8 | 10 | 10 | 11 | 11 |
| Meter Installation/Repair | 3 | 6 | 7 | 9 | 11 | 12 |
| Distribution Records | - | 5 | 5 | 5 | 5 | 5 |
| | 34 | 72 | 77 | 91 | 96 | 98 |
| **Clerical** | | | | | | |
| Administrative Clerk Typist | - | 1 | 1 | 1 | 1 | 1 |
| Stores and Equipment | - | 3 | 3 | 4 | 4 | 4 |
| Customer Accounts | | 3 | 4 | 5 | 6 | 7 |
| Meter Reader | 6 | 7 | 9 | 11 | 13 | 15 |
| Cashier | | 1 | 1 | 2 | 2 | 2 |
| | 6 | 15 | 18 | 23 | 26 | 29 |
| **Laborer*** | | | | | | |
| Treatment Operation | | 8 | 8 | 10 | 10 | 10 |
| Building and Grounds | | 6 | 6 | 6 | 6 | 6 |
| Laboratory | 94 | 2 | 2 | 2 | 2 | 2 |
| Equipment Maintenance | | 3 | 3 | 4 | 4 | 5 |
| Mains and Services | | 24 | 30 | 30 | 33 | 33 |
| Valve Maintenance | | 12 | 12 | 15 | 15 | 18 |
| | 94 | 55 | 61 | 67 | 70 | 74 |
| Subtotal | 163.5 | 181.5 | 204.5 | 229.5 | 241.5 | 251.5 |
| Equivalent of Senior Maintenance Technicians from SCA Central Shops | 10 | 12 | 14 | 16 | 18 | 20 |
| TOTAL | 173.5 | 193.5 | 218.5 | 245.5 | 259.5 | 271.5 |

*Includes meter repair staff below technician level. Does not include contract-hire laborers for slow sand filters.


PROCUREMENT
PLANNING
ENGINEERING
DIRECTOR OF WORKS SUEZ CANAL AUTHORITY
ADMINISTRATION
FINANCE
CENTRAL SCA SHOPS
VICE-DIRECTOR PORT SAID
WORKS DIRECTOR PORT SAID
PERSONNEL AND TRAINING DIVISION
GENERAL ACCOUNTS
DATA PROCESSING CUSTOMER ACCOUNTS
NOTE.
STAFFING SHOWN IS FOR YEAR 2000
FOR OTHER YEARS SEE TABLE 10.3
WORKS DIRECTOR WATER DEPT. PORT SAID
ADMIN ASST
CLERK-TYPIST
NEW PROJECTS
TREATMENT
CHIEF ENGINEER
MECH ENG. ASST
5 SHIFT MANAGERS
WATER DISTRIBUTION
CHIEF
ASST CHIEF
RECORDS
2- TECHNICIANS
3- DRAFTSMEN
CUSTOMER SERVICES
CHIEF
1 ENGINEER
OPERATIONS SECTION
5 PUMPING FOREMEN
5 TREATMENT FOREMEN
40 OPERATORS
10 LABORERS/ TRAINEES
1
MAINTENANCE
2
ELEC / MECH
1 CHIEF
1 ASST. CHIEF
10 TECHNICIANS
BUILDING AND GROUNDS
1 FOREMEN
6 LABORERS
LABORATORY
1 CHIEF
1 CHEMIST
3 TECHNICIANS
2 LABORERS
STORES AND EQUIPMENT
1 STOREKEEPER
1 CLERK-TYPIST
3 STOCK CLERKS
1 EQUIP. FOREMAN
4 MECHANICS
2 WELDERS
5 LABORERS
MAINTENANCE MAINS AND SERVICES
3
11 CREW CHIEFS
11 TECHNICIANS
11 VEHICLE/EQUIP OPERATORS
33 LABORERS
VALVE MAINTENANCE
6 FOREMEN
18 LABORERS
METER INSTALLATION AND REPAIR
2 FOREMEN
2 TECHNICIANS
CUSTOMER ACCOUNTS SECTION
1 CHIEF
15 METER READERS
7 CUSTOMER ACCOUNT CLERKS
COLLECTION SECTION
2 CASHIERS
* S C A DEPARTMENTS PROVIDING SUPPORT.
** OTHER STAFF ON LOAN FROM TREATMENT AND DISTRIBUTION DIVISIONS.
1 CLEANING OF SLOW SAND FILTERS ASSUMED TO BE BY CONTRACT LABOR
2 IT IS ASSUMED THAT AN EQUIVALENT OF 20 SPECIALISTS WILL BE SUPPLIED FROM THE CENTRAL SHOPS OF THE SCA.
3 INCLUDES EMERGENCY CREW AND CREWS FOR INSTALLING SERVICES.
HAZEN AND SAWYER
ECG - ENGINEERING CONSULTANTS GROUP
ARAB REPUBLIC OF EGYPT
MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION
PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN
RECOMMENDED WATER ORGANIZATION
VOL. 2
FIG.
10-A

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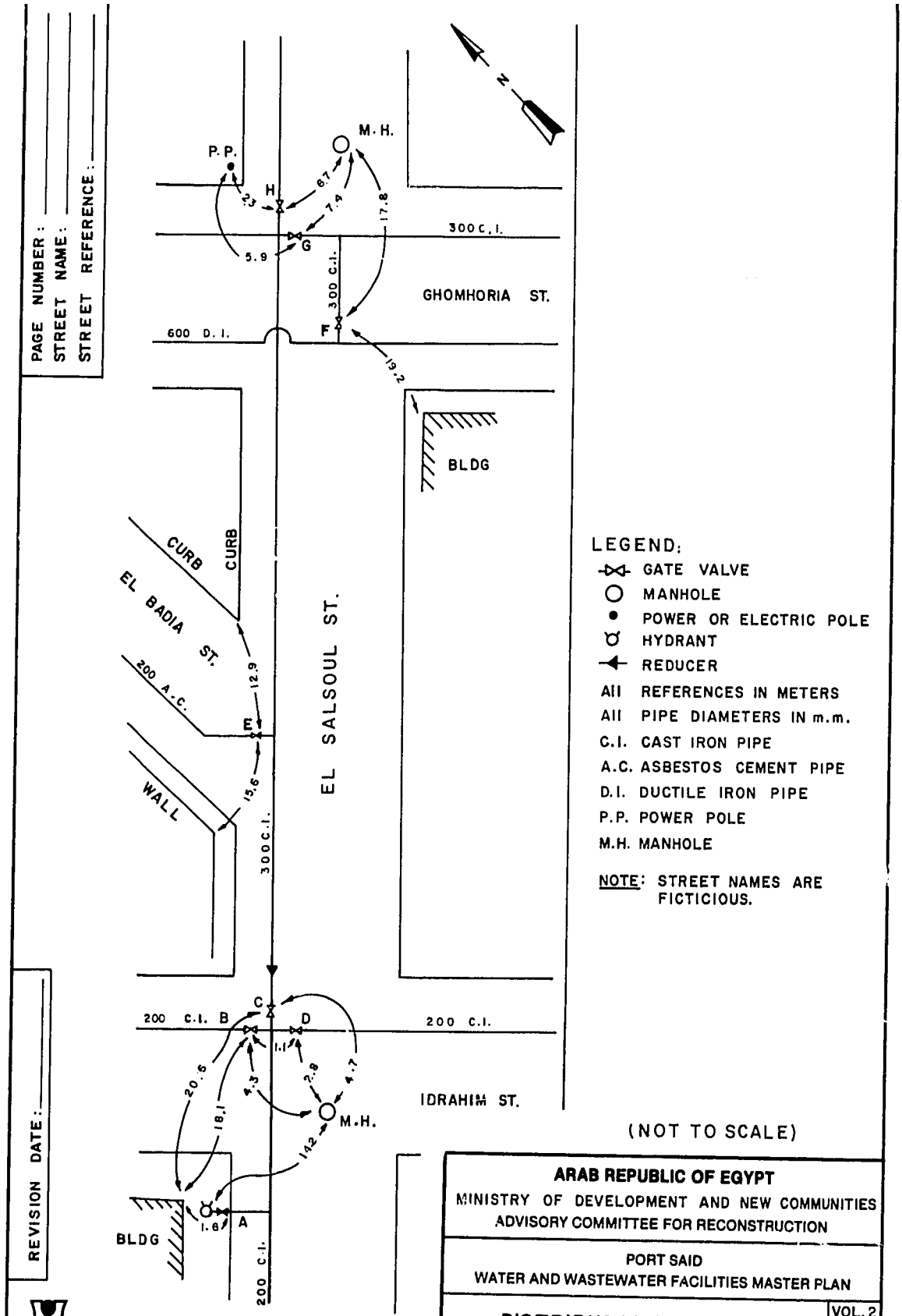
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M.H.
P.P.
H
G
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C
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D
A
6.7
7.4
17.8
2.3
5.9
300 C.I.
300 C.I.
GHOMHORIA ST.
600 D.I.
19.2
BLDG
CURB
CURB
EL BADIA ST.
200 A.C.
12.9
15.6
WALL
EL SALSOUL ST.
300 C.I.
200 C.I.
200 C.I.
1.1
20.6
18.1
4.3
2.8
4.7
M.H.
IDRAHIM ST.
14.2
1.6
BLDG
200 C.I.
LEGEND:
GATE VALVE
MANHOLE
POWER OR ELECTRIC POLE
HYDRANT
REDUCER
All REFERENCES IN METERS
All PIPE DIAMETERS IN m.m.
C.I. CAST IRON PIPE
A.C. ASBESTOS CEMENT PIPE
D.I. DUCTILE IRON PIPE
P.P. POWER POLE
M.H. MANHOLE
NOTE: STREET NAMES ARE FICTICIOUS.
(NOT TO SCALE)
REVISION DATE:
HAZEN AND SAWYER
ECG - ENGINEERING CONSULTANTS GROUP
ARAB REPUBLIC OF EGYPT
MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION
PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN
DISTRIBUTION SYSTEM
STRIP MAP EXAMPLE
VOL. 2
FIG.
10-B

CHAPTER 11

# PROGRAM EXECUTION

This chapter outlines procedures for the overall water facilities program execution with specific emphasis on implementing the High Priority Projects. Included are overall schedules for program execution, annual capital outlays and operation and maintenance costs. The chapter also considers contractor capabilities and availability of materials for the proposed work.

## 11.1 FRAMEWORK AND PROCEDURES

Under present plans, the Suez Canal Authority (SCA) would execute the High Priority Projects with financing from USAID, and would contract for engineering service from a consortium of Consultants. Negotiations for consortium services are underway with a joint U.S. venture called the Canal Cities Consultants (Hazen and Sawyer, Metcalf and Eddy International, Inc., and Pirnie Harris International) who would be in association with the Egyptian Canal City Consultants (Engineering Consultants Group, Middle East Consulting Office and J. Gaffar and Partners). These firms prepared the facilities master plans for the three canal cities.

We assume that in so far as practical the work would be handled under the normal SCA project execution framework, involving appropriate SCA departments (Engineering, Planning, Procurement, Finance) in addition to the Works Department, which has the basic responsibility for water systems in the canal cities. Within SCA a single person (Project Director) should be designated to direct the overall High Priority Projects program for the three cities, project managers should be assigned for specific projects. For continuity, the same project manager should see work through from preliminary design to final acceptance of newly constructed facilities. The managers would be responsible for coordinating all in-house project activities and would be the liason between SCA headquarters and the Engineer, the construction contractors and the staff of the New Projects Division in the local water system organization.

Procedures established for execution of the High Priority Project are outlined below. With few exceptions, these procedures would apply, as well, to further projects after the High Priority Projects are completed.

### Negotiation of Consultant's Services

Negotiations for consultant services for the High Priority Projects would define a scope of work to include the following phases:

- Inception Report
- Rehabilitation
- Training



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- Design Report

- Design and Construction

Services would be performed on a cost plus fixed fee basis.

Project Authorization

Based on its review of the design report, the SCA would select specific projects to be executed, conclude financial arrangements, and authorize detailed design and supervision of construction by work orders.

Detailed Design

The Consultant would prepare plans and specifications for tendering both for construction and for direct procurement of materials and equipment by SCA. The design would be submitted for SCA review at appropriate stages.

Bidding, Review and Award

Tenders would be received by SCA. The Consultant would analyze all bids to assure their compliance with the tender documents and then make a recommendation for contract award to SCA.

Engineer's Services During Construction

These services, to be contracted by work order, would include review of contractor schedules and work plans, review of submittals on materials and equipment to be supplied by the contractor, interpretation of the intent of the design documents, decisions on suggested changes, witnessing shop tests on major equipment, certification of compliance with contract requirements, and processing of change orders for approval by SCA.

Project Director's Authority

To discharge his responsibilities, the Project Director from SCA should have authority to:

- Act as liaison with the Consultant.

- Coordinate design review by SCA.

- Issue tender documents.

- Receive bids from tenders, review the tender analysis prepared by the Consultants and recommend award to SCA.

- Approve contractors' submittals, invoices and, within prescribed limits, change orders.

- Recommend final acceptance of work.

The Consultant would support the SCA Project Director in his work. Appropriate higher management levels in SCA would approve final tender documents, sign contracts, approve

change orders (beyond the limits for which the Project Director has authority) and accept completed activities.

During the High Priority Project, procedures should be adopted to rely more on in-house capabilities and less on outside consultants for implementation of the immediate and final stage programs. Specifically this would involve:

- Ongoing, in-house review of the facilities master plans to define projects to be considered for authorization. (The Consultant may be authorized to update the Master Plan).

- Establish procedures for selection of projects to be authorized.

- In-house preparation of preliminary designs to serve as a basis for decision making with outside consultants.

## 11.2 SCHEDULE

A detailed CPM for the High Priority/Immediate Phase Projects is shown on Figure 11-A. Figure 11-B shows an overall schedule for execution of water system improvements by staged developments to keep pace with the needs through the year 2000. Chapters 6, 7 and 8 detail when the required new capacity must be on line to meet increasing demands.

The High Priority Projects and the remaining Immediate Phase Projects were classified in four categories (local measures, equipment procurement, major capital construction and procurement of services) according to the nature of the work and how it was to be executed. A summary of the work is as follows:

### Local Measures

The recommended local measures in the High Priority Program including repairs at treatment plant and leak repairs in distribution system are well within the capabilities of SCA's own forces and should start immediately.

### Equipment Procurement

The recommended water system High Priority equipment procurement projects include immediate procurement of rapid mix, raw, finished and backwash pumps, water plant flow metering devices, electrical equipment, valves, hydrants, operations equipment and meter testing equipment. The Immediate Phase Program calls for the purchase of water meters for the distribution system. The Consultant would prepare specifications, coordinate purchase and delivery, and supervise installation and start up of this equipment. A local contractor or the Suez Canal Authority can perform the equipment installation. Sufficient skilled manpower is available in Port Said to install this equipment.

### Major Capital Projects

Considerable engineering effort will be required for detailed design of the proposed facilities, preparation of specifications for equipment materials and construction, and procurement of major elements of the projects.

Source of Supply

The High Priority/Immediate Phase project including elimination of seepage, removal of obstacles, limited dredging and proper control of diversions for irrigation should insure an adequate supply of water until 1985. However, engineering planning for the staged development of the canal to meet needs beyond 1985 should begin in 1980.

Scheduling of the staged development canal lining program is based on the following assumptions:

- In preparation for lining, individual reaches of up to 1 km would be by-passed and dewatered.
- To minimize the outlay for by-pass facilities, work would be restricted to one reach at a time.
- Set-up time for a new reach, including removal and placement of cofferdams, relocation of pumps and piping and dewatering, would amount to 10 days.
- After dewatering, shaping and lining would proceed at a rate of 100 m/d.

One the above basis, with allowances for mobilization and unforeseen difficulties, the minimum construction period would be 36 months.

Preliminary engineering for this work should be completed in 1980, and then applied in the Immediate Phase dredging program. Thus it is essential that the decision be reached early as to whether canal lining will be the method used to increase raw water supply capacity so that design can start in 1980. Ideally the Immediate Phase and Final Stage work would be integrated in a single project, with priority attention to reaches of the canal which represents the worst constrictions.

The proposed raw water reservoir construction in the staged development program should be integrated with landfill and dredging operations in the vicinity of El Raswa. Based on using stockpiled, dredged fill, a construction period of twenty-four months would be adequate.

Water Treatment Plant

High Priority/Immediate Phase projects include construction of a new finished water pump station, modification of the raw water pump station, new yard piping, and centralized chemical feed and chlorination facilities.

A total period of forty-two months would be allowed for design and construction of first stage upgrading of flow trains 4 and 5 during the staged development program. This includes 3 months for start-up and testing. Final upgrading would require only thirty months for design and construction since physical changes to facilities would be minimal.

The allowance for engineering, equipment procurement, and installation of future motor pump replacements includes long lead times for pump delivery.

Distribution System

Initial effort in the High Priority Project will be to assure adequate distribution system pressure in the northwest section of the city. During the Immediate Phase, extension of the primary and secondary distribution systems and service connections would be made to newly developed areas. The replacement of broken and inaccessible water meters and the installation of new meters will be done during the Immediate Phase.

The schedule for distribution pipeline improvements for the High Priority/Immediate Phase and Staged Development is based on spreading work needed by each target year uniformly over the period since the previous target year. Actual schedules may vary depending on needs at the time and on the general construction market. A year period is allowed for design and construction of distribution storage, with timing as required to meet projected storage needs.

The leak detection program is the only project for the water system involving procurement of services. This program must have the services of personnel with considerable experience in distribution system operation, maintenance, and field testing. The leak detection program for Port Said would require experts on a private service contract. These individuals would supervise and train local engineers and technicians. An initial leak survey using sound techniques will be performed during the High Priority program. After improvements are made to the distribution system a more detailed leak survey by velocity measurement will be performed under the Immediate Phase program.

The execution schedule on Figure 11-A shows time allowances for engineering design, purchase of equipment, land acquisition where needed, construction periods and the start-up and testing of new facilities. The availability of competent local contractors and suitable construction materials is discussed in Appendix B.

## 11.3 COST SCHEDULES

For the major capital construction projects under the High Priority/Immediate Phase Program, engineering was scheduled for late 1979 and 1980 with construction cost spread over 1981 and 1982.

Costs for Staged Development projects allow for engineering prior to the first year of construction followed in general by a two year construction period. The major exception to this is engineering for the lining of the Port Said Canal. Preliminary engineering for this project should begin in 1980 to coordinate Immediate Phase dredging work with Staged Development needs.

Construction costs for two year projects were in general split as follows:

| | Percent | |
|---|---|---|
| | 1st Year | 2nd Year |
| Piping | 50 | 50 |
| Equipment | 0 | 100 |
| Civil Works | 50 | 50 |

The cost schedule for engineering and construction of primary and secondary distribution mains was estimated directly for each year.

Table 11-1 lists annual outlays for capital improvements based on the execution schedule in Figure 11-C. Outlays are broken down by source of supply, treatment and distribution, and by the following classification according to expected useful life.

| Work Classification | Useful Life |
|---|---|
| Civil Works/Pipelines | 40 yr |
| Mechanical/Electrical Equipment | 20 yr |
| Vehicles, Construction Equipment and Tools | 10 yr |

The costs are based on the assumptions shown in Appendix B. If regulations require U.S. origin for reinforcing steel and cement, costs for structural work will increase by about 30% of the total in place cost for structures. This has only a slight overall effect on the total project costs. For the High Priority water system program, costs would be increased by only about 50,000 LE were cement and steel purchased from the USA.

Table 11-2 shows annual capital outlays broken down into local and foreign exchange costs. All capital costs are given in constant value 1978 LE. Chapter 12 also considers the effects of construction cost escalation on financing.

Table 11-3 shows expected annual operation and maintenance costs for the system through the year 2000. Details for calculation of these costs are presented in Appendix B. Labor costs are based on the recommended organization and salary levels presented in Chapter 10.

All costs are in 1978 LE. These schedules are applied in Chapter 12 to develop financial projections for the system through the year 2000.

## 11.4 CONSTRUCTION PERSONNEL AND EQUIPMENT REQUIREMENT

### Manpower

Table 11-4 shows the manpower, both skilled and unskilled, which we estimate will be needed to build the recommended facility. The average local manpower requirement for implementation of the recommended Water Facilities Improvements is estimated at 135 skilled and 160 unskilled laborers per year. During periods of intensive construction work, such as at the time of the High Priority Projects and the work on the concrete lining of the Port Said Canal, the need for skilled laborers will increase to 250 and to as many as 370 for unskilled laborers. No less than about 90 skilled and 120 unskilled laborers per year will be needed in any period, assuming the construction schedule as shown in Figure 11-B.

The amount of labor needed and the ratio of skilled to unskilled labor is influenced by the type of construction method employed (intensive hand work versus mechanized) and the production rate needed within the allowable construction period time frame.

Manpower requirements were estimated based on the following assumptions:

- 270 working days per year (6 day work week with minimal allowances for vacation, holidays and sick time).
- Six productive work hours per day.
- Labor rates of LE 7 per day for skilled labor (pipe layer, equipment operator) and LE 3 per day for unskilled.

- Appropriate mixes of skilled and unskilled labor for different types of work.

- Mechanized construction practices for the erection of pump stations and treatment units, with labor cost representing an estimated 40 percent of total construction costs.

- Intensive hand work for installing water lines, valves and appurtenances, with labor representing the bulk of the total construction costs.

In future years, much of the pipeline work in new areas may be mechanized because of the high cost of hand labor. This would increase skilled labor needs and accordingly reduce unskilled labor needs.

The supply of unskilled labor is abundant and should remain so as agricultural workers continue to be attracted by higher and more regular wages in the construction industry.

There is, however, a shortage of skilled and semi-skilled labor, supervisory personnel and technicians, many of whom have been drawn to other Arab countries where higher paying jobs are available. This situation is not expected to change and is likely to result in continuing escalation of construction costs.

Current standards of workmanship vary widely in Egypt. High standards are needed to assure properly operating water facilities with low maintenance costs. To recruit workmen who can meet such standards, labor rates beyond average market levels must be allowed for.

To get high quality work completed on time, the supply of skilled labor must be increased. We concur with the conclusion of the Greater Cairo Waterworks Master Plan(1) that a formal and permanent national training program is needed for skilled construction workers. Otherwise it could prove necessary to import labor and/or to contract with foreign construction firms. The first of these plans would raise local contractor costs; the second would raise initial bid prices for work reflecting both higher mobilization and labor costs.

Construction Equipment

General construction equipment needed to carry out the recommended programs would include:

a) Three (3) concrete transit mix trucks, 6 cu m capacity.

b) One (1) concrete pump, truck mounted - 125 mm discharge - 15 m lift - 30 cu m/hr capacity.

c) Two (2) diesel hydraulic crawler backhoes; one 0.50 cu m and one 0.75 cu m capacity.

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(1) Draft Final Report, Part II, Staged Development, ES-Parsons in Association with ECG, page 22-8, 1978.

d) One (1) flatbed truck and trailer.

e) Two (2) wheeled tractor loaders - 1.2 cu m capacity.

f) One (1) water truck - 20 cu m capacity.

g) Two (2) backhoes, loader wheeled type - 60 HP.

h) Five (5) dump trucks - 12 cu m capacity.

i) Two (2) air compressors - 7 cu m/min capacity with jack hammers, hose, etc.

j) One (1) grader 12 ton capacity.

k) One (1) hydraulic truck mounted crane - 18 ton capacity - 30 m boom.

l) Twelve (12) gas water pumps - six 50 mm and six 100 mm discharge with hoses, etc.

m) Two (2) tractor dozers - 140 HP.

n) Two (2) towed vibrating rollers - 1.8 ton.

o) One (1) self propelled vibratory steel drum roller - 10 ton capacity.

p) One (1) pneumatic tire diesel roller - 11 ton capacity.

q) Five (5) trench compactors vibratory plate.

r) Two (2) welders - 200 amp capacity each.

s) One (1) pavement breaker.

Equipment of the types above generally is already in the hands of Egyptian contractors who are able to amortize it over a number of projects. If there is any doubt of equipment availability, the government agencies responsible for the major utility programs now being planned could themselves procure needed equipment and make it available to contractors working on the programs. The volume of work in these programs is certainly sufficient to assure continued utilization of the equipment during its amortization period.

Well point equipment for dewatering trenches will be one type of special equipment needed for construction in Port Said. A concrete batch plant, special by-pass pumping and piping equipment, canal dredging, trimming and concrete lining machines will be needed for the lining of the Port Said Canal. The details as to the type capacity of this equipment will be determined during the design phase of the project.

## 11.5 SPECIAL CONSTRUCTION PROBLEMS

Installation of large waterlines in existing areas of Port Said presents special problems. Streets are narrow, closely lined with structures, laced with existing utilities and filled daily with traffic or street markets.

The most difficult problem will be to protect adjacent structures and existing utilities during pipeline construction. Similar but less difficult construction problems may

arise where it is necessary to remove the clay layer and replace it with select material. In some cases, trenches must be supported by timber or steel sheeting. Dewatering plans, where needed, should be carefully developed based on tested soil permeability.

To minimize disruption along narrow streets used as pipeline routes, excavated material must be stored in a manner that does not block off access. This could require either temporary retaining structures or off-site storage.



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# TABLE 11.1

## ANNUAL CAPITAL OUTLAYS
## RECOMMENDED WATER SYSTEM IMPROVEMENTS
## (Thousands of 1978 LE)

| Line No. | | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CAPITAL IMPROVEMENTS | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Source of Supply (Ch.6) | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Civil Works/ Pipelines | | 135 | 988 | 800 | 1047 | 1048 | 4287 | 5837 | 5839 | 800 | 800 | 800 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 4 | Mechanical | | -- | -- | -- | -- | -- | 7 | 59 | 58 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 5 | Treatment Works (Ch.7) (1) | | | | | | | | | | | | | | | | | | | | | | |
| 6 | Civil Works/Piping | 44 | 60 | 847 | 847 | -- | 14 | 101 | 174 | 188 | 101 | 188 | 402 | 34 | 63 | 2 | 17 | 34 | 18 | 75 | 379 | 438 | 438 |
| 7 | Mechanical | 101 | 1917 | 277 | 277 | -- | 21 | 152 | 265 | 293 | 312 | 418 | 367 | 51 | 96 | 8 | 125 | 49 | 27 | 117 | 670 | 658 | 658 |
| 8 | Distribution System (Ch. 8) (2) | | | | | | | | | | | | | | | | | | | | | | |
| 9 | Civil Works - Tanks | -- | -- | -- | -- | 4 | 46 | 84 | -- | -- | -- | -- | -- | -- | 4 | 46 | 92 | 92 | 168 | -- | 8 | 92 | 168 |
| 10 | Primary Distr.-Lines | 108 | 1595 | 1421 | 1421 | 643 | 643 | 643 | 724 | 724 | 725 | 725 | 725 | 180 | 181 | 181 | 181 | 181 | 247 | 247 | 247 | 247 | 248 |
| 11 | Secondary Distr. - Lines | 60 | 842 | 490 | 490 | 514 | 515 | 515 | 632 | 633 | 633 | 633 | 633 | 561 | 561 | 561 | 561 | 561 | 559 | 559 | 559 | 559 | 559 |
| 12 | DISTRIBUTION SUBTOTAL-CIVIL WORKS/PIPELINES | 168 | 2437 | 1911 | 1911 | 1161 | 1204 | 1242 | 1356 | 1357 | 1358 | 1358 | 1358 | 741 | 746 | 788 | 834 | 834 | 974 | 806 | 814 | 898 | 975 |
| 13 | Water Meters & Test Equipment | 45 | 1069 | -- | -- | -- | -- | 29 | 87 | 87 | 87 | 87 | 88 | 82 | 83 | 82 | 83 | 82 | 84 | 85 | 85 | 85 | 85 |
| 14 | Other Mechanical (3) | -- | -- | -- | -- | -- | 6 | 11 | -- | -- | -- | -- | -- | -- | -- | 6 | 12 | 11 | 22 | -- | 1 | 11 | 22 |
| 15 | DISTRIBUTION SUBTOTAL-MECHANICAL | 45 | 1069 | -- | -- | -- | 6 | 40 | 87 | 87 | 87 | 87 | 88 | 82 | 83 | 88 | 95 | 93 | 106 | 85 | 86 | 96 | 107 |
| 16 | CAPITAL IMPROVEMENTS SUBTOTALS | | | | | | | | | | | | | | | | | | | | | | |
| 17 | Civil Works/Pipelines | 212 | 2632 | 3746 | 3558 | 2208 | 2266 | 5630 | 7367 | 7384 | 2259 | 2346 | 2560 | 775 | 809 | 790 | 851 | 868 | 992 | 881 | 1193 | 1336 | 1413 |
| 18 | Mechanical | 146 | 2986 | 277 | 277 | -- | 27 | 199 | 411 | 438 | 399 | 505 | 455 | 133 | 179 | 96 | 220 | 142 | 133 | 202 | 756 | 754 | 765 |
| 19 | Vehicles and Maintenance Equipment | 9 | 168 | 40 | -- | -- | -- | 50 | -- | -- | -- | -- | 50 | -- | -- | -- | -- | 50 | -- | -- | -- | -- | -- |
| 20 | Service Connections | 91 | 330 | 206 | 206 | 216 | 216 | 216 | 263 | 263 | 263 | 263 | 263 | 235 | 236 | 236 | 236 | 236 | 234 | 235 | 235 | 235 | 235 |
| 21 | TOTAL CAPITAL IMPROVEMENTS | 386 | 6116 | 4269 | 4041 | 2424 | 2509 | 6095 | 8041 | 8085 | 2921 | 3114 | 3328 | 1143 | 1224 | 1122 | 1307 | 1296 | 1359 | 1318 | 2184 | 2325 | 2413 |
| 22 | Rehabilitation (4) | 87 | 39 | 453 | 79 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

(1) Includes raw and finished water pumping.
(2) Excluding service connections.
(3) Includes pumping at ground storage facilities; excludes vehicles and maintenance equipment.
(4) Not considered part of capital improvement program, but entered as an expense in Table 11.3.

## TABLE 11.2

## ANNUAL CAPITAL OUTLAYS: FOREIGN AND LOCAL CURRENCY
(Thousands of 1978 LE)

| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FOREIGN CURRENCY OUTLAYS | | | | | | | | | | | | | | | | | | | | | | |
| Source of Supply | 66 | 89 | 245 | -- | 137 | 138 | 706 | 1118 | 1118 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Treatment Works | 98 | 1405 | 664 | 664 | -- | 19 | 138 | 241 | 264 | 270 | 376 | 486 | 47 | 87 | 6 | 107 | 46 | 24 | 106 | 604 | 600 | 600 |
| Distribution System (2) | 124 | 2097 | 978 | 998 | 410 | 417 | 447 | 530 | 530 | 530 | 530 | 531 | 212 | 212 | 218 | 224 | 223 | 284 | 262 | 263 | 274 | 285 |
| Vehicles & Maintenance Equipment | 9 | 168 | 40 | -- | -- | -- | 50 | -- | -- | -- | -- | 50 | -- | -- | -- | -- | 50 | -- | -- | -- | -- | -- |
| SUBTOTAL-FOREIGN CURRENCY | 297 | 3759 | 1927 | 1662 | 547 | 574 | 1341 | 1889 | 1912 | 800 | 906 | 1067 | 259 | 299 | 224 | 331 | 319 | 308 | 368 | 867 | 874 | 885 |
| LOCAL CURRENCY OUTLAYS | | | | | | | | | | | | | | | | | | | | | | |
| Source of Supply | 20 | 71 | 1149 | 800 | 910 | 910 | 3588 | 4778 | 4779 | 800 | 800 | 800 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Treatment Works | 47 | 572 | 460 | 460 | -- | 16 | 115 | 198 | 217 | 143 | 230 | 283 | 38 | 72 | 4 | 35 | 37 | 21 | 86 | 445 | 496 | 496 |
| Distribution System (2) | 109 | 1753 | 1186 | 1198 | 967 | 1009 | 1051 | 1176 | 1177 | 1178 | 1178 | 1178 | 846 | 853 | 894 | 941 | 940 | 1030 | 864 | 872 | 955 | 1032 |
| SUBTOTAL-LOCAL CURRENCY | 175 | 2396 | 2795 | 2438 | 1877 | 1935 | 4754 | 6152 | 6173 | 2121 | 2208 | 2261 | 884 | 925 | 898 | 976 | 977 | 1051 | 950 | 1317 | 1451 | 1528 |
| TOTAL | 473 | 6155 | 4722 | 4120 | 2424 | 2509 | 6095 | 8041 | 8085 | 2921 | 3114 | 3328 | 1143 | 1224 | 1122 | 1307 | 1296 | 1359 | 1318 | 2184 | 2325 | 2413 |

(1) Includes rehabilitation costs.
(2) Includes service connections.

# TABLE 11.3

## OPERATION AND MAINTENANCE COSTS
## (Thousands of 1978 LE)

| Line No. | | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MAINTENANCE MATERIAL/ SERVICES | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Civil Works | 57 | 60 | 70 | 79 | 79 | 79 | 80 | 82 | 83 | 84 | 85 | 88 | 88 | 88 | 89 | 89 | 90 | 91 | 92 | 94 | 98 | 102 |
| 3 | Mechanical Equipment | 347 | 450 | 478 | 507 | 507 | 507 | 512 | 522 | 533 | 545 | 559 | 572 | 577 | 582 | 587 | 593 | 598 | 602 | 606 | 627 | 649 | 672 |
| 4 | Distribution Lines Maint. | 82 | 96 | 107 | 116 | 122 | 128 | 134 | 141 | 149 | 156 | 162 | 170 | 174 | 179 | 182 | 186 | 190 | 194 | 198 | 202 | 207 | 211 |
| 5 | Service Connection | 11 | 13 | 14 | 15 | 16 | 17 | 18 | 20 | 21 | 23 | 24 | 25 | 26 | 28 | 29 | 30 | 31 | 33 | 34 | 35 | 36 | 38 |
| 6 | Canal Maintenance | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| 7 | Vehicle Oper. & Maint. | 5 | 5 | 11 | 11 | 11 | 11 | 11 | 14 | 14 | 14 | 14 | 14 | 19 | 19 | 19 | 19 | 19 | 23 | 23 | 23 | 23 | 23 |
| 8 | WTP Operating Supplies | 113 | 119 | 122 | 126 | 134 | 142 | 150 | 159 | 167 | 176 | 186 | 193 | 202 | 215 | 225 | 235 | 245 | 253 | 260 | 272 | 283 | 295 |
| 9 | WTP Power | 97 | 100 | 103 | 106 | 110 | 115 | 119 | 124 | 128 | 132 | 136 | 141 | 145 | 149 | 152 | 155 | 159 | 162 | 166 | 170 | 174 | 178 |
| 10 | Labor (O&M Staff) | 285 | 295 | 305 | 315 | 330 | 345 | 362 | 373 | 383 | 390 | 396 | 404 | 407 | 412 | 415 | 416 | 419 | 425 | 431 | 437 | 438 | 440 |
| 11 | REHABILITATION | 87 | 39 | 453 | 79 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 12 | TOTAL | 1098 | 1191 | 1677 | 1368 | 1323 | 1358 | 1400 | 1449 | 1492 | 1534 | 1576 | 1621 | 1652 | 1686 | 1712 | 1737 | 1765 | 1797 | 1824 | 1874 | 1922 | 1973 |

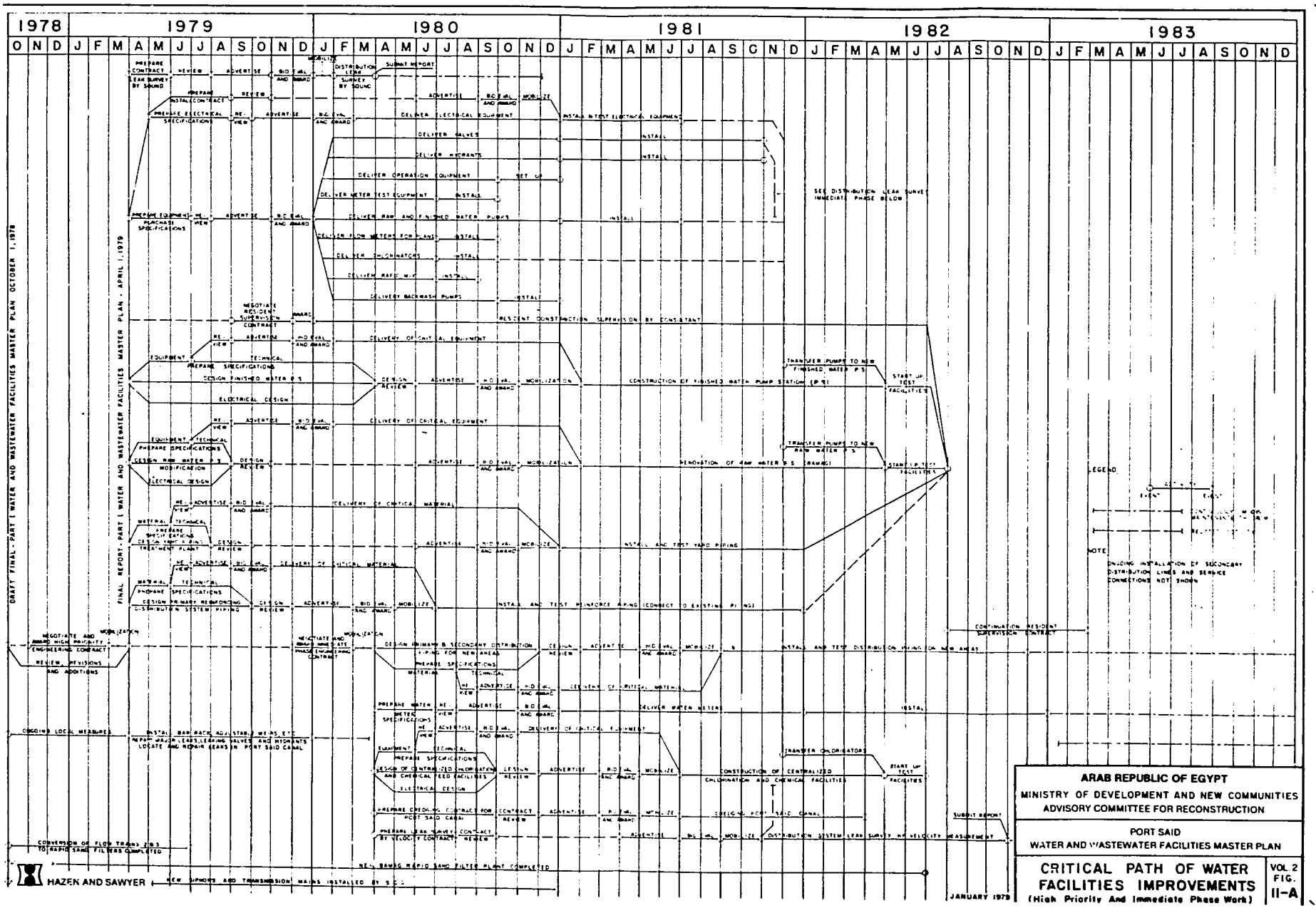
(1) See Chapter 5 for derivation of O&M costs.

(2) Includes rehabilitation work in High Priority and Immediate Phase Program.

## TABLE 11.4

## CONSTRUCTION PERSONNEL REQUIREMENTS

| Improvement | Period | No. Skilled | No. Unskilled |
|---|---|---|---|
| Seepage and Weed Control - PSC | | | |
| Rayah Barrage to El Raswa | 1979-84 | 10 | 50 |
| Manual Weed Cutting<br>Placing Clay Sealer<br>Excavation | | | |
| Lining of Port Said Canal | 1985-87 | 100 | 150 |
| Equipment Operation<br>Equipment Relocation<br>Concrete Lining<br>Temporary Dams | | | |
| Raw Water Reservoir | 1986-87 | 50 | 100 |
| Placing & Compacting Embankment<br>Trimming<br>Installing Liner | | | |
| WTP Pumping Stations and Chlorination - High Priority and Immediate Phase | 1980-82 | 120 | 50 |
| Civil Works<br>Mechanical/Electrical Installation | | | |
| WTP - Staged Development | 1983-2000 | 50 | 20 |
| Civil Works<br>Mechanical/Electrical Installation | | | |
| Primary Distribution Lines | 1979-2000 | 80 | 100 |
| Secondary Distribution Lines | 1979-2000 | 15 | 50 |
| Storage Tanks | 1983-84 | 20 | 10 |
| | 1993-94 | 40 | 20 |

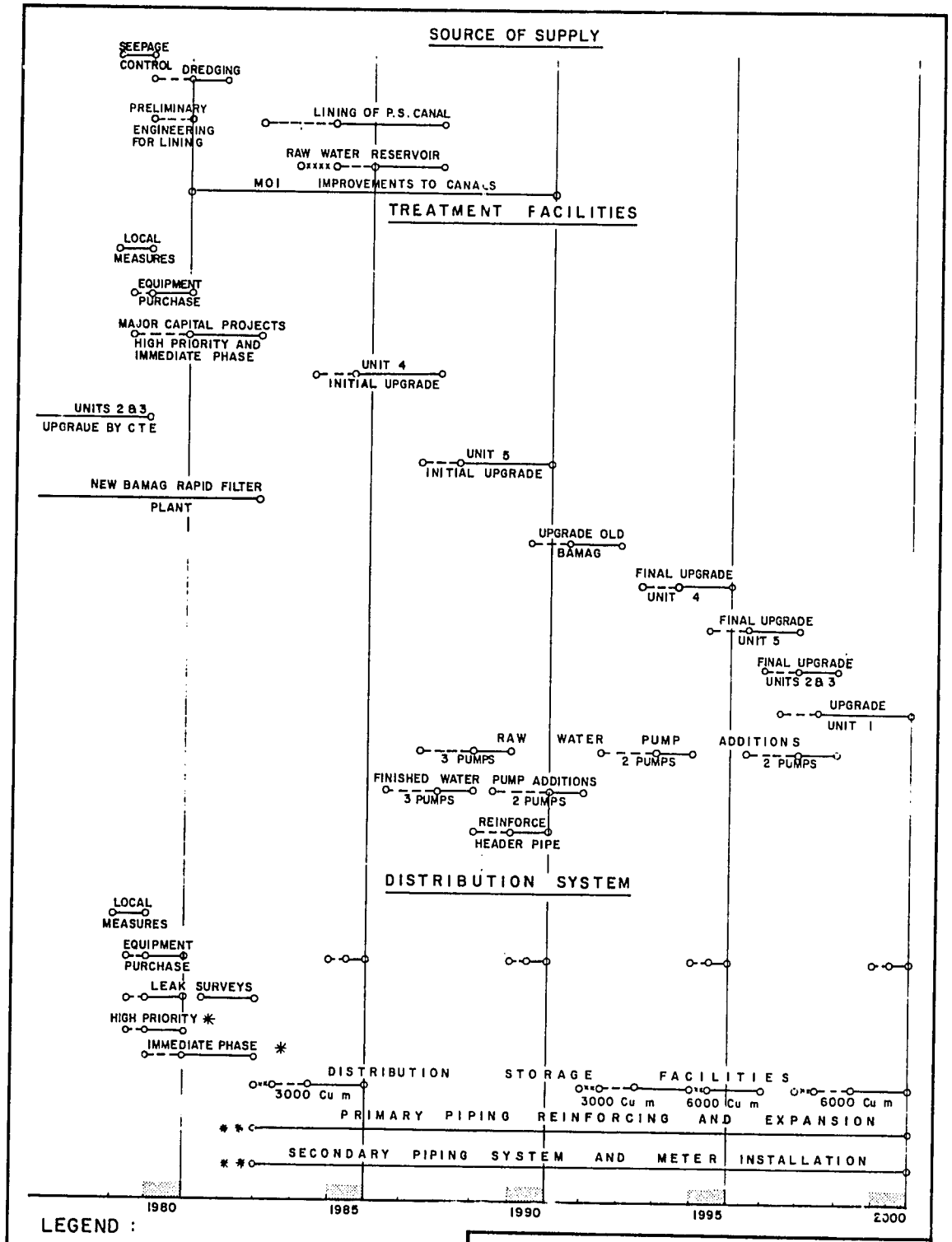



**ARAB REPUBLIC OF EGYPT**
**MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES**
**ADVISORY COMMITTEE FOR RECONSTRUCTION**

**PORT SAID**
**WATER AND WASTEWATER FACILITIES MASTER PLAN**

**CRITICAL PATH OF WATER FACILITIES IMPROVEMENTS**
**(High Priority And Immediate Phase Work)**

VOL 2
FIG. II-A




LEGEND :

- ○×××××××○ SITE ACQUISITION.
- ○— — — —○ ENGINEERING, BIDDING.
- ○————○ CONSTRUCTION, TESTING AND START UP.
- * INCLUDES PRIMARY AND SECONDARY PIPING SERVICE CONNECTION, METERS
- ** ENGINEERING NOT SHOWN SEPARATELY

HAZEN AND SAWYER

ECG - ENGINEERING CONSULTANTS GROUP

JANUARY 1979

**ARAB REPUBLIC OF EGYPT**

MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION

PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

WATER FACILITIES PROGRAM EXECUTION

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CHAPTER 12

FINANCING

## 12.1 SUMMARY OF ALTERNATIVES

Three approaches to financing the recommended program were examined:

- Self sustaining user charge financing - utility basis
- Self sustaining user charge financing - debt service basis
- Deficit financing

These alternatives differ significantly in the extent to which current users would pay for present and future service.

Under the utility basis alternative, users would pay the cost of present service and make some contribution to future replacement of facilities. Rates and revenues would be set to cover operating and maintenance (O&M) expenses plus depreciation, and to yield a return on investment of at least six percent (as called for in the WWFMP scope). (Cash flow must be checked to see that it covers debt service i.e., interest and amortization on loans obtained for new construction). In later years, as debt service declines, funds could be accumulated to pay in part for replacement of facilities as they wear out.

With financing on a debt service basis, present users would pay just for system O&M plus debt service on loans covering new facilities. Customers would have "free" use of existing facilities until the facilities were replaced.

Under deficit financing, rates would be kept at present low levels (Section 12.5 below). General government revenues would be used to cover operating deficits and to fund new construction.

### Cost Escalation

To permit year-to-year comparisons of financial condition, the analysis of utility basis financing was made entirely in 1978 LE. The resulting rates were used in assessing the economic impact of projected charges on water customers (Section 13.2).

The analyses of debt service basis and deficit financing included cost escalation in order to anticipate expected effects of inflation on loan requirements or on levels of government support in deficit financing.

The effect of inflation on rates required for self-financing is less critical since customer income presumably will rise with costs. For local costs, escalation is likely to be especially steep during the High Priority and Immediate Phase of the recommended program. This is due to the substantial increases in construction investment occurring in many sections of the Egyptian economy, including utilities. From review of other reports and from discussions with persons familiar with construction costs in Egypt, we believe it reasonable to allow for escalation rates as follows:

| Year | Annual Rate of Cost Escalation (Percent) Domestic Goods and Services (Local) | Foreign Equipment and Supplies (Imports) |
|---|---|---|
| 1978 | 20 | 7 |
| 1979 | 20 | 7 |
| 1980 | 19 | 7 |
| 1981 | 18 | 7 |
| 1982 | 16 | 7 |
| 1983 | 14 | 7 |
| 1984 | 12 | 7 |
| 1985 | 10 | 7 |
| 1986 | 8 | 7 |
| 1987-2000 | 7 | 7 |

## 12.2 UTILITY BASIS FINANCING

The analysis of utility basis financing is summarized in tables projecting asset values, depreciation, operating revenues and costs, cash flow, and balance sheets. Capital outlays for recommended projects, and estimated future system operating costs were taken from Tables 11.1, 11.2 and 11.3. Revenues were assumed to include charges for water delivered to customers plus direct charges for new service connections at cost. Based on projections of water sold, average charges per cu m were calculated to meet revenue needs. The basis for individual projections is detailed below.

### Assets

The value of existing facilities and those being added under projects-in-process is presented in Tables 12.1 and 12.2. Applicable accumulated depreciation is shown as a percent of asset value. Assets were valued on a replacement cost basis, using the same unit prices as for recommended new works but without allowances for contingencies and support services. For simplicity, inventory values were neglected. The present status of depreciation was based on estimates by the SCA.

Additions to fixed assets and cumulative depreciable values of fixed assets are scheduled in Table 12.3. Assets are separated in categories according to applicable depreciation rates. Added and cumulative values of service connections in the system are also shown in Table 12.3. Since these connections are paid for directly by building owners, we have not treated them as assets of the utility. We recommend, however, that the utility assume responsibility for maintaining service connections and for replacing them when necessary. The utility, not the customer, has an incentive to prevent leakage losses up to the customer's meter. Funds to cover maintenance and eventual replacement of service connections are included in the financial analysis below.

### Depreciation

Annual and accumulated depreciation for fixed assets of the water utility is projected in Table 12.4, calculated on a straight line basis with the following services lives:

| Type of Fixed Asset | Service Life |
|---|---|
| Civil Works/Pipe lines | 40 yr |
| Mechanical* | 20 yr |
| Vehicles & Maintenance Equipment | 10 yr |

(* Mechanical refers to installed mechanical or electrical equipment such as pumps, motors and controls. Maintenance equipment is largely for pipeline excavation.)

Also shown in Table 12.4 are annual and cumulative service connection replacement allowances. Annual figures are calculated in the same manner as depreciation, using a 40 year life.

A small fraction of assets (10 year service life) will be fully depreciated during the study period. Depreciation calculations assume these assets will be replaced at original cost when fully depreciated.

Since many of these assets are likely to serve beyond their nominal useful life, the small capital outlays for their replacement have not been scheduled in the financial tables for the sake of simplicity.

Operating Statement

The utility basis for determining required water revenues and charges is shown in Table 12.5.

Flows are based on the projected demands discussed in Chapter 4. Water produced is the annual amount at average daily demand. Water sold represents the annual amount for which payment may be expected, based on 90 percent of total demand excluding leakage. The 10 percent reduction allows for under-registration of meters and default on customers' bills.

The return on investment for each year is calculated on a rate base equal to accumulated capital investment in fixed assets less accumulated depreciation.

Annual depreciation and added allowance for service connection replacement are taken from Table 12.4.

Revenue sources in the analysis are limited to (1) charges for service connections at cost, and (2) charges for water sold (see Section 12.5, below). For utility basis financing, average annual water charges required to balance revenues against operating costs, depreciation and return on investment would jump from present levels (LE 0.018/cu m) to LE 0.10/cu m in 1979, ranging as high as LE 0.138/cu m through the late 1980's (Table 12.3). Thereafter, as the fixed assets depreciate and costs are spread over more customers, the average charge would decline, reaching LE 0.092/cu m by the year 2000.

Cash Flow

A pro-forma cash flow analysis, showing how interest and amortization of long term loans would be covered, is presented in Table 12.6. In this analysis the entire program of recommended improvements is assumed to be financed by long term loans covering

both foreign exchange and local cost. To date the SCA has financed system improvements, including the current projects-in-progress, out of its regular budget.

Loan proceeds were treated as received and the corresponding capital outlays were treated as made at year end. (Interest during construction is allowed for under the costs of facilities). At the direction of the ACR, interest and amortization were based on the following terms for both foreign and local currency loans.

| | |
|---|---|
| Interest | 6% |
| Grace Period for Principal Payment | 3 years |
| Payoff Period | 20 years |

As indicated in Table 12.6, revenues determined on the "utility" basis would yield adequate cash flow to cover operation and maintenance, plus interest and amortization cost throughout the planning period. There would in fact be a steady build-up of surplus funds. These funds should be put in a capital reserve fund to handle normal capital replacements. It is important that the reserve be invested at rates of return sufficient to preserve the capital until needed. (This return is not included in the analysis.) Depending upon other factors such as availability of loans, interest rates, and inflation, the reserve could also be used to finance system extensions or to reduce the amount of borrowings. The reserve should not be used to reduce rates. Such use would only result in greater borrowing and higher rates later.

Balance Sheets

The pro forma balance sheets presented in Table 12.7 project the overall financial position of the utility through the planning period. Assuming no re-investment of surplus funds in replacements, new facilities or system extensions, total cash reserves would exceed LE 18 million by the year 2000; the initial capital contribution would be preserved; and a modest increase (LE 3 million) in net worth would be generated from earned surpluses. The depreciated asset value (LE 38 million) would exceed the outstanding long-term debt by almost LE 6 million.

Cash in the year 2000 would be less than one-third of the accumulated depreciation. If level rates (in constant value LE) were maintained thereafter, cash accumulation would rapidly increase as early loans became fully amortized. Since most facilities will probably serve beyond their normal useful lives, major replacement of assets is unlikely to be needed before sufficient cash is accumulated to cover the costs.

## 12.3 DEBT SERVICE BASIS

Self-sustaining financing of the recommended program on a debt service basis is summarized in Table 12.9, with escalation applied to capital and operating costs as shown in Table 12.10. The escalated costs of capital improvements each year are assumed to be loan-financed on the same terms as shown in Section 12.2 above. Charges for service connections are assumed equal to the escalated cost of these connections.

Unit charges for water are determined for each year to provide revenue to cover O&M plus debt service costs. These charges represent the minimum for financing on a self-sustaining basis, providing no accumulation of funds to meet future needs.

## 12.4 DEFICIT FINANCING

Water system deficits based on escalated capital and operating costs are projected in Table 12.10, assuming no change in the present tariff schedule (nominal average water cost of 0.018/cu m).

If rates are kept at present levels, the government must make up the deficits from other sources or defer system improvements and expansion.

From 1980 on, the indicated annual deficits range from LE 6,000,000 to a peak of over LE 25,000,000 in 1987. The accumulated deficit through the year 2000 would total almost LE 288,000,000.

## 12.5 WATER REVENUES

Revenues from water customers have ranged as follows over recent years:

| | LE |
|---|---|
| 1975 | 243,000 |
| 1976 | 293,000 |
| 1977 | 338,000 |

The SCA derives these revenues from four types of charges:

| | Percent of Revenue | |
|---|---|---|
| | 1975 | 1977 |
| Water | 89.8 | 82.9 |
| Installation & Repair of Services | 6.9 | 14.8 |
| Meter Rent | 2.4 | 1.5 |
| Meter Repairs | 0.9 | 0.8 |

Water charges are based on the SCA tariff schedule shown in Table 12.8. This schedule has not changed since 1926. Regular domestic and industrial consumers, paying a basic rate of LE .018, account for the bulk of water sold. Special classes of customers have higher or lower rates, but revenues average close to the basic rate. Industrial users in the Free Zone pay almost twice the basic rate.

In sharp contrast to the SCA schedule, private vendors who carry water to homes with no piped supply charge the equivalent of as high as LE 1.00/cu m.

The financial analyses in this chapter are based on revenues from water charges and from installation charges for services. The relatively minor revenues currently received from meter rent could be obtained from water charges with less bookkeeping effort. Routine meter servicing could also be covered by general water revenues. Meter repair charges should be made where customers are negligent or willfully damage meters. Including this small cost in the financial projection would be a needless refinement.

### Appropriate Water Charges

The fluctuating water costs shown in Table 12.5 would be undesirable in an actual tariff schedule. An equivalent average "level" cost for water (in constant 1978 LE) would be LE 0.113/cu m. An even lower "level" cost of LE 0.10/cu m would generate enough



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revenue to cover O&M costs and debt service, though it would not provide for the same build-up of cash reserves.

Since cost estimates in the WWFMP are necessarily ample, we regard the lower figure as more appropriate to use in assessing the economic impact on customers of self-sustaining, user charge financing (Section 13.2).

Water rates will need to be adjusted periodically to offset the effects of cost escalation. The rates calculated in Table 12.9 illustrate how much rates may have to be increased to keep the system self-financing.

TABLE 12.1

ESTIMATED REPLACEMENT VALUE OF EXISTING FACILITIES(1)(2)
(Thousands of 1978 LE)

| Line No. | Item | Existing | Depreciation % | Depreciation on Existing Amount | 1978 Added | 1978 Total | 1979 Added | 1980 | 1981 | 1982 | Total (1978-1982) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Treatment Works | | | | | | | | | | |
| 2 | Existing Bamag Plant(3)(4) | 2512 | 20 | 502 | | 2512 | | | | | 2512 |
| 3 | Flow Train 1(3) | 529 | 75 | 397 | | 529 | | | | | 529 |
| 4 | Flow Train 2(3) | 1485 | 65 | 965 | 1155(5) | 2640 | | | | | 2640 |
| 5 | Flow Train 3(3) | 1485 | 65 | 965 | 1155(5) | 2640 | | | | | 2640 |
| 6 | Flow Train 4(3) | 1668 | 50 | 834 | | 1668 | | | | | 1668 |
| 7 | Flow Train 5(3) | 1668 | 50 | 834 | | 1668 | | | | | 1668 |
| 8 | Existing Bamag Pumping Station(6) | 320 | 20 | 64 | | 320 | | | | | 320 |
| 9 | Main Pumping Station Building(7) | 80 | 50 | 40 | | 80 | | | | | 80 |
| 10 | New Bamag Plant(8) | - | | | 770 | 770 | 770 | 770 | 770 | 770 | 3850 |
| 11 | New Bamag Raw Water Pumping(8) | - | | | 42 | 42 | 42 | 42 | 42 | 42 | 210 |
| 12 | New Bamag Finished Water Pumping(8) | - | | | 70 | 70 | 70 | 70 | 70 | 70 | 350 |
| 13 | Subtotal Civil Works/Piping(9) | 3947 | | 1866 | 1277 | 5224 | 353 | 353 | 353 | 353 | 6636 |
| 14 | Subtotal Mechanical(9) | 5800 | | 2735 | 1915 | 7715 | 529 | 529 | 529 | 529 | 9831 |
| 15 | TOTAL | 9747 | | 4601 | 3192 | 12939 | 882 | 882 | 882 | 882 | 16467 |
| 16 | Distribution System | | | | | | | | | | |
| 17 | Elevated Storage | 133 | 50 | 67 | | 133 | | | | | 133 |
| 18 | Primary & Secondary Dist. Lines | 8591(10) | 47(11) | 4038 | 1896 | 10487 | 482 | 310 | | | 11279 |
| 19 | Total (Civil Works/Pipelines) | 8724 | | 4105 | 1896 | 10620 | 482 | 310 | | | 11412 |
| 20 | Meters | 413 | 20 | 83 | | 413 | | | | | 413 |
| 21 | Subtotals | | | | | | | | | | |
| 22 | Civil Works/Piping | 12671 | | 6051 | 3173 | 15844 | 835 | 663 | 353 | 353 | 18048 |
| 23 | Mechanical | 6213 | | 2818 | 1915 | 8128 | 529 | 529 | 529 | 529 | 10244 |
| 24 | Vehicles & Maintenance Equip. | 100 | 50 | 50 | | 100 | | | | | 100 |
| 25 | TOTAL - Treatment Works & Dist. | 18984 | | 8919 | 5088 | 24072 | 1364 | 1192 | 882 | 882 | 28392 |
| 26 | Land | 825 | | | | 825 | | | | | 825 |
| 27 | Service Connections | 1428 | 47 | 671 | | 1428 | 72 | | | | 1500 |

(1) Including facilities being added under projects-in-progress; CTE, Bamag, SCA and locally installed secondary distribution and service connections. Valued at costs used in report for new facilities, excluding contingencies and support services.
(2) No asset value assigned to source of supply since Port Said Canal not water system property. If reach below Rayah Barrage is turned over to water system, only a nominal value should be assigned in view of low historical cost of canal and current need for major outlays to improve it. Also no asset value assigned to Auxiliary Raw or Annex Finished Water Pumping Stations which are to be retired upon completion of High Priority work.
(3) Valued at cost of ultimate capacity, less estimated cost of upgrading to that capacity.
(4) Excluding raw and finished water pumping station.
(5) CTE conversion assumed to be completed in 1978.
(6) Valued at cost of new raw water pumping station proposed capacity less cost of conversion to that capacity.
(7) Valued solely as building available for other uses.
(8) Work assumed spread evenly over five years, with completion in 1982.
(9) All treatment and pumping facilities assumed 60% mechanical, 40% civil works/piping (except Main Pumping Station Building assumed 100% civil works).
(10) From Table 12.2; water lines, plus LE 639,000 for siphons and deducting LE 361,000 for facilities to be retired under High Priority Program.
(11) Overall weighted figure from Table 12.2.

TABLE 12.2

EVALUATION OF EXISTING WATER DISTRIBUTION SYSTEM

| Size mm | Length m | Unit Cost LE/m | Existing Value LE | Percent Depreciation | Accumulated Depreciation | Percent Weighted Depreciation |
|---|---|---|---|---|---|---|
| 100 | 37,776 | 25 | 944,000 | 60 | 566,000 | 53.4 |
| | 18,000 | 25 | 450,000 | 40 | 180,000 | |
| 150 | 3,280 | 33 | 108,000 | 60 | 65,000 | |
| | 4,055 | 33 | 134,000 | 40 | 54,000 | 45.0 |
| | 1,152 | 33 | 38,000 | 20 | 8,000 | |
| 200 | 14,112 | 43 | 607,000 | 60 | 364,000 | 48.7 |
| | 18,362 | 43 | 790,000 | 40 | 316,000 | |
| 300 | 4,490 | 60 | 269,000 | 60 | 161,000 | |
| | 8,905 | 60 | 534,000 | 40 | 214,000 | 43.2 |
| | 2,028 | 60 | 122,000 | 20 | 24,000 | |
| 400 | 1,456 | 121 | 176,000 | 60 | 106,000 | |
| | 4,349 | 121 | 526,000 | 40 | 210,000 | 34.6 |
| | 4,156 | 121 | 503,000 | 20 | 101,000 | |
| 500 | 582 | 178 | 104,000 | 60 | 62,000 | |
| | 2,784 | 178 | 496,000 | 40 | 198,000 | 42.3 |
| | 177 | 178 | 32,000 | 20 | 6,000 | |
| 550 | 1,036 | 194 | 201,000 | 40 | 80,000 | 40.0 |
| 600 | 1,848 | 210 | 388,000 | 60 | 233,000 | |
| | 727 | 210 | 153,000 | 40 | 61,000 | 48.0 |
| | 586 | 210 | 123,000 | 20 | 25,000 | |
| 800 | 4,025 | 327 | 1,316,000 | 60 | 790,000 | 52.6 |
| | 915 | 327 | 299,000 | 20 | 60,000 | |
| TOTALS | 134,801 | | 8,313,000 | | 3,884,000 | 47 |

Replacement values at cost levels used for new lines, but excluding contingencies and support services.
Siphons not included in tabulation.

# TABLE 12.3

## SCHEDULE OF ADDITIONS TO FIXED ASSESTS AND SERVICE CONNECTION VALUES
## (Thousands of 1978 LE)

| Line No. | | Existing 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ADDED ASSETS (1) | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Civil Works/ Piping | 15,844 | 1,047 | 3,295 | 4,099 | 3,911 | 2,208 | 2,266 | 5,630 | 7,367 | 7,384 | 2,259 | 2,346 | 2,560 | 775 | 809 | 790 | 851 | 868 | 992 | 881 | 1,193 | 1,336 | 1,413 |
| 3 | Mechanical (2) | 8,128 | 675 | 3,515 | 806 | 806 | -- | 27 | 199 | 411 | 438 | 399 | 505 | 455 | 133 | 179 | 96 | 220 | 142 | 133 | 202 | 756 | 754 | 726 |
| 4 | Vehicles and Maintenance Equipment | 100 | 9 | 168 | 40 | -- | -- | -- | 50 | -- | -- | -- | -- | 50 | -- | -- | -- | -- | 50 | -- | -- | -- | -- | -- |
| 5 | Land | 825 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 6 | TOTAL | 24,897 | 1,731 | 6,978 | 4,945 | 4,717 | 2,208 | 2,293 | 5,879 | 7,778 | 7,822 | 2,658 | 2,851 | 3,065 | 908 | 988 | 886 | 1,071 | 1,060 | 1,125 | 1,083 | 1,949 | 2,090 | 2,178 |
| 7 | DEPRECIATION VALUES | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | Civil Works/ Piping (1) | 15,844 | 16,891 | 20,186 | 24,285 | 28,196 | 30,404 | 32,670 | 3 ,300 | 45,667 | 53,051 | 55.310 | 57,656 | 60,216 | 60,991 | 61,800 | 62,590 | 63,441 | 64,309 | 65,301 | 66,182 | 67,375 | 68,711 | 70,124 |
| 9 | Mechanical (2) | 8,128 | 8,803 | 12,318 | 13,124 | 13,930 | 13,930 | 13,957 | 14,156 | 14,567 | 15,005 | 15,404 | 15,909 | 16,364 | 16,497 | 16,676 | 16,772 | 16,992 | 17,134 | 17,267 | 16,469 | 18,225 | 18,979 | 19,744 |
| 10 | Vehicles and Maintenance Equipment | 100 | 109 | 277 | 317 | 317 | 317 | 317 | 367 | 367 | 367 | 367 | 367 | 417 | 417 | 417 | 417 | 417 | 467 | 467 | 467 | 467 | 467 | 467 |
| 11 | TOTAL | 24,072 | 25,803 | 32,781 | 37,726 | 42,443 | 44,651 | 46,944 | 52,823 | 60,601 | 68,423 | 71,081 | 73,932 | 76,997 | 77,905 | 78,893 | 79,779 | 80,850 | 81,910 | 83,035 | 84,118 | 86,067 | 88,157 | 90,335 |
| 12 | ADDED VALUE OF SERVICE CONDITIONS | -- | 91 | 330 | 206 | 206 | 216 | 216 | 216 | 263 | 263 | 263 | 263 | 263 | 235 | 236 | 236 | 236 | 236 | 234 | 235 | 235 | 235 | 235 |
| 13 | VALUE OF SERVICE CONDITIONS | 1,428 | 1,519 | 1,849 | 2,055 | 2,261 | 2,477 | 2,623 | 2,909 | 3,172 | 3,435 | 3,698 | 3,961 | 4,224 | 4,459 | 4,645 | 4,931 | 5,167 | 5,403 | 5,637 | 5,872 | 6,107 | 6,342 | 6,577 |

(1) 1978 added assets represent existing facilities plus SCA projects-in-progress.
1978-82 values include SCA projects-in-progress.
(2) Includes electric work.

TABLE 12.3 (Cont.)

BASIS FOR PREPARING TABLE 12.3

Schedule of Fixed Assets and Service Connection Values
(Year End Values)

| Line | |
|---|---|
| 1 | Added Assets. Heading for lines 2 to 6. |
| 2 | Civil Works/Piping. From line 17 of Table 11.1. Up to 1982 add line 22 from Table 12.1. |
| 3 | Mechanical. From line 18 of Table 11.1. Up to 1982 add line 23 from Table 12.1. |
| 4 | Vehicles and Maintenance Equipment. From line 19 of Table 11.1. |
| 5 | Land. From line 26 of Table 12.1. |
| 6 | Total. Sum of lines 2 to 5 above. |
| 7 | Depreciable Values. Heading for lines 8 to 11. |
| 8 | Civil Works/Piping. Cumulative sum of values in line 2 above. |
| 9 | Mechanical. Cumulative sum of values in line 3 above. |
| 10 | Vehicles and Maintenance Equipment. Cumulative sum of values in line 4 above. |
| 11 | Total. Sum of lines 8 to 10 above. |
| 12 | Added Value of Service Connections. From line 20 of Table 11.1; 1978 value from line 27 in Table 12.1; up to 1979 add line 27 in Table 12.1. |
| 13 | Value of Service Connections. Cumulative sum of values in line 12 above. |

# TABLE 12.4

## SCHEDULE OF DEPRECIATION COSTS AND SERVICE CONNECTION REPLACEMENT ALLOWANCES
## (Thousands of 1978 LE)

| Line No. | | Per-cent | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ANNUAL DEPRECIATION COSTS ON FIXED ASSETS | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Civil Works/ Piping | 2.5 | -- | 396 | 422 | 505 | 607 | 705 | 760 | 816 | 956 | 1,142 | 1,326 | 1,383 | 1,441 | 1,505 | 1,525 | 1,545 | 1,565 | 1,586 | 1,608 | 1,633 | 1,655 | 1,684 | 1,718 |
| 3 | Mechanical (1) | 5 | -- | 406 | 440 | 616 | 656 | 697 | 697 | 698 | 708 | 728 | 750 | 770 | 795 | 818 | 825 | 833 | 839 | 850 | 857 | 864 | 873 | 911 | 949 |
| 4 | Vehicle and Maintenance Equipment | 10 | -- | 10 | 11 | 28 | 32 | 32 | 32 | 32 | 37 | 37 | 37 | 37 | 37 | 42 | 42 | 42 | 42 | 42 | 47 | 47 | 47 | 47 | 47 |
| 5 | TOTAL | | -- | 812 | 873 | 1,149 | 1,295 | 1,434 | 1,489 | 1,546 | 1,701 | 1,907 | 2,117 | 2,190 | 2,273 | 2,365 | 2,392 | 2,420 | 2,446 | 2,478 | 2,512 | 2,544 | 2,575 | 2,642 | 2,714 |
| 6 | ACCUMULATED DEPRECIATION ON FIXED ASSETS | | 8,919 | 9,731 | 10,604 | 11,753 | 13,048 | 14,482 | 15,971 | 17,517 | 19,218 | 21,125 | 23,238 | 25,428 | 27,701 | 30,066 | 32,458 | 34,878 | 37,324 | 39,802 | 42,314 | 44,858 | 47,433 | 50,075 | 52,789 |
| 7 | ANNUAL DEPRECIATION ON SERVICE CONNECTIONS | 2.5 | 671 | 36 | 38 | 46 | 51 | 57 | 62 | 67 | 73 | 79 | 86 | 92 | 99 | 106 | 111 | 117 | 123 | 129 | 135 | 141 | 147 | 153 | 161 |
| 8 | ACCUMULATED DEPRECIATION ON SERVICE CONNECTIONS | | 671 | 707 | 745 | 791 | 842 | 899 | 961 | 1,028 | 1,101 | 1,180 | 1,266 | 1,358 | 1,457 | 1,563 | 1,674 | 1,791 | 1,914 | 2,043 | 2,178 | 2,319 | 2,466 | 2,619 | 2,780 |

(1) Including electrical work.

TABLE 12.4 (Cont.)

BASIS FOR PREPARING TABLE 12.4

Schedule of Depreciation Costs
and Service Connection Replacement Allowances

Line

1 Annual Depreciation on Fixed Assets. Heading for lines 2 to 5. No 1978 values are shown. Depreciation on existing facilities is picked up in lines 7 to 9 below.

2 Civil Works/Piping. 2.5 percent of asset value shown on line 8 of Table 12.3 for previous year.

3 Mechanical. 5 percent of asset value shown on line 9 of Table 12.3 for previous year.

4 Vehicles and Maintenance Equipment. 10 percent of asset values shown on line 10 of Table 12.3 for previous year.

5 Total. Sum of lines 2 to 4.

6 Accumulated Depreciation on Fixed Assets. The 1978 value is based on existing assets times the applicable weighted percent of accumulated depreciation (Table 12.1, line 25). Values for succeeding years are cumulative sums of 1978 value and values shown in line 5 above.

7 Annual Added Allowance for Service Connection Replacement. 2.5 percent of value shown on line 13 of Table 12.3 for previous year.

8 Accumulated Allowance for Service Connection Replacement. The 1978 value is from line 27 of Table 12.1. Other years' values are cumulative sums of 1978 value and values shown in line 7 above.

# TABLE 12.5

## PRO FORMA OPERATING STATEMENTS 1978-2000
## (Thousands of 1978 LE)

| Line No. | | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | FLOWS (cu m x $10^6$) | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Water Produced | 36.5 | 38.0 | 40.0 | 41.8 | 44.0 | 46.5 | 49.4 | 52.0 | 55.0 | 58.0 | 61.0 | 64.0 | 67.5 | 70.5 | 73.5 | 76.5 | 79.1 | 82.5 | 86.0 | 89.0 | 92.0 | 95.2 |
| 3 | Water Sold | 27.0 | 29.0 | 31.0 | 32.7 | 34.6 | 36.5 | 38.9 | 41.0 | 43.5 | 46.0 | 48.5 | 51.5 | 53.5 | 56.0 | 58.5 | 60.8 | 63.0 | 66.0 | 68.5 | 71.0 | 73.4 | 75.8 |
| 4 | Wastewater Collected (10) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 5 | ANNUAL COSTS (2) | | | | | | | | | | | | | | | | | | | | | | |
| 6 | Operation and Maintenance | 1,011 | 1,152 | 1,224 | 1,289 | 1,323 | 1,358 | 1,400 | 1,449 | 1,492 | 1,534 | 1,576 | 1,621 | 1,652 | 1,686 | 1,712 | 1,737 | 1,765 | 1,797 | 1,824 | 1,874 | 1,922 | 1,973 |
| 7 | Depreciation on Fixed Assets | 812 | 873 | 1,149 | 1,295 | 1,434 | 1,489 | 1,546 | 1,701 | 1,907 | 2,113 | 2,190 | 2,273 | 2,365 | 2,392 | 2,420 | 2,446 | 2,478 | 2,512 | 2,544 | 2,575 | 2,642 | 2,714 |
| 8 | Depreciation on Service Connections | 36 | 38 | 46 | 51 | 57 | 62 | 67 | 73 | 79 | 86 | 92 | 99 | 106 | 111 | 117 | 123 | 129 | 135 | 141 | 147 | 153 | 161 |
| 9 | Return on Investment | 959 | 1,014 | 1,386 | 1,608 | 1,813 | 1,860 | 1,908 | 2,168 | 2,532 | 2,889 | 2,920 | 2,960 | 3,007 | 2 920 | 2,836 | 2,711 | 2,661 | 2,576 | 2,493 | 2,405 | 2,368 | 2,334 |
| 10 | TOTAL ANNUAL COSTS | 2,818 | 3,077 | 3,805 | 4,243 | 4,627 | 4,769 | 4,921 | 5,391 | 6,010 | 6,622 | 6,778 | 6,953 | 7,130 | 7,109 | 7,085 | 7,017 | 7,033 | 7,020 | 7,002 | 7,001 | 7,085 | 7,182 |
| 11 | REQUIRED REVENUES | | | | | | | | | | | | | | | | | | | | | | |
| 12 | Water Charges | 2,727 | 2,747 | 3,599 | 4,037 | 4,411 | 4,553 | 4,705 | 5,128 | 5,747 | 6,359 | 6,515 | 6,690 | 6,895 | 6,873 | 6,849 | 6,781 | 6,797 | 6,786 | 6,767 | 6,766 | 6,850 | 6,947 |
| 13 | Connection Charges | 91 | 330 | 206 | 206 | 216 | 216 | 216 | 263 | 263 | 263 | 263 | 263 | 235 | 236 | 236 | 236 | 236 | 234 | 235 | 235 | 235 | 235 |
| 14 | TOTAL ANNUAL REVENUE | 2,818 | 3,077 | 3,805 | 4,243 | 4,627 | 4,769 | 4.921 | 5,391 | 6,010 | 6,622 | 6,778 | 6,953 | 7,130 | 7,109 | 7,085 | 7,017 | 7,033 | 7,020 | 7,002 | 7,001 | 7,085 | 7,182 |
| 15 | Required ave. cost of water sold milleums/cu m | 101 | 95 | 117 | 123 | 127 | 125 | 121 | 125 | 132 | 138 | 134 | 130 | 129 | 123 | 117 | 111 | 108 | 103 | 99 | 95 | 93 | 92 |

(1) Used in Volume III only.
(2) Not including rehabilitation.

## TABLE 12.5 (Cont.)

## BASIS FOR PREPARING TABLE 12.5

## Pro Forma Operating Statements 1978-2000

Line

1 Flows. Annual flows expressed in millions of cu m/d. Used for operating cost estimates and estimates of average charges to provide needed revenues.

2 Water Produced. The quantity of water treated annually at the WTP. Based on average daily flow in Table 4.9.

3 Water Sold. The amount of water paid for, whether metered or estimated. It is assumed equal to 90 percent of the water delivered to customers, which in turn is calculated as average water produced less leakage, both as given in Table 4.9.

4 Wastewater Collected. Basis for wastewater operating cost estimates. Entered in Volume 3 only.

5 Annual Costs. Heading for lines 6 to 10.

6 Operation and Maintenance. From Table 11.3, line 12, deducting the cost of rehabilitation (1979 to 1982) from Table 11.1.

7 Depreciation on Fixed Assets. From Table 12.4, line 5.

8 Depreciation on Service Connections. From Table 12.4, line 7.

9 Return on Investment. 6 percent of the depreciated fixed assets for previous year end, as shown in line 6 of Table 12.7.

10 Total Annual Costs. Sum of lines 6 to 9.

11 Required Revenues. Heading for lines 12 to 14.

12 Water Charge. The money required from water sales to generate required total annual revenues. Line 14 less line 13.

13 Connection Charge. Estimated revenue from installing service connections at cost. The cost of service connections is derived from line 20 in Table 11.1. For 1979, add line 27 in Table 12.1.

14 Required Total Annual Revenues. Set equal to total annual costs to make system self-financing.

15 Required Annual Cost of Water Sold. The average cost per cu m to the customer to generate required revenues.

# TABLE 12.6

## PRO FORMA CASH FLOW SCHEDULES 1978-2000
## (Thousands of 1978 LE)

| Line No. | | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SOURCE OF FUNDS | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Loans | 473 | 6,155 | 4,722 | 4,120 | 2,424 | 2,509 | 6,095 | 8,041 | 8,085 | 2,921 | 3,114 | 3,328 | 1,143 | 1,224 | 1,122 | 1,307 | 1,296 | 1,359 | 1,318 | 2,184 | 2,325 | 2,413 |
| 3 | Revenues | 2,818 | 3,077 | 3,805 | 4,243 | 4,627 | 4,769 | 4,921 | 5,391 | 6,010 | 6,622 | 6,778 | 6,953 | 7,130 | 7,109 | 7,085 | 7,017 | 7,033 | 7,020 | 7,002 | 7,001 | 7,085 | 7,182 |
| 4 | TOTAL | 3,291 | 9,232 | 8,527 | 8,363 | 7,051 | 7,278 | 11,016 | 13,392 | 14,095 | 9,543 | 9,892 | 10,281 | 8,273 | 8,333 | 8,207 | 8,324 | 8,329 | 8,379 | 8,320 | 9,185 | 9,410 | 9,595 |
| 5 | APPLICATION OF FUNDS | | | | | | | | | | | | | | | | | | | | | | |
| 6 | Capital Additions | 1,822 | 7,308 | 5,151 | 4,923 | 2,424 | 2,509 | 6,095 | 8,041 | 8,085 | 2,921 | 3,114 | 3,328 | 1,143 | 1,224 | 1,122 | 1,307 | 1,296 | 1,359 | 1,318 | 2,184 | 2,325 | 2,413 |
| 7 | Interest | | 28 | 398 | 681 | 927 | 1,052 | 1,169 | 1,488 | 1,917 | 2,341 | 2,436 | 2,520 | 2,592 | 2,523 | 2,451 | 2,362 | 2,281 | 2,195 | 2,111 | 2,020 | 1,977 | 1,938 |
| 8 | Amortization | | | | 24 | 331 | 568 | 774 | 895 | 1,020 | 1,325 | 1,727 | 2,131 | 2,277 | 2,433 | 2,599 | 2,657 | 2,718 | 2,774 | 2,839 | 2,904 | 2,972 | 3,038 |
| 9 | Operation and Maintenance | 1,098 | 1,191 | 1,677 | 1,368 | 1,323 | 1,358 | 1,400 | 1,449 | 1,492 | 1,534 | 1,576 | 1,621 | 1,652 | 1,686 | 1,712 | 1,737 | 1,765 | 1,797 | 1,824 | 1,874 | 1,922 | 1,973 |
| 10 | TOTAL | 2,920 | 8,527 | 7,226 | 6,996 | 5,005 | 5,487 | 9,438 | 11,873 | 12,514 | 8,121 | 8,853 | 9,600 | 7,664 | 7,866 | 7,884 | 8,063 | 8,060 | 8,125 | 8,091 | 8,982 | 9,196 | 9,362 |
| 11 | NET SURPLUS (DEFICIT) | 371 | 705 | 1,301 | 1,367 | 2,046 | 1,791 | 1,578 | 1,519 | 1,581 | 1,422 | 1,039 | 681 | 609 | 567 | 323 | 261 | 269 | 254 | 229 | 203 | 314 | 233 |
| 12 | BALANCE (CASH & RECEIVABLES LESS ACCOUNTS PAYABLE) | | | | | | | | | | | | | | | | | | | | | | |
| | At Beginning of Year | | 371 | 1,076 | 2,377 | 3,744 | 5,790 | 7,581 | 9,159 | 10,678 | 12,259 | 13,781 | 14,720 | 15,401 | 16,010 | 16,577 | 16,900 | 17,161 | 17,430 | 17,684 | 17,913 | 18,116 | 18,430 |
| | At end of year | 371 | 1,076 | 2,377 | 3,744 | 5,790 | 7,581 | 9,159 | 10,678 | 12,259 | 13,681 | 14,720 | 15,401 | 16,010 | 16,577 | 16,900 | 17,161 | 17,430 | 17,684 | 17,913 | 18,116 | 18,430 | 18,663 |
| 13 | OUTSTANDING LONG TERM DEBT | | | | | | | | | | | | | | | | | | | | | | |
| | Accumulated Loans | 473 | 6,628 | 11,350 | 15,470 | 17,894 | 20,403 | 26,498 | 34,539 | 42,624 | 45,545 | 48,659 | 51,987 | 53,130 | 54,534 | 55,476 | 56,783 | 58,079 | 59,438 | 60,756 | 62,940 | 65,265 | 67,678 |
| | *Amortization | | | | (24) | (355) | (923) | (1,697) | (2,592) | (3,612) | (4,937) | (6,664) | (8,795) | (11,072) | (13,505) | (16,104) | (18,761) | (21,479) | (24,253) | (27,092) | (29,996) | (32,968) | (36,006) |
| | Net Outstanding Debt | 473 | 6,628 | 11,350 | 15,446 | 17,539 | 19,480 | 24,801 | 31,947 | 39,012 | 40,608 | 41,995 | 43,192 | 42,058 | 40,849 | 39,372 | 39,022 | 36,590 | 35,185 | 33,664 | 32,994 | 32,297 | 31,672 |

*Less Accumulated Amortization

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## TABLE 12.6 (Cont.)

## BASIS FOR PREPARING TABLE 12.6

## Pro Forma Cash Flow Schedules 1978-2000

| Line | |
|---|---|
| 1 | Source of Funds. Heading for the anticipated sources of required money. (Lines 2 to 4). |
| 2 | Loans. The annual capital requirement to finance the recommended programs. |
| 3 | Revenue. Money to be collected from the customers for water service and connection. Line 14 of Table 12.5. |
| 4 | Total. Sum of lines 2 and 3. |
| 5 | Application of Funds. Heading for the anticipated annual expenditures. (Lines 6 to 10). |
| 6 | Capital Additions. The amount of money invested in capital facilities. Table 12.3, line 6 plus line 12. |
| 7 | Interest. The required annual interest payment based on assumed terms for foreign and local loans. (Apply to outstanding loan balance at end of previous year.) |
| 8 | Amortization. The required annual amortization based on assumed terms for foreign and local loans. |
| 9 | Operation and Maintenance. Total from Table 11.3, line 12. |
| 10 | Total. Sum of lines 5 to 9. |
| 11 | Net Surplus (Deficit). The total funds (line 4) less the total application of funds. |
| 12 | Balance. The cumulative total of the surplus indicated at the beginning and end of each year. The build-up will be less than indicated since funds will be used for renewal of facilities and likely also for extensions of the system. |
| 13 | Outstanding Long-Term Debt. A schedule summarizing the accumulated long-term debt and amortization to be used for comparing the net outstanding debt with the Balance. |

# TABLE 12.7

## PRO FORMA BALANCE SHEETS
## 1978-2000 (END OF YEAR)
## (Thousands of 1978 LE)

| Line No. | | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ASSETS | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Existing and Recommended Facilities | 24,072 | 25,803 | 32,781 | 37,726 | 42,443 | 44,651 | 46,944 | 52,823 | 60,601 | 68,423 | 71,081 | 73,932 | 76,997 | 77,905 | 78,893 | 79,779 | 80,850 | 81,910 | 83,035 | 84,118 | 86,067 | 88,157 | 90,335 |
| 3 | Less Accumulated Depreciation) | (9,919) | (9,731) | (10,604) | (11,753) | (13,048) | (14,482) | (15,971) | (17,517) | (19,218) | (21,125) | (23,238) | (25,428) | (27,701) | (30,066) | (32,458) | (34,878) | (37,324) | (39,802) | (42,314) | (44,858) | (47,433) | (50,075) | (52,789) |
| 4 | SUBTOTAL - Depreciated Facilities | 15,153 | 16,072 | 22,177 | 25,973 | 29,395 | 30,169 | 30,973 | 35, 306 | 41,383 | 47,298 | 47,843 | 48,504 | 49,296 | 47,839 | 46,435 | 44,901 | 43,526 | 42,108 | 40,721 | 39,260 | 38,634 | 38,082 | 37,546 |
| 5 | Land | 825 | 825 | 825 | 825 | 825 | 825 | 825 | 825 | 825 | 825 | 825 | 825 | 825 | 825 | 825 | 825 | 825 | 825 | 825 | 825 | 825 | 825 | 825 |
| 6 | SUBTOTAL - Depreciated Fixed Assets | 15,978 | 16,897 | 23,002 | 26,798 | 30,220 | 30,994 | 31,798 | 36,131 | 42,208 | 48,123 | 48,668 | 49,329 | 50,121 | 49,664 | 47,260 | 45,726 | 44,351 | 42,933 | 41,546 | 40,085 | 39,459 | 38,007 | 38,371 |
| 7 | Cash | -- | (232) | 419 | 1,598 | 2,815 | 4,751 | 6,516 | 8,059 | 9,465 | 10,895 | 12,168 | 13,173 | 13,815 | 14,383 | 14,95[illegible] | 15,291 | 15,572 | 15,840 | 16,101 | 16,336 | 16,546 | 16,845 | 17,059 |
| 8 | Accounts Receivable | -- | 705 | 769 | 951 | 1,061 | 1,157 | 1,192 | 1,230 | 1,348 | 1,503 | 1,656 | 1,695 | 1,738 | 1,783 | 1,77[illegible] | 1,771 | 1,754 | 1,758 | 1,755 | 1,751 | 1,750 | 1,771 | 1,795 |
| 9 | TOTAL ASSETS | 15,978 | 17,370 | 24,190 | 29,347 | 34,096 | 36,902 | 39,506 | 45,420 | 53,021 | 60,521 | 62,492 | 64,197 | 65,674 | 64,830 | 63,996 | 62,788 | 61,677 | 60,531 | 59,402 | 58,172 | 57,755 | 57,523 | 57,226 |
| 10 | LIABILITIES AND NET WORTH | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | Accounts Payable | -- | 102 | 112 | 172 | 132 | 118 | 127 | 130 | 135 | 139 | 143 | 148 | 152 | 156 | 159 | 162 | 165 | 168 | 172 | 174 | 180 | 186 | 192 |
| 12 | Long-Term Loans | -- | 473 | 6,628 | 11,350 | 15,446 | 17,539 | 19,480 | 24,801 | 31,947 | 39,012 | 40,608 | 41,995 | 43,192 | 42,058 | 40,849 | 39,372 | 38,022 | 36,590 | 25,185 | 33,664 | 32,994 | 32,297 | 31,672 |
| 13 | Allowance for Depreciation of Customer Services | 671 | 707 | 745 | 791 | 842 | 899 | 961 | 1,028 | 1,101 | 1,180 | 1,266 | 1,358 | 1,457 | 1,563 | 1,674 | 1,791 | 1,914 | 2,043 | 2,178 | 2,319 | 2,466 | 2,619 | 2,780 |
| 14 | TOTAL LIABILITIES | 671 | 1,282 | 7,485 | 12,313 | 16,420 | 18,556 | 20,568 | 25,959 | 33,183 | 40,331 | 42,071 | 43,501 | 44,801 | 43,777 | 42,682 | 41,325 | 40,101 | 38,801 | 37,535 | 36,157 | 35,640 | 35,102 | 34,644 |
| 15 | Capital Contributions | 15,978 | 17,342 | 18,354 | 19,416 | 20,298 | 20,298 | 20,298 | 20,298 | 20,298 | 20,298 | 20,298 | 20,298 | 20,298 | 20,298 | 20,298 | 20,298 | 20,298 | 20,298 | 20,298 | 20,298 | 20,298 | 20,298 | 20,298 |
| 16 | Earned Surplus (Deficit) | (671) | (1,254) | (1,649) | (2,382) | (2,622) | (1,952) | (1,360) | (837) | (460) | (180) | 177 | 398 | 575 | 755 | 1,016 | 1,165 | 1,278 | 1,432 | 1,569 | 1,717 | 1,817 | 2,123 | 2,284 |
| 17 | Net Worth | 15,307 | 16,088 | 16,705 | 17,034 | 17,676 | 18,346 | 18,938 | 19,461 | 20,475 | 20,190 | 20,475 | 20,696 | 20,873 | 21,053 | 21,314 | 21,463 | 21,576 | 21,730 | 22,867 | 22,015 | 22,115 | 22,421 | 22,582 |
| 18 | TOTAL LIABILITIES AND NET WORTH | 15,978 | 17,370 | 24,190 | 29,347 | 34,096 | 36,902 | 39,506 | 45,420 | 53,021 | 60,521 | 52,492 | 64,197 | 65,674 | 64,830 | 63,996 | 62,788 | 61,677 | 60,531 | 59,402 | 58,172 | 57,755 | 57,523 | 57,226 |

TABLE 12.7 (Cont.)

BASIS FOR PREPARING TABLE 12.7

Pro Forma Balance Sheets 1978-2000

| Line | |
|---|---|
| 1 | Assets. Heading for lines 2 to 9. |
| 2 | Existing and Recommended Facilities. From line 11, Table 12.3. |
| 3 | Less Accumulated Depreciation. The accumulated depreciation from Table 12.4. (Entered as negative figure.) |
| 4 | Sub-Total Depreciated Facilities. Line 2 less line 3. |
| 5 | Land. Cumulative sum of values on line 5 of Table 12.3. |
| 6 | Sub-Total Fixed Assets. Sum of lines 4 and 5. |
| 7 | Cash. The surplus year-end balance indicated on line 12 of Table 12.6, less line 8 below, plus line 11 below. |
| 8 | Accounts Receivable. Estimated at 25 percent of total revenues. |
| 9 | Total Assets. Sum of lines 6 to 8. |
| 10 | Liabilities and Net Worth. Heading for lines 11 to 18. |
| 11 | Accounts Payable. Estimated at 1-1/2 month's cost less salaries (0.125 times the sum of line 12 less line 10 of Table 11.3). |
| 12 | Long-Term Loans. The net outstanding debt from line 13 of Table 12.6. |
| 13 | Accumulated Depreciation on Customer Services. From line 8, Table 12.4. This represents a fund for replacement of services as needed. |
| 14 | Total Liabilities. Sum of lines 11 to 13. |
| 15 | Capital Contribution. The depreciated value of the existing facilities as of 1978 plus projects-in-progress, by year, through 1982. Value includes facilities and land minus depreciation on these facilities (not including service connections) from Table 12.1. |
| 16 | Earned Surplus (Deficit). Line 17 less line 15 (balancing factor). |
| 17 | Net Worth. Line 9 less line 14. |
| 18 | Total Liabilities and Net Worth. Sum of lines 14 and 17. |

TABLE 12.8

SCA WATER TARIFF SCHEDULE

1978 milliemes/cu m

| | |
|---|---|
| Transiting Ships(1) | 100 |
| Port Said Free Zone | 35 |
| Outside City Limits | 30 |
| Domestic Use(2) | 18 |
| Hotels | 18 |
| Private Business | 18 |
| SCA | 9 |
| Public Fountains(3) | 6 |
| Religious Institutions(4) | 6 |
| Government Buildings | 6 |
| Schools, Hospitals | 6 |
| Trade Unions, Political Offices | 4.5 |
| Street Washing | 3.9 |

(1) Price to Ships Supply Company. Resale to ships at LE 0.25/cu m.
(2) Public housing tenants pay LE 0.20 or LE 0.30/mo. depending on flat size. We estimate this recovers less than 75% of potential revenue at the regular rates.
(3) First eight cu m daily is free.
(4) After 1,800 cu m per year, 18 milliemes.

Sources: USAID, Egypt: Canal Cities Water and Sewerage, Project Paper Annex Mc. PSMP Volume 6, Table 2.5.1

# TABLE 12.9

## DEBT SERVICE FINANCING
## (All Values in Thousands of LE)

| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Amount of Loan(1) | 528 | 7,725 | 7,071 | 6,944 | 4,950 | 5,690 | 15,204 | 21,486 | 23,098 | 8,774 | 9,927 | 11,190 | 4,300 | 4,887 | 4,893 | 5,549 | 6,634 | 7,171 | 7,260 | 12,149 | 13,986 | 14,706 |
| Amortization(2) | - | - | - | - | 26 | 413 | 766 | 1,113 | 1,361 | 1,645 | 2,406 | 3,480 | 4,635 | 5,074 | 5,570 | 6,129 | 6,344 | 6,589 | 6,833 | 7,131 | 7,481 | 7,822 |
| Interest(3) | - | 32 | 405 | 919 | 1,335 | 1,607 | 1,902 | 2,748 | 3,955 | 5,242 | 4,624 | 6,011 | 6,405 | 6,358 | 6,317 | 6,243 | 6,220 | 6,223 | 6,243 | 6,251 | 6,531 | 6,900 |
| TOTAL DEBT SERVICE(4) | | 32 | 495 | 919 | 1,361 | 2,020 | 2,668 | 3,861 | 5,316 | 6,887 | 8,030 | 9,491 | 11,040 | 11,432 | 11,887 | 12,372 | 12,564 | 12,812 | 13,076 | 13,382 | 14,012 | 14,722 |
| Operations & Maintenance(5) | 1,266 | 1,556 | 2,581 | 2,310 | 2,495 | 2,843 | 3,208 | 3,583 | 3,951 | 4,345 | 4,784 | 5,266 | 5,791 | 6,334 | 6,891 | 7,489 | 8,154 | 8,884 | 9,651 | 10,599 | 11,051 | 11,531 |
| TOTAL EXPENSES | 1,266 | 1,588 | 3,076 | 3,229 | 3,856 | 4,863 | 5,876 | 7,444 | 9,267 | 11,233 | 12,814 | 14,757 | 16,831 | 17,776 | 18,778 | 19,861 | 20,718 | 21,696 | 22,727 | 23,981 | 25,063 | 26,253 |
| Required Cash(6) | 211 | 265 | 513 | 538 | 643 | 811 | 979 | 1,241 | 1,545 | 1,872 | 2,136 | 2,460 | 2,805 | 2,961 | 3,130 | 3,310 | 3,453 | 3,616 | 3,788 | 3,997 | 4,177 | 4,376 |
| Additions to Cash | 211 | 54 | 248 | 25 | 105 | 168 | 168 | 262 | 304 | 327 | 264 | 324 | 345 | 156 | 169 | 180 | 143 | 163 | 172 | 209 | 180 | 199 |
| Revenue from Service Conn(5) | 23 | 471 | 347 | 403 | 481 | 539 | 593 | 780 | 834 | 893 | 955 | 1,022 | 977 | 1,050 | 1,124 | 1,202 | 1,286 | 1,365 | 1,467 | 1,569 | 1,679 | 1,797 |
| Req. Revenue from Water Charge | 1,454 | 1,171 | 2,977 | 2,851 | 3,480 | 4,492 | 5,451 | 6,926 | 8,737 | 10,667 | 12,123 | 14,059 | 16,199 | 16,872 | 17,823 | 18,839 | 19,575 | 20,494 | 21,432 | 22,621 | 23,564 | 24,655 |
| Water Sold, $10^6$ x cu m | 27.0 | 29.0 | 21.0 | 32.7 | 34.6 | 36.5 | 38.9 | 41.0 | 43.5 | 46.0 | 48.5 | 51.5 | 53.5 | 56.0 | 58.5 | 60.8 | 63.0 | 66.0 | 68.5 | 71.0 | 73.4 | 75.8 |
| Req. Rate, LE/cu m | .054 | .040 | .142 | .087 | .101 | .123 | .140 | .169 | .201 | .232 | .250 | .273 | .303 | .301 | .305 | .310 | .311 | .311 | .313 | .319 | .321 | .325 |

(1) Total capital cost, including inflation, from Table 12.10.
(2) 5% of cum. loans, 4-23 yrs.
(3) 6% of outstanding balance.
(4) Interest plus amortization.
(5) From Table 12.10.
(6) Two months of total expenses.

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# TABLE 12.10

## OPERATING STATEMENTS 1979-2000
## DEFICIT FINANCING BASIS
## (Thousands of LE)

| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rate of Inflation | | | | | | | | | | | | | | | | | | | | | | |
| Local | 20% | 19% | 18% | 16% | 14% | 12% | 10% | 8% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% |
| Foreign | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% | 7% |
| Capital Outlays (1) | | | | | | | | | | | | | | | | | | | | | | |
| Local 1978 LE | 175 | 2,396 | 2,795 | 2,438 | 1,877 | 1,935 | 4,754 | 6,152 | 6,173 | 2,121 | 2,208 | 2,261 | 884 | 925 | 898 | 976 | 977 | 1,051 | 950 | 1,317 | 1,451 | 1,528 |
| Inflated | 210 | 3,421 | 4,710 | 4,765 | 4,183 | 4,829 | 13,051 | 18,240 | 19,583 | 7,200 | 8,025 | 8,787 | 3,676 | 4,116 | 4,275 | 4,927 | 5,326 | 6,130 | 5,929 | 8,794 | 10,367 | 10,918 |
| Foreign 1978 LE | 297 | 3,759 | 1,927 | 1,662 | 547 | 574 | 1,341 | 1,889 | 1,912 | 800 | 906 | 1,067 | 259 | 299 | 224 | 331 | 319 | 308 | 368 | 867 | 874 | 885 |
| Inflated | 318 | 4,304 | 2,361 | 2,179 | 767 | 861 | 2,153 | 3,246 | 3,515 | 1,574 | 1,907 | 2,403 | 624 | 771 | 618 | 977 | 1,008 | 1,041 | 1,331 | 3,355 | 3,619 | 3,788 |
| Operation & Maintenance (2) | | | | | | | | | | | | | | | | | | | | | | |
| Local 1978 LE | 701 | 681 | 1,145 | 802 | 774 | 809 | 843 | 877 | 906 | 934 | 960 | 988 | 1,035 | 1,062 | 1,083 | 1,102 | 1,125 | 1,146 | 1,164 | 1,192 | 1,219 | 1,245 |
| Inflated | 841 | 972 | 1,929 | 1,568 | 1,725 | 2,019 | 2,314 | 2,600 | 2,874 | 3,170 | 3,487 | 3,840 | 4,304 | 4,725 | 5,156 | 5,614 | 6,132 | 6,684 | 7,264 | 7,960 | 8,140 | 8,314 |
| Foreign 1978 LE | 397 | 510 | 532 | 566 | 549 | 549 | 557 | 572 | 586 | 598 | 616 | 633 | 617 | 624 | 629 | 635 | 640 | 651 | 660 | 682 | 703 | 726 |
| Inflated | 425 | 584 | 652 | 742 | 770 | 824 | 894 | 983 | 1,077 | 1,176 | 1,297 | 1,426 | 1,487 | 1,609 | 1,735 | 1,875 | 2,022 | 2,200 | 2,387 | 2,639 | 2,911 | 3,217 |
| TOTAL EXPENSES (w/inflation) | 1,794 | 9,381 | 9,652 | 9,254 | 7,445 | 8,533 | 18,412 | 25,069 | 27,049 | 13,120 | 14,711 | 16,456 | 10,090 | 11,221 | 11,784 | 13,438 | 14,448 | 16,066 | 16,911 | 22,748 | 25,037 | 26,237 |
| Required Cash (3) | 299 | 1,564 | 1,609 | 1,542 | 1,241 | 1,422 | 3,069 | 4,178 | 4,508 | 2,187 | 2,452 | 2,743 | 1,682 | 1,870 | 1,964 | 2,240 | 2,408 | 2,678 | 2,819 | 3,791 | 4,173 | 4,373 |
| Additions to Cash | 299 | 1,265 | 45 | (67) | (301) | 182 | 1,647 | 1,109 | 330 | (2,321) | 265 | 291 | (1,061) | 188 | 94 | 276 | 168 | 270 | 141 | 972 | 382 | 200 |
| Revenues (4) | | | | | | | | | | | | | | | | | | | | | | |
| Water Sold, cu m x $10^6$ | 27.0 | 29.0 | 31.0 | 32.7 | 34.6 | 36.5 | 38.9 | 41.0 | 43.5 | 46.0 | 48.5 | 51.5 | 53.5 | 56.0 | 58.5 | 60.8 | 63.0 | 66.0 | 68.5 | 71.0 | 73.4 | 75.8 |
| Water Revenues | 486 | 522 | 558 | 589 | 623 | 657 | 700 | 738 | 783 | 828 | 873 | 927 | 963 | 1,008 | 1,058 | 1,094 | 1,134 | 1,188 | 1,233 | 1,278 | 1,321 | 1,364 |
| Serv. Conn. Revenues | 23 | 471 | 347 | 403 | 481 | 539 | 593 | 780 | 834 | 893 | 955 | 1,022 | 977 | 1,050 | 1,124 | 1,202 | 1,286 | 1,365 | 1,467 | 1,569 | 1,679 | 1,797 |
| TOTAL REVENUE | 509 | 993 | 905 | 992 | 1,104 | 1,196 | 1,293 | 1,518 | 1,617 | 1,721 | 1,828 | 1,949 | 1,940 | 2,058 | 2,182 | 2,296 | 2,420 | 2,553 | 2,700 | 2,847 | 3,000 | 2,161 |
| DEFICIT | 1,584 | 9,553 | 8,792 | 8,195 | 6,020 | 7,519 | 18,766 | 24,620 | 25,762 | 9,078 | 13,148 | 14,798 | 7,089 | 9,351 | 9,696 | 11,418 | 12,236 | 13,772 | 14,352 | 20,873 | 22,419 | 23,276 |

(1) From Table 11.2
(2) From Table 11.3. O&M costs on mechanical equipment considered foreign. Foreign/local split on distribution system O&M based on foreign/local split for capital cost of distribution system, Table 11.2.
(3) Two months of total expenses.
(4) Water revenues calculated at LE 0.018/cu m. Service connection revenues equal to capital cost of service connection (Table 11.1), adjusted by local inflation rate.

CHAPTER 13

# ECONOMIC AND ENVIRONMENTAL CONSIDERATIONS

## 13.1 INVESTMENT PERSPECTIVE

As part of the overall effort to reconstruct and expand Egypt's vital physical infrastructure, the Port Said Water and Wastewater Facilities Master Plan will require substantial investment.

Investment in new infrastructure has not kept pace with social and economic needs. Funds for regular maintenance work have been totally inadequate for upkeep of existing systems. An additional problem for the canal cities is the damage still remaining from the 1967 and 1973 wars.

Water and wastewater projects must compete nationally with projects which address other infrastructure needs. Moreover, the needs of Port Said must compete with those of other cities and regions. This section summarizes surveys of infrastructure needs in Egypt reported by others.

### Five Year Plan

A five year plan for 1978-82 was prepared by the Ministry of Planning. The plan calls for a total public investment of LE 10 billion, or about LE 2 billion per year. As shown in Table 13.1, about six percent, or LE 125 million, is allocated annually to utilities, presumably water and sewerage. By comparison, 1976 utilities investments (also calculated at 1977 price levels) amounted to LE 45 million.(1) During the previous decade (1966-75), public investment in utilities ranged from LE 2.5 to LE 16.4 million.(2)

### WHO/World Bank Needs Projection

Projections by the WHO/World Bank Cooperative Program of annual water and sewerage financing needs through the year 2000 are presented in Table 13.2.

The level of investment need identified for the 1978-82 period is only LE 85 million per year, significantly below that in the Five Year Plan.

Table 13.3 presents a breakdown of these utility needs by location; Cairo is allocated 36 percent, rural projects 17 percent, Alexandria 11 percent and for all other cities together 36 percent.

### Adequacy of Needs Projections

The Port Said share of the above need projections may be inferred on a population basis. Table 13.4 compares Port Said population and growth figures from this report with projected figures for total Egypt, total urban, and total urban less Greater Cairo and Alexandria.

(1) World Bank, Economic Management in a Period of Transition, Vol. 5, Table 17-1.
(2) WHO/World Bank Cooperative Program, Water Supply and Sewage Sector Study, Vol. 2, pages 78-79, June 1977.

Based on its proportion of urban population growth for 1980-85, the Port Said share of the 1978/82 Five Year Plan projected investment in utilities (Table 13.1) would amount to LE 10.0 million, or LE 2.0 million per year. This covers a bit over half of the costs for the High Priority and Immediate Phase water programs. It would be totally inadequate for both water and wastewater.

Based on its population growth for the period 1986-2000, the Port Said share of the WHO/World Bank water needs projection in Table 13.2 would be 0.83 million/yr.

At 1978 cost levels, the recommended program involves capital outlays totaling LE 15,540,000 between now and 1982, and a capital outlay of 52,208,000 (averaging LE 2,900,000 per yr) from 1983 through the year 2000. Even if adjusted to 1978 cost levels, the Five Year Plan and WHO/World Bank projections appear very low in relation to these Port Said needs. A new national needs projection, based on current water and wastewater master plans should be prepared.

Priority Assessment

In making public capital investment decisions, the central government is faced with competing demands between various sectors and local areas. Priority may be expected for projects which can be financed by their own revenues or those which provide sufficient general benefits to the overall economy. In developing countries, charges are often set too low to provide adequate revenues, reflecting a judgment that charges high enough to provide self-financing would impose an undue burden on much of the population. Applying this judgment often results in under financing and inferior service.

In Section 13.2, below, an assessment is made of whether or not the Port Said water utilities can be financed from user charges. General economic benefits, as a basis for justifying any portion of the recommended program, are assessed in Section 13.3. Section 13.4 includes a number of environmental benefits which cannot be assessed in quantitative economic terms. This latter section also considers adverse effects of the program and defines required commitments of resources.

The assessment is made for the program as whole, since only one element - the raw water storage reservoir - could be deferred without reducing the level of storage on a day-to-day basis. This deferral would eliminate capital outlays by LE 3,900,000, lowering water costs by about LE 0.01/cu m in the early years of the program.

Deferral of other program elements would lead to poor service to existing customers or require denial of service to new developments. It is important to note that customer meters, representing an investment of over LE 2,000,000 during the planning period, will be of little benefit to the system unless rates are high enough to discourage waste. In the absence of adequate user charges, funds allocated to metering might better be diverted to production and distribution capacity to meet the demands resulting from more waste.

## 13.2 COSTS TO SYSTEM USERS

A breakdown of projected water use by consumer category is shown in Table 13.5. As would be expected, the largest category is domestic, representing over 60 percent of water use from 1982 through 2000. Industry accounts for up to 27 percent; institutional (government) about 10 percent; and public taps and gardens 5 to 6 percent.

As noted in Chapter 12, an average charge of LE .100/cu m (1978 LE) could provide adequate financing for the water system through the year 2000. The details of any future rate structure fall under the scope of the National Management and Tariff Study, now being carried out for the ACR. We propose here to assess the impact of the above average charge on different consumer categories, particularly domestic users.

In this analysis we assume that the high water users correspond to the highest income group; the medium water users to the middle income group; and the low water users to the lowest income group. Such a correspondence can reasonably be expected where water is sold at true cost, and individual consumers see their water use reflected in the bill they receive. If any subsidy is provided to users, it should apply only to a limited quantity of water representing basic needs. Otherwise any relation between water use and income level would break down.

Demand forecasts for the WWFMP are based on increasing water consumption within each domestic water use class, and on an increasing proportion of the population in the higher use classes. Individual figures are as follows:

| Use Class | Percent of Population | | Per Capita Use lcd | |
|---|---|---|---|---|
| | 1977 | 2000 | 1977 | 2000 |
| High | 20 | 30 | 250 | 275 |
| Medium | 40 | 40 | 170 | 195 |
| Low | 40 | 30 | 85 | 110 |

Table 13.5 shows that by the year 2000 the high water use class - presumably the group best able to pay - will account for the largest single portion of total water consumption: 26 percent.

Figure 13-A shows present and projected year 2000 income distributions based on estimates in the PSMP, updated to 1978 LE. Income ranges corresponding to high, medium and low water use are identified, based on the assumption that water use varies with income. Presumably the PSMP income projections relate to the employment forecast in the PSMP. Under better economic conditions, where structural unemployment is reduced or eliminated, it would be reasonable to expect average incomes to be even higher. If its urban economy prospers, incomes in Port Said should average higher than in other cities in Egypt simply because Port Said has no rural fringe areas where people growing their own food could subsist on very low incomes.

For each water use class, typical household annual water charges are projected in Table 13.6 and relate to income. Household water costs were based on a unit charge of LE 0.10/cu m. Incomes were based on PSMP projections, assuming the relation of water use to income outlined above. Average household size was taken to be 4.6 in 1978 and 4.4 in the year 2000, following PSMP projections.

At 1978 consumption and income levels, annual water charges for the low water use class would range from 2.6 to 5.6 percent of household income. Ranges for the higher water use classes would be from 1.0 to 4.4 percent. Since household income is expected to increase more rapidly than household water consumption during the period 1978-2000, the proportion of income represented by water charges is expected to decrease. By the year 2000, water charges would range between 0.8 and 4.2% of household income.

A substantial portion of water consumption (32% at the lowest water use level) is attributable to waste. If waste were reduced, water charges would decrease even further.



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The charge for water actually used, excluding wastage, amounts to 3.8% of household income for the lowest income group in 1978, decreasing to 3.0% by 2000.

Based on figures for systems in other developing countries, we judge that the proposed unit charge for water is reasonable and within the ability of Port Said residents to pay.

Among bases for this judgment we note the following:

- Recently planned water improvements for a number of Middle Eastern and African cities are to be self-financed at rates equivalent to more than U.S. $0.30/cu m, much higher than the equivalent of the proposed Port Said rates (LE 0.10 = U.S. $0.14), as shown:

| | U.S. %/cu m (1978) |
|---|---|
| Amman, Jordan | 0.76(1) |
| Mombasa, Kenya | 0.55(1) |
| Mogadishu, Somalia | 0.48(1) |
| Taiz, Yemen | 0.44(2) |
| Nairobi, Kenya | 0.33(1) |
| Blantyre, Malawi | 0.29(1) |

- At present rates, bills in the Taiz system amount to 2 to 4 percent of income. The proposed rate will increase this range to from 3 to 6 percent of income.

- Information from the World Bank indicates that 5 percent of household income is commonly regarded by funding agencies as a reasonable maximum for water bills of the lowest income group in developing countries.

Proper water supply is an essential service. Failure to levy adequate charges is likely to result in a level of service below what the public wants and would willingly support.

Table 13.7 shows the impact of the proposed average water charge on several existing industrial establishments in Port Said. Annual water costs, based on present consumption are compared with estimated current salary costs based on compensation figures in Table 13.8. (These figures are results of a survey of private sector business primarily in Cairo. No comparable results are available for Port Said in particular but the figures are likely to be applicable.) For almost all of the industries, water bills would represent only a small fraction of operating costs. The exceptions are slaughtering and food processing operations with high water use and very small staffs.

## 13.3 ECONOMIC BENEFITS

For many types of infrastructure investment - particularly in transportation economic benefits are both identifiable enough and sufficiently quantifiable so that user

(1) DeAnne Julius, Project Economist, Department of Energy, Water and Telecommunication, IBRD, Personal Communication.
(2) Water and Wastewater Tariff Study, Taiz, Yemen, prepared for USAID by Deloitte, Haskins and Sells, September 1977.



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charges may be reduced or eliminated. This is not the case in Port Said. Reliance on general economic benefits to justify the investment and eventual recurrent costs would risk under-financing the system.

The major types of general economic benefits which might be assigned to the WWFMP are enhancement of real estate values, increases in health-related industrial productivity and additional tourist earnings. Each of these benefits will be considered in the context of Port Said.

Real estate values are enhanced by location as well as by the improvement in any aspect of the infrastructure (water and wastewater, electricity, transportation) and environmental considerations such as quiet, clean air, or an attractive view and setting. A building supplied with water and wastewater services obviously has a higher value than a building without these advantages. In Port Said, where the WWFMP applies to the entire city, there is no relative advantage. Rent will be determined by the play of supply and demand for different types of real estate.

An additional consideration is that utilities are only one aspect of an infrastructure which is being upgraded in its entirety. Attributing a specific amount of increase in value to improved water supply, or to improved electrical supply, is not possible. Benefits which accrue to real estate values from utilities are "captured" by the utilities companies in the form of appropriate user charges on domestic and industrial users. To add economic benefits to user charges would therefore be double counting.

Improvement in utilities may lead to a reduction of work days lost due to water-related sickness. If the resulting increase in productivity were defined, it could possibly be captured by higher industrial user charges. However, a large share of the work force in Port Said is either self-employed in the formal sector or employed in service industries where productivity cannot be measured. Any effort, therefore, to ascribe economic benefits to increased output resulting from an improved water system would be theoretical.

Additional tourist earnings would depend on many factors of which proper water supply is only one. Again, attributing portions of benefits to specific infrastructure improvements would be quite arbitrary. There would also be major questions as to how the benefits should be "captured" for the support of specific infrastructure.

In sum, there appear to be no general benefits to the Egyptian economy which, in the absence of adequate user charges, would justify the proposed investment. By the same token, it is not likely that such general economic benefits could be found to justify priority investment in utilities for any other cities in Egypt.

## 13.4 ENVIRONMENTAL CONSIDERATIONS

### General

Adequate water supply is important in promoting industrial, commercial, and tourism activity.

Benefits of expanding such activity presumably will be reflected in water charges. This section considers the more general environmental and health benefits of the recommended program of water system improvements, together with whatever adverse effects may be expected.



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## Benefits

A continuous supply of adequately treated water is critical to the protection of a community from water-borne diseases. The availability, reliability and quality of the water encourages better and more frequent hygienic practices.

In Port Said, daily interruptions in water service have occurred in recent years. In July, 1978, isolation of a leaking siphon enabled 24-hour service to be restored (see Section 4.1). If the recommended projects are not implemented as needed, intermittent water service will soon be forced on the users of the system again. Reduced pressures and service interruptions may cause back siphonage of polluted water into the distribution system. Lack of continuous service also induces such practices as storing water in improper containers and manual delivery of water. These practices increase the possibility of contamination.

Health records for Port Said show high rates of parasitic and gastro-intestinal disorders (see Tables 2.7 and 2.8). Even where not transmitted directly by the water system, disease can result from inadequate water service. The incidence of these diseases rises markedly in the summer when the water requirements of Port Said reach their annual peak and water shortages are most likely to occur. With the increased population projected for Port Said, the potential for disease transmission will increase significantly. An adequate water supply is a key factor in efforts to reduce the incidence of disease in Port Said. Though difficult to quantify, the economic benefits of better health can be easily recognized, both in worker productivity and in reduced medical costs.

In addition to improved health, the program will also provide aesthetic benefits, such as sufficient water for parks, fountains and other public amenities.

## Adverse Effects

Direct adverse effects of the recommended water system projects will be limited to the period of construction. These effects consist of disruption of traffic and possible temporary relocation of some commercial activities, as well as noise and dust associated with construction activities. The adverse effects are temporary, and the city will return to normal following completion of the projects.

Long term indirect environmental effects must be expected from the development which the improved water system permits. Keeping development within the framework of the Port Said Master Plan should minimize any potential long term adverse effects.

Increased water consumption will result in higher wastewater flows and greater system capacity requirements. It is anticipated that the sewerage improvements will minimize the impact of the increased wastewater quantities.

Potential air pollution or problems with toxic materials from increased industrial development will require specific controls.

## Compatability with Long Range Planning

Evaluation of the water system projects took into account long term goals as presented in the PSMP. Of special interest is the planned expansion of tourist facilities. Without proper water supply, promoting use of new tourist facilities in Port Said would be extremely difficult.

Other Environmental Considerations

The recommended projects require a considerable and irretrievable outlay of funds which will not be available for other potential beneficial projects. Other commitments of resources are primarily limited to construction materials. If no new raw water canal is built, there will be no significant commitment of land resources. All proposed water treatment additions are located at the existing plant site. Pipeline construction will be in existing or planned streets or rights-of-way.

The proportion of Nile River water required for Port Said will increase, but Port Said's needs in the year 2000 will still represent only about 0.2 percent of the average Nile flow of 150 million cu m/d.

## 13.5 CONCLUSION

Although the benefits cannot be quantified, the necessity for a safe, adequate water supply system is beyond question. The benefits accrue locally rather than to the country as a whole. Hence the system costs should ultimately be borne locally. The benefits can be "captured" for support of the system through a system of user charges. The charges required for proper support of the system would be over five times those presently imposed for water service.

Users of the system should be made aware of the cost of water and discouraged from wasting it. There are major obstacles to such awareness in a system where most households do not pay individually metered water bills. Metering individual dwelling units appears neither practical nor cost effective, but adequate rates would at least impress the need for water conservation on those responsible for paying the bills for particular connections. These people in turn could be expected to promote proper maintenance of fixtures and wiser use by the ultimate consumers.



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TABLE 13.1

PLANNED PUBLIC INVESTMENT 1978 - 1982

(LE Million)

| | Total Investment | Annual Average | % |
|---|---|---|---|
| Total | 10,175(1) | 2,035 | 100 |
| Agriculture | 396 | 79 | 4 |
| Irrigation & Drainage | 483 | 96 | 5 |
| Industry | 2,413 | 483 | 24 |
| Petroleum | 562 | 112 | 5 |
| Electricity | 924 | 185 | 9 |
| Construction | 214 | 43 | 2 |
| Transportation & Communication | 2,307 | 461 | 23 |
| Suez Canal | 475 | 95 | 5 |
| Commerce & Finance | 226 | 45 | 2 |
| Housing | 585 | 117 | 6 |
| Utilities | 623(2) | 125 | 6 |
| Services | 978 | 195 | 9 |

(1) Foreign exchange component calculated at incentive rate would add LE 3,057 million to total cost.
(2) LE 902 million if adjusted to 1978 price levels with foreign exchange component calculated at the incentive rate.

Source: World Bank, Economic Management in a Period of Transition, Vol. 1, Table 5-4. At 1977 prices.

TABLE 13.2

WATER AND WASTEWATER EXPENDITURE REQUIREMENTS FORECAST
(Millions of 1976 LE)

| Annual Expenditure | Total | Water | Sewerage |
|---|---|---|---|
| 1976 | 81 | 52 | 29 |
| 1977 | 83 | 49 | 34 |
| 1978 | 78 | 46 | 32 |
| 1979 | 72 | 38 | 34 |
| 1980 | 53 | 31 | 22 |
| 1981-1985 | 109 | 59 | 50 |
| 1986-2000 | 127 | 63 | 64 |

Source: WHO/World Bank Cooperative Program, Water Supply and Sewerage Sector Study, June 1977, Vol. 2, p. 77. (Assumed 1977 purchasing power)

TABLE 13.3

TOTAL WATER AND WASTEWATER EXPENDITURE REQUIREMENTS FORECAST, 1976-2000
(Millions of 1976 LE)

| | Total | % | Water | Sewerage |
|---|---|---|---|---|
| Total | 2,824 | 100 | 1,461 | 1,363 |
| Rural Projects | 455 | 17 | 455 | - |
| Cairo | 1,030 | 36 | 308 | 722 |
| Alexandria | 314 | 11 | 237 | 77 |
| Other Cities | 1,025 | 36 | 461 | 564 |

Source: WHO/World Bank, Vol. 2, p. 77. Error in original text corrected.

## TABLE 13.4

## PORT SAID POPULATION AND GROWTH COMPARED TO NATIONAL TRENDS

| | Year | | |
|---|---|---|---|
| | 1980 | 1985 | 2000 |
| Port Said Population as Percentage of: | | | |
| Total National Population | 0.7% | 0.8% | 1.0% |
| Total National Urban Population | 1.5% | 1.6% | 1.7% |
| Total National Urban Population excluding Cairo and Alexandria | 3.9% | 4.0% | 4.1% |

| | Period | |
|---|---|---|
| | 1980-1985 | 1986-2000 |
| Port Said Population Growth as Percentage of: | | |
| Total National Population | 1.6% | 1.5% |
| Total National Urban Population | 1.8% | 1.8% |
| Total National Urban Population excluding Cairo and Alexandria | 4.2% | 4.2% |

## TABLE 13.5

## WATER CONSUMPTION FORECAST, PORT SAID

| Consumer Category | 1977 Million cu m/yr | 1977 % Consumption | 1982 Million cu m/yr | 1982 % Consumption | 2000 Million cu m/yr | 2000 % Consumption |
|---|---|---|---|---|---|---|
| Domestic | 17.7 | 68 | 23.1 | 64 | 52.3 | 62 |
| High Water Use | 5.8 | 22 | 7.8 | 22 | 21.9 | 26 |
| Medium Water Use | 7.8 | 30 | 10.2 | 28 | 20.8 | 25 |
| Low Water Use | 4.1 | 16 | 5.1 | 14 | 9.6 | 11 |
| Industry/Tourism | 4.4 | 16 | 7.2 | 21 | 18.5 | 22 |
| General Industry | 2.3 | 9 | 4.5 | 12 | 12.9 | 15 |
| Shipyard | 1.1 | 4 | 1.3 | 4 | 2.8 | 4 |
| Tourism | 0.3 | 1 | 0.5 | 2 | 1.2 | 1 |
| Ships | 0.4 | 1 | 0.5 | 2 | 1.1 | 1 |
| Port | 0.3 | 1 | 0.4 | 1 | 0.5 | 1 |
| Institutional | 2.8 | 11 | 3.5 | 9 | 8.9 | 11 |
| Taps and Gardens | 1.3 | 5 | 2.3 | 6 | 4.6 | 5 |
| TOTAL* | 26.2 | 100 | 36.1 | 100 | 84.3 | 100 |

*Metered consumption including wastage.

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TABLE 13.6

PROJECTED WATER CHARGES(1) AS PERCENT OF ESTIMATED HOUSEHOLD INCOME

| Domestic Water Use Class | 1978 | | | 2000 | | |
|---|---|---|---|---|---|---|
| | Annual Income(2) | Annual Water Charges | | Annual Income(2) | Annual Water Charges | |
| | LE (1978) | LE (1978) | % of Income | LE (1978) | LE (1978) | % of Income |
| Low | 376-800 | 21 | 2.6-5.6 | 580-1150 | 24 | 2.1-4.2 |
| Medium | 800-1150 | 35 | 3.1-4.4 | 1150-1560 | 38 | 2.4-3.3 |
| High | 1150-4980 | 49 | 1.0-4.2 | 1560-6620 | 51 | 0.8-3.2 |

(1) Per household, based on unit charge of LE .100/cu m, water use as shown in Section 13.2, wastage of 40 lpcd, and average household size as given in PSMP, Vol. 3, p. 37.
(2) See Figure 13-A.

## TABLE 13.7

## INDUSTRY WASTEWATER COST AS PERCENT OF SALARY COST

| | Water Use | | Employees | | Water Cost as % of Salary Cost |
|---|---|---|---|---|---|
| | cu m(1) | Cost (LE)(2) | No. | Salary (LE)(3) | |
| Portex/Thick Cover | 84,376 | 8,438 | 1,400 | 2,353,000 | X |
| Slaughterhouse | 52,252 | 5,225 | 27 | 45,360 | 12 |
| El Nasr Dehydration | 44,507 | 4,451 | 150 | 252,000 | 2 |
| Egyptian Milling | 21,422 | 2,142 | 70 | 117,600 | 2 |
| Canal Rope Co. | 21,110 | 2,111 | 600 | 1,008,000 | X |
| Edfina | 17,904 | 1,790 | 140 | 235,000 | 1 |
| El Nasr Salines | 9,963 | 996 | 300 | 504,000 | X |
| Ice Company | 9,591 | 959 | 45 | 75,600 | 1 |
| Defres "Fina" | 9,092 | 909 | 200 | 336,000 | X |
| Gereco Freezing Co. | 9,076 | 908 | 15 | 25,200 | 4 |
| Egyptian Tea Co. | 7,773 | 777 | 250 | 420,000 | X |

(1) See Table 4.1.
(2) At rate of LE 0.100/cu m.
(3) LE 1,680/yr average salary, based on private industry compensation (Table 13.8).
X Less than 1%.

TABLE 13.8

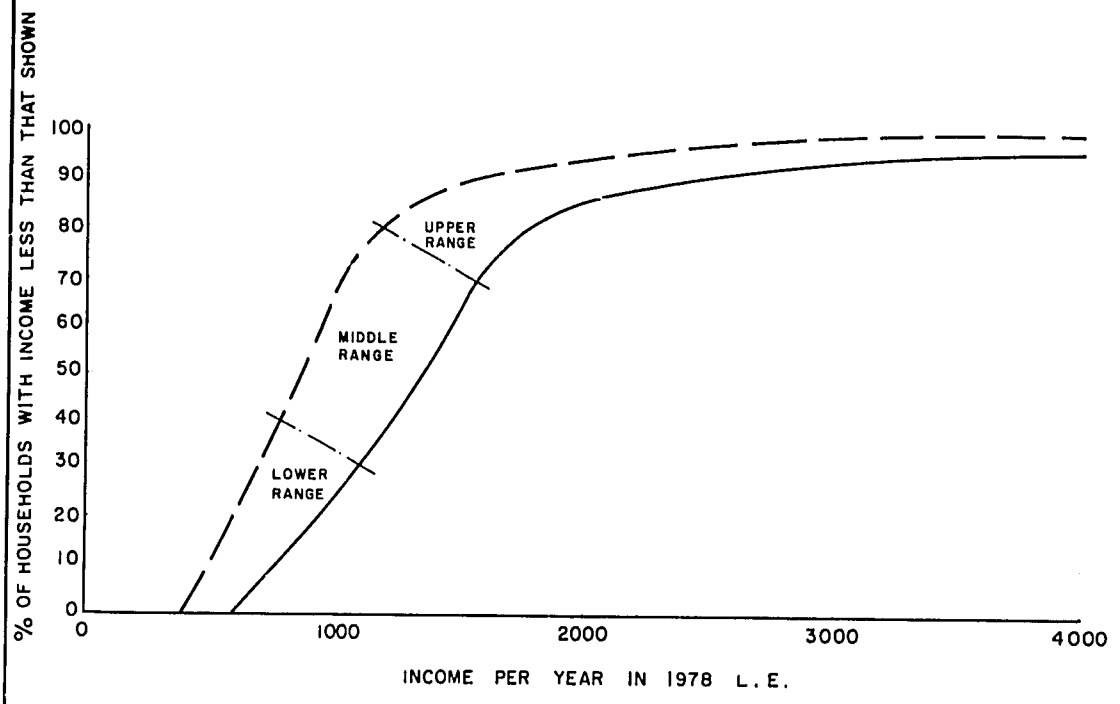
AVERAGE ANNUAL COMPENSATION IN PRIVATE SECTOR

CAIRO AREA

(LE)

| | Salary | Plus Bonuses & Overtime | Plus Company Benefits |
|---|---|---|---|
| **Categories** | | | |
| Managers | 4,416 | 5,244 | 6,636 |
| Professionals | 2,220 | 2,544 | 3,300 |
| Skilled Clerical | 3,156 | 3,648 | 4,644 |
| Skilled Technical | 1,716 | 2,160 | 2,688 |
| Semi-Skilled Clerical | 1,308 | 1,608 | 2,112 |
| Semi-Skilled Technical | 1,140 | 1,644 | 2,256 |
| Unskilled | 660 | 972 | 1,608 |
| **Positions** | | | |
| Financial Mgr/Controller | 5,214 | 5,542 | 7,397 |
| Administration Manager | 4,644 | 5,459 | 6,645 |
| Sales Manager | 6,342 | 6,905 | 7,833 |
| Economist | 3,970 | 4,269 | 4,510 |
| Mechanical Engineer | 3,078 | 4,147 | 5,374 |
| Chemist | 1,974 | 2,065 | 3,600 |
| Accountant | 2,232 | 2,533 | 2,905 |
| Secretary | 2,146 | 2,433 | 2,709 |
| Skilled Draftsman | 2,436 | 2,555 | 3,017 |
| Skilled Electrician | 1,770 | 2,332 | 3,097 |
| Skilled Mechanic | 1,236 | 1,359 | 2,695 |
| Senior Salesperson | 2,127 | 2,315 | 3,823 |
| Clerk, General | 1,413 | 1,513 | 1,990 |
| Typist | 1,378 | 1,531 | 1,863 |
| Semi-Skilled Mechanic | 882 | 1,600 | 2,356 |
| Semi-Skilled Electrician | 768 | 1,425 | 2,181 |
| Factory/Lab Worker | 576 | 665 | 1,394 |

Source: Copyright Middle East Advisory Group, Survey of Personnel Policies and Salary Levels, December 1978. Used by permission.




| INCOME RANGE | 1978 | | 2000 | |
|---|---|---|---|---|
| | % OF HOUSEHOLDS | INCOME LE/yr | % OF HOUSEHOLDS | INCOME LE/yr |
| UPPER | 20 | 1150-4980 | 30 | 1560-6690 |
| MIDDLE | 40 | 800-1150 | 40 | 1150-1560 |
| LOWER | 40 | 376-800 | 30 | 580-1150 |

* ASSUMING UPPER INCOME RANGE DEFINED BY HIGH WATER USE LEVEL MIDDLE RANGE BY MEDIUM USE, ETC (PERCENT OF HOUSEHOLDS AT EACH WATER USE LEVEL IS THAT ASSUMED IN FORECASTING WATER DEMAND).

LEGEND:

— — — YEAR 1978

——— YEAR 2000

SOURCE : ADAPTED FROM PSMP VOL.4 TABLE 8, P 155.

**ARAB REPUBLIC OF EGYPT**

MINSTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION

PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

HAZEN AND SAWYER
ECG · ENGINEERING CONSULTANTS GROUP

INCOME DISTRIBUTION

VOL.2
FIG.
13-A

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# APPENDIX A

# DESIGN CRITERIA AND STANDARDS

APPENDIX A

DESIGN CRITERIA AND STANDARDS

## A. WATER FACILITIES

Assessment of the adequacy of existing water treatment at El Raswa and of the distribution system, and the sizing and costing of additional works, were based upon commonly accepted criteria for facilities of this type, as follows:

1. Rapid sand filtration including coagulant feed, rapid mixing, coagulation, sedimentation, single media filtration, and chlorination:

Coagulant mixing - $G^*$ = 700 to 900 at point of application

Coagulation - $GT^*$ = 40,000 to 100,000, and detention between 20 and 40 minutes

Filtration - Media effective size ($D_{10}$) 0.3 to 1.0 mm, uniformity coefficient ($D_{60}/D_{10}$) 1.3 to 1.7, filtration rate between 120 and 240 m/day and bed depth 0.60 to 1 m

With multi-media filters (e.g., layer of coarse coal above sand), the pretreatment can be reduced and filtration rate increased.

2. Slow Sand Filtration

Chemical pretreatment usually not required, except where coarse prefilters or roughing filters are installed to reduce slow sand filter loading of algae and turbidity. In any event, algicides and other chemicals must be selected to avoid slow sand filter clogging.

| | |
|---|---|
| Media effective size (D10) | 0.3 mm |
| Media uniformity coefficient | 2 to 3 |
| Filtration rate | 3 to 6 m/day |

3. Chlorination

Prechlorination, if used for better treatment: 2 to 10 mg/l; post chlorination 1-3 mg/l, with contact time not less than 30 min.

4. Demand Factors

Maximum day to average day ratio for sizing raw water pumps and treatment units: 1.25 to 1. Peak hour to average day ratio: 1.7 to 1.

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*G = velocity gradient in reciprocal seconds; T = detention time in seconds.



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5. Fire Flow

30 l/sec in residential areas and 150 l/sec in commercial and industrial areas for 10 hours or about 5000 cu m.

6. Design Flows

Transmission mains, distribution lines and service connections: the peak hourly flow.

7. Design Pressures and Friction Loss

Maximum line pressure: normally not more than 5 kg/sq cm (50 m of water), unless economics justify a higher rating. Minimum pressure at peak flow to maintain pressures in top floors of all buildings which are predominantly 5 and 6 floors: 2 kg/sq cm (20 m of water).

8. Distribution System

a) Material

| | Service Connections | Mains - Diameter in mm 150-400 | above 400 |
|---|---|---|---|
| Asbestos Cement, local | | X | |
| Ductile Iron, cement lined, imported | | | X |
| Polyethylene, imported | X | | |

b) Depth of Piping

| Type of Line | Minimum Cover in m |
|---|---|
| Transmission | 1.0 |
| Distribution | 1.0 |
| Service Connection | 0.6 |

c) Appurtenances

Maximum fire hydrants spacing: 150 m (average area covered by one hydrant - 5000 sq m).

Automatic air and vacuum relief valves at all high points in the system; drain valves at all low points.

Sectionalizing valves as follows: three at crosses, two at tees, one on each fire hydrant branch, and spaced along mains at intervals of not more than 500 m. (Operation will normally be manual, opening counterclockwise).

Thrust blocks at all bends over 7 degrees.

9. Storage

Adequate to meet peak hour variations and fire flow without adjusting output rate of water treatment plant.



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10. Finished Water Pumping

Firm capacity (one of largest units out of service): sufficient, together with ground and elevated storage, to meet peak hourly demands.

11. Pumps

Constant-speed, single-stage, horizontal, split-case, centrifugal-type pumps, with electric motor and two independent power sources. All pumps to be housed in a permanent structure. (See specifications in Appendix D.)

12. Pipe and Friction Formula

Hazen-Williams 'C' coefficients for existing pipe are shown in Table 8.1. Coefficients were chosen to reflect the expected deterioration of pipes of various diameters, ages and materials. The estimates were based on experience with similar systems elsewhere, field measurements, and visual inspection of pipes removed from the system during regular maintenance. For future pipe lines, the following 'C' values are used:

| | Pipe Diameter | 'C' Value |
|---|---|---|
| Asbestos Cement Pipe | 200 | 100 |
| | 300 | 100 |
| | 400 | 110 |
| Cement Lined Ductile Iron | 500 | 115 |
| | 600 | 120 |
| | 800 | 130 |
| | 1000 | 140 |

These values are conservative. The values for future ductile iron pipe are higher than those shown for existing pipe because existing pipe was not cement lined.

B. ELECTRICAL

1. Reliability

a) Two independent sources of power for pumping stations critical to maintaining water supply.

b) Transfer switches or circuit breakers as required to avoid paralleling supply sources.

2. System Voltages

| | |
|---|---|
| New Primary Feeders | 11 KV |
| Feeders from SCA system | 5.5 KV |
| Secondary | 3.3 KV or 380V/220V |

3. Motor and Lighting Voltages

| | |
|---|---|
| Motors over 200 HP | 3.3 KV |
| Motors up to 200 HP | 380 V |
| Lighting, motors less than 2 HP | 220 V (single phase) |



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4. Capacity

Adequate to limit voltage dips due to motor starting requirements, so that the motors will properly accelerate the driven machines and connected loads to rated speed.

System voltage dips and their time duration during start-up of large motors limited to acceptable values so as to prevent tripping of control relays, etc., and to avoid shutting off mercury lighting and other equipment susceptible to voltage dips of long time duration.

Capacity adequate to provide power for future requirements as described in the report.

5. Codes and Standards

Conform to the following codes and standards:

| | |
|---|---|
| IEEE | Institute of Electrical and Electronic Engineers |
| IPCEA | International Power Cable Engineers Association |
| ANSI | American National Standards Institute |
| NEC | National Electrical Code (USA) |
| NEMA | National Electrical Manufacturers Association (USA) |
| IES | Illuminating Engineers Society |

Operate at 50 hz and an ambient temperature of 44°C.

6. Power Distribution

11-KV, 3-phase, 3-wire underground electrical service cables will be used for high voltage distribution.

7. Branch Circuiting

a) 220-V single phase branch circuits for 2 HP and smaller.

b) 380-V, 3 phase circuits for 200 HP and smaller.

c) Lighting and general purpose convenience receptacles - 220-volts, 1-phase service.

d) Copper conductors for all installations except for underground 11-KV primary circuits which shall be aluminum.

e) Rigid galvanized steel conduits except conduits in hazardous and corrosive areas, which shall be rigid galvanized steel with extruded plastic covering.

8. Lighting

Fluorescent lighting fixtures for all interior building locations.

Mercury vapor lighting fixtures for all exterior lighting fixtures. Explosion proof construction and fixtures, complying with established standards, in hazardous and chlorine areas.



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## C. SOILS AND FOUNDATIONS

### 1. Footings

Structures can be founded on spread footings or rafts bearing on the sand stratum beneath the surface clay. Foundation designs should limit differential settlement due to consolidation of the lower clay as follows:

| | |
|---|---|
| Within structures | |
| Steel framed | 2.5 cm |
| Concrete | 1.25 cm |
| Between pipes and structures | 5.0 cm |

(Use flexible pipe connections into buildings to accommodate expected differential settlement.)

### 2. Bearing Pressures

For the WWFMP - 1.0 kg/sq cm. In final design, bearing pressure for each structure should be determined individually based on expected settlement in the lower clay. Adjacent structures should be adequately spaced so that resulting soil pressures from their overlapping loadings do not cause the structures to tilt excessively.

### 3. Pipelines in Reclamation Areas

Pipelines may be directly bedded in the sand fill, provided at least 30 cm (or one quarter of the trench width if trench exceeds 1.2 m) of sand fill remains between the bottom of the pipe and top of the surface clay layer. Otherwise, the surface clay layer should be removed to its full depth within the trench limits, and replaced with clean compacted sand, in which the pipe can be bedded. If the surface clay layer is not removed, allowance must be made for expected settlement due to surface clay consolidation under the sand fill. This consolidation will be rapid but not uniform. See Table A-1 for estimated consolidation time.

### 4. Dikes

Dikes to form lagoons or storage basins, or to provide access and pipeline corridors in areas of Lake Manzala, will be based on removal of the soft surface clay and end dumping of sand fill. Design will include conservative side slopes (1 on 2.5), rip rap protection against wave action, and allowance for settlement in the lower clay layer.

## TABLE A-1

## ESTIMATED TIME FOR PRIMARY CONSOLIDATION OF SURFACE CLAY

| Reclamation* Area | Approximate Mean Time for 90% Consolidation |
|---|---|
| 8 | 2 mo |
| 6 | 3 mo |
| 1 | 1-1/4 yr |
| 9 | 2 yr |
| 3 | 1-3/4 yr |
| 7 | 2-1/2 yr |

*See Figure 1-B for locations.

Source: Golder Associates, Port Said Urban Land Reclamation Design Study, Final Report, Volume 4, p. 104.

# APPENDIX B

# BASIS FOR CAPITAL COST ESTIMATES

APPENDIX B

BASIS FOR CAPITAL COST ESTIMATES

## A. INTRODUCTION

This Appendix establishes the basis for estimating capital costs of water projects in the WWFMP. Included are basic labor and material costs, unit construction costs, and cost curves for certain project elements. Costs are based on design approaches, materials, and construction methods considered most appropriate, practical and economical under local conditions.

Costs presented reflect anticipated commercial prices without import duties. The foreign exchange portion of costs identified herein refers to direct foreign expenses which are limited to:

1. Items directly imported for use in the project whether by governmental agencies or by contractors working for these agencies.

2. Expenditures outside Egypt of foreign contractor and consultant, including:

   a) salaries of expatriate personnel paid in foreign currency

   b) home office overhead, profit and financial charges

## B. FACTORS AFFECTING COSTS

The physical and economic factors reviewed below must be taken into account in design, selection of materials and choice of construction methods and equipment.

1. Physical Factors

   - Climate - The coastal location requires above ground structures resistant to corrosive effects of sea spray.

   - Soils - The soft layer of surface clay should be completely removed and replaced with sand where pipe inverts are in or closely above this layer (see Section C, "Soils and Foundations", in Appendix A). Foundations for all but the lightest structures must extend through the clay layer to the firm sand below.

   - Groundwater - The high water table (1 m depth) will require sheeting and pumping for all but the most shallow excavations. Well point costs should be allowed, but in detailed design other dewatering alternatives should be considered (see Chapter 11). Groundwater is mildly corrosive (200-800 mg/l sulphates) at depths where water lines will be installed. Hence pipes should be of corrosion resistant material completely and heavily coated. Acid resistant cement should be used for structures.

   - Congestion - Pipeline costs must allow for difficulties of working in narrow, heavily traveled streets while also minimizing disruption to the city. Where space does not permit conventional stockpiling, pipe and excavated



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material will have to be kept in special retaining structures or stored off-site.

- Existing Utilities - Maps of buried water, sewer, electric and telephone lines are often inaccurate or unavailable. Construction costs must allow for hand excavation at locations and depths where existing utilities are likely to be found.

2. Economic Factors

- Contractor Capability - The large nationalized Egyptian contracting firms have the experience to carry out almost all aspects of possible projects. In addition, smaller firms are available for water and sewer line work. Planning will be based on likely need for foreign contractors to install automated electric controls and specialized process equipment.

- Labor - Many of Egypt's skilled and semi-skilled laborers, supervising personnel and technicians have been drawn to other Arab countries by high wages, leaving a shortage at home. On the other hand, unskilled construction labor is readily available. Escalating costs for needed skilled labor are expected to continue, giving incentive to construction methods intensive in use of unskilled labor.

- Quality of Work - Standards vary widely in Egypt. Cost premium likely to be needed to assure compliance with quality specifications.

- Customs Regulation - Exemption of project components from import duties is anticipated. Needless customs tie-ups must be avoided (see Section 5.6, "Capital Cost Estimates", in Chapter 5).

## C. CONSTRUCTION MATERIAL SOURCES

Many of the basic materials required for civil works construction of water and wastewater facilities are manufactured in Egypt, but items such as cement, reinforcing bars and structural steel are in chronically short supply. Almost all mechanical and electrical equipment will have to be imported.

Table B-1 summarizes information on material sources and indicates those upon which facilities planning and costs were based. Prices for imported materials were based on U.S. sources except in the case of cement, reinforcing and structural steel, where current local market prices for imported materials were used. It is normal A.R.E. practice to supplement local production of these items with imports to meet current construction needs. The costing in the report allows for the possible need for the project to obtain these materials from the supplemental sources. Chapter 11 indicates the bulk portion of foreign exchange costs related to procurement of these materials and the added cost if they have to be procured from the U.S.

## D. DEVELOPMENT AND APPLICATION OF COST DATA

### 1. General

Cost data are presented in three forms: basic labor and material prices, unit costs for particular construction, and cost curves for major project elements related to size or capacity. Sources or derivations of all data are given below. Finally allowances are stated

on project cost components not covered by unit prices or cost curves. All prices contained in this Appendix are August, 1978 levels. U.S. Dollar costs have been converted to Egyptian Pounds at a rate of U.S. $1.00 = LE 0.70.

2. Basis for Cost Curves

a) Civil Works

1. All civil works were assumed to be constructed by Egyptian contractors.

2. The basic cost inputs of labor, materials and equipment were assembled to form unit construction rates, i.e., for trench excavation and reinforced concrete. Unit costs include an allowance of 40% for contractor's overhead and profit.

3. Derived unit rates were then integrated to calculate cost of major project components such as pipe lines and pumping stations.

b) Mechanical and Electrical Equipment

1. All mechanical and electrical equipment was assumed to be imported from the U.S.

2. Prices of imported equipment were obtained directly from U.S. suppliers through recent quotations.

3. Fifty percent of equipment costs was added to the supplier's quote for costs of shipping, insurance and export/import charges to Port Said. Customs duties and local taxes were not included.

4. Installation of mechanical and electrical equipment contained in water and sewage pumping stations, except for electronic sensors, were assumed to be installed by an Egyptian contractor with supervision by the U.S. supplier.

5. Installation of mechanical and electrical equipment contained in treatment process units was assumed to be by a U.S. contractor with direct support by the U.S. supplier.

6. Installation cost of pumping station and process equipment was estimated at 50 percent of equipment price.

c) None of the cost curves include engineering design, construction supervision, legal and administrative costs nor contingencies. Allowances for these are applied separately as shown in Table B-5.

3. Labor

Table B-2 indicates average wage rates for various types of construction workers. The rates include social security and reflect the contractor's cost of labor per eight-hour day.

4. Materials

a) Local: Prices of local construction materials have been obtained from factory list prices, discussions with contractors, private and government engineers. These prices are shown in Table B-3 and include delivery from point of manufacture to Port Said.

b) Imported: Prices of imported materials shown in Table B-3 have been obtained from a review of past tenders, generally from European sources. Customs duties and local taxes are not included.

5. Unit Costs

Table B-4 presents unit costs for appropriate items of work associated with proposed water supply facility construction. These unit costs have been derived by applying a realistic productivity rate of local labor and equipment to their basic cost. These rates include contractor's overhead and profit of 40 percent.

6. Construction Cost Curves

Water facility construction envisioned by the WWFMP includes water lines, water storage tanks and distribution pumping. For purposes of economic evaluations and budget estimates, costs derived from unit cost data for each major component were prepared. Derivation of the cost curves is outlined below for the water lines and described in Chapter 8 for the water storage tanks and pumping stations. Allowances must be added to cover engineering design, construction supervision, legal, administrative and interest costs and contingencies.

Water Lines - Figure B-1 presents construction cost curves for various diameters of imported cement lined and asphaltic coated ductile iron pipe, and local asbestos cement pipe, for primary distribution system transmission lines and mains. Prices include an allowance of 25 percent of pipe cost for fittings and appurtenances such as valves and fire hydrants. Prices of ductile iron pipe are based upon U.S. costs, including freight, insurance and handling, delivered to Port Said. Cost of asbestos cement pipe up to 300 mm dia is the local manufacturer's price plus delivery cost to Port Said. The cost of removing soft surface clay is allowed for pipe greater than 400 mm dia. Average cover on the mains is estimated to be 1 meter. Trench width during construction is estimated to be the outside diameter of the pipe plus 0.5 m on either side of the pipe. Appendix D specifies the types of valves and fire hydrants to be used. Smaller lines are assumed to be high enough above clay to avoid problems. It is assumed that sheeting and dewatering (except for small amounts by sump pumps) will not be necessary for pipe sizes up to 300 mm dia. In-place cost does not include any allowance for secondary distribution piping.

Costs of new service connections and new secondary distribution lines were calculated based on our estimates of the costs of systems shown for the New Community[1] and Industrial Estate[2] in the Port Said Demonstration Projects.

---

(1) Shankland Cox Partnership et al, Port Said Demonstration Projects, Draft Final Report, New Community Project, February 1978.
(2) Ibid, Industrial Estate Project, February 1978.

The figures we developed are:

| | Service Connections (LE) | Secondary Distribution Lines (LE) |
|---|---|---|
| Residential/Institutional cost per added person in newly developed area | 10.09 | 19.67 |
| Industrial cost per gross hectare of new industrial area | 373 | 6291 |

These costs include project allowances as outlined in Table B-5 and Section 8 below.

7. Land Costs

Construction cost estimates contained in this Appendix do not include aquisition of land or easement rights. Water line easements were assumed to be in public land or streets, involving no cost to projects. Costs of new sites for project facilities were based on the unit costs of creating new land, as given in the Golder Associates Report. These include the cost of mobilization and demobilization of dredges (LE 40,000 for a 12-inch dredge), disposal of surface clay (1.0 LE/cu m) and dredging and placement of sand fill. Where the sand fill is to be end dumped for dikes a cost of 3.5 LE/cu m was used. For land reclamation entirely with dredged sand (without removing the surface clay), an overall cost of 32,600 LE/ha was used.

8. Project Allowances

Table B-5 presents the estimated percentage allowances for contingencies, support and design related costs. These percentages are to be applied to the foreign plus local components of estimated costs for each project category. The total cost of project, therefore, will include the estimated local plus foreign costs and project allowance costs where applicable. The project allowance percentages were based on review of reports for other locations and on discussion with contractors.

## TABLE B-I

## MATERIAL SOURCES

| Item | Produced in Egypt | Comments | Source for Planning |
|---|---|---|---|
| Cement | X | Egyptian production does not meet present demands. | I |
| Sand & Aggregate | X | Most significant cost is for transportation. | E |
| Reinf. & Structural Steel | X | 50% of finished and high tension steel is imported. Raw material is imported. | I |
| Pipe | | | |
| Clay - up to 1200 mm | X | Not suitable for tight sealing rubber or plastic joints; 6 to 7 mo predelivery notice required. | E |
| Asbestos Cement - up to 400 mm | X | Epoxy coating and lining not presently available but may be so in future if demand warrants. | E |
| Cast Iron - up to 400 mm | X | Imported pig iron; 6 mo predelivery notice required. | N |
| Ductile Iron | - | | I |
| Valves - 200 mm | X | Quality reported uncertain. | E |
| 200 mm | X | | I |
| Small Pumps | X | Quality reported uncertain. | N |
| Machinery, Equip. & Electric | - | | I |

E = Egyptian
I = Imported
N = Not used in planning

TABLE B-2

LABOR COSTS

DAILY RATE (LE) AT PORT SAID[1]

August, 1978

| | |
|---|---|
| Unskilled Laborer | 2.5 |
| Skilled Laborer | 4.8 |
| Carpenter | 6.0 |
| Brick Layer | 7.2 |
| Iron Worker | 6.0 |
| Plasterer | 6.0 |
| Concrete Finisher | 7.8 |
| Painter | 5.6 |
| Pipe Layer | 7.2 |
| Sheet Metal Worker | 6.0 |
| Electrician | 7.2 |
| Equipment Operator (Light) | 6.0 |
| Equipment Operator (Medium) | 7.2 |
| Equipment Operator (Heavy) | 10.8 |
| Truck Driver | 7.2 |
| Mechanic | 6.2 |
| Foreman | 6.0 |
| Guard | 2.0 |

(1) Reflects contractor's cost of labor.

TABLE B-3

CONSTRUCTION MATERIAL COSTS

PORT SAID

August, 1978

| Item | Unit | Price per Unit (LE)(1) |
|---|---|---|
| Sand | cu m | 4 |
| Aggregate | cu m | 6 |
| Bricks, Acid Resistant | 1000 | 125 |
| Plywood, Imported | cu m | 200 |
| Cement, Imported | ton | 50 |
| Reinforcing Steel, Imported | ton | 265 |
| Structural Steel, Imported | ton | 330 |
| Timber, Imported | cu m | 180 |
| Ductile Iron Pipe(2) (Pressure), Imported Diameter, mm | | |
| 200 | | 30 |
| 300 | | 45 |
| 400 | | 60 |
| 600 | | 105 |
| 900 | | 205 |
| 1050 | | 270 |
| Asbestos Cement Pipe (Pressure), Local Diameter, mm | | |
| 150 | | 7 |
| 200 | | 10 |
| 300 | | 20 |

(1) Includes handling and transportation charges for delivery from place of manufacture to Port Said. Water pressure pipe prices do not include cost of couplings, fittings and related appurtenances (valves and hydrants). Must add a 25% allowance to D.I. pipe cost to include cost of imported valves, hydrants and fittings.

(2) Cement lined and asphaltic coated.

TABLE B-4

CONSTRUCTION UNIT COSTS

PORT SAID

August, 1978

| | Unit | Price per Unit (LE) |
|---|---|---|
| Trench Excavation by hand | | |
| Depth of trench, meters | | |
| 0-2 | cu m | 2.2 |
| 2-3 | cu m | 3.8 |
| 3-4 | cu m | 4.8 |
| 4-5 | cu m | 6.0 |
| 5-6 | cu m | 7.2 |
| 6-7 | cu m | 8.0 |
| Trench Excavation by machine | | |
| Depth of trench, meters | | |
| 0-2 | cu m | 1.8 |
| 2-3 | cu m | 3.0 |
| 3-4 | cu m | 4.0 |
| 4-5 | cu m | 5.0 |
| 5-6 | cu m | 6.0 |
| Rock Excavation | cu m | 12.0 |
| Dewater trench by wellpoint | cu m | 9.0 |
| Dewater trench by sump pump | cu m | 1.1 |
| Furnish, install & remove wood sheeting | sq m | 1.0 |
| Bedding material | cu m | 5.0 |
| Trench, backfill & compaction | cu m | 1.0 |
| Pavement removal & replacement | sq m | 7.5 |
| Dispose of surplus excavation to 10 km | cu m | 3.0 |
| Sewer pipe laying & testing | 1m/ 100 mm dia | 0.8 |
| Reinforced concrete walls, beams and floors above grade | cu m | 135 |
| Reinforced concrete foundations | cu m | 90 |
| Plain concrete, no formwork | cu m | 30 |
| Hydraulic fill by dredging, up to 3 km | cu m | 1.80 |
| Rock slope protection | cu m | 13 |
| Filter blanket | cu m | 11 |

## TABLE B-5

## PROJECT COST ALLOWANCES

1. Contingencies

Percentages applied to total cost estimates by category:

| | Percent |
|---|---|
| a) Capital Construction Projects | 20 |
| b) Equipment Procurement | 5 |
| c) Procurement of Services | - |
| d) Local Measures | - |

2. Other Cost Allowances

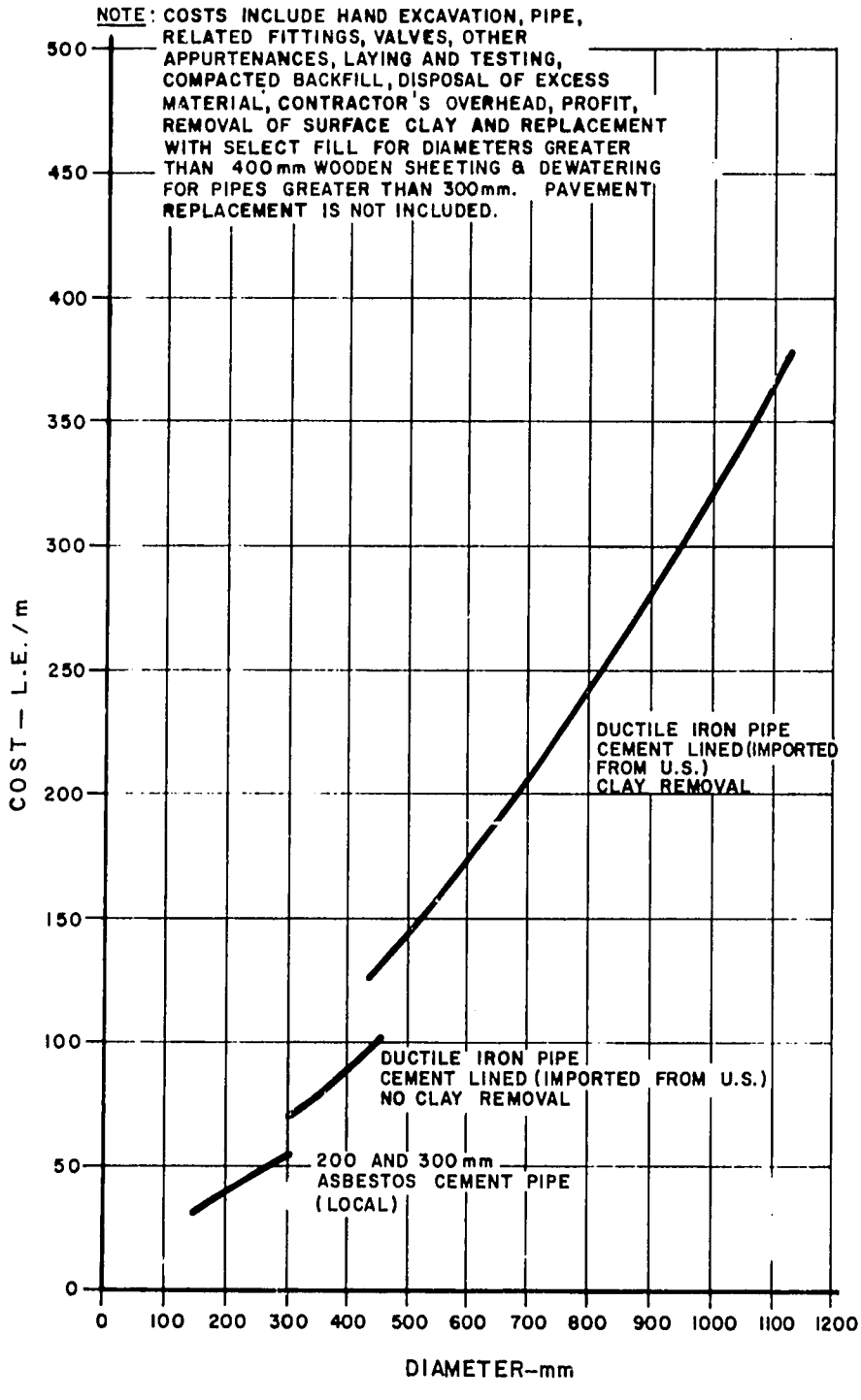
Percentages applied to total cost estimates (without contingencies) to cover support and design related categories shown below:

| | Capital Construction Projects % | Equipment Procurement % | Procurement of Services % |
|---|---|---|---|
| a) Engineering | 9 | 5 | 5 |
| b) Legal and Administrative | 5 | 8 | 8 |
| c) Construction Supervision | 10 | 4 | - |
| d) Cost of Money | 7.5 | - | - |
| TOTAL | 31.5 | 17 | 13 |

No allowance is needed for "local measures" projects.

3. Foreign/Local Division of Cost Allowances

| | Capital Construction Projects % | | Secondary Distribution & Service Connections % | | Equipment Procurement % | | Procurement of Services % | |
|---|---|---|---|---|---|---|---|---|
| | Foreign | Local | Foreign | Local | Foreign | Local | Foreign | Local |
| a) Engineering | 5 | 4 | 2 | 4 | 4 | 1 | 4 | 1 |
| b) Legal and Administrative | - | 5 | - | 3.5 | - | 8 | - | 8 |
| c) Construction Supervision | 6 | 4 | 3 | 4 | 2 | 2 | - | - |
| d) Cost of Money | - | 7.5 | - | 7.5 | - | - | - | - |
| Percent of Total Cost | 11 | 20.5 | 5 | 19 | 6 | 11 | 4 | 9 |




**ARAB REPUBLIC OF EGYPT**
MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION

PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

HAZEN AND SAWYER
ECG - ENGINEERING CONSULTANTS GROUP

WATER MAIN COSTS

VOL.2
FIG.
B-1

N52321

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APPENDIX C

EQUIPMENT INVENTORY AND DESIGN DATA
EL RASWA WTP

A. Raw Water Pumps

| Location | Pump No. | Capacity cu m/hr | Motor HP | Year Station Installed |
|---|---|---|---|---|
| Main Station | 1 | 400 | 22 | 1924 |
| | 2 | 400 | 41 | |
| | 3 | 700 | 41 | |
| | 4 | 700 | 40 | |
| Auxiliary Station | 5 | 700 | 45 | 1946 |
| | 6 | 400 | 22 | |
| | 7 | 400 | 22 | |
| | 8 | 700 | 50 | |
| Rapid (Bamag) | 9 | 1080 | 46 | 1964 |
| | 10 | 1080 | 46 | |
| | 11 | 1080 | 46 | |

B. Finished Water Pumps

| Location | Pump No. | Capacity cu m/hr | Motor HP | Year Station Installed |
|---|---|---|---|---|
| Main Station | 1 | 400 | 90 | 1924 |
| | 2 | 500 | 90 | |
| | 3 | 500 | 90 | |
| | 4 | 400 | 90 | |
| Annex | 5 | 400 | 90 | 1946 |
| | 6 | 1000 | 190 | |
| | 7 | 500 | 90 | |
| | 8 | 1000 | 170 | |
| Rapid (Bamag) | 9 | 900 | 175 | 1964 |
| | 10 | 900 | 175 | |
| | 11 | 900 | 175 | |

Note: See Tables C-1 and C-2 for electrical equipment.

C. Auxiliary Equipment

Air Compressors for Air Scour

| Location | No. of Units | Capacity |
|---|---|---|
| Stream I | 2 | 25 HP |
| Streams 4 and 5 | 2 | 45 HP |
| Existing Bamag | 2 | 58 HP; 38 cu m/hr |

Back Wash Pumps

| Location | No. of Units | Capacity |
|---|---|---|
| Stream I | 1 | 7.5 HP; 120 cu m/hr* |
| Streams 4 and 5 | 1 | 3 HP; 30 cu m/hr* |
| Existing Bamag | 2 | 39 HP; 800 cu m/hr |

D. Flow Train I Data

Treatment Capacity

| | |
|---|---|
| Nominal Capacity | 6,000 cu m/d |
| Operating Capacity | 10,000 cu m/d |

Chemical Addition: None

Flocculation: None

Settling Tank

| | |
|---|---|
| Useful Volume | 2,900 cu m |
| Detention Time (operating capacity) | 8 hrs. |

Roughing Filters

| | First Stage | Second Stage | Third Stage |
|---|---|---|---|
| Number of Filters | 6 | 6 | 6 |
| Unit Area | 29 sq m | 59 sq m | 89 sq m |
| Total Area | 174 sq m | 354 sq m | 534 sq m |
| Nominal Filtration Rate | 1.44 m/hr | 0.71 m/hr | 0.47 m/hr |
| Operating Filtration Rate | 2.40 m/hr | 1.18 m/hr | 0.78 m/hr |
| Media Effective Size | 30 mm | 15 mm | 8 mm |
| Media Depth | 0.4 m | 0.4 m | 0.8 m |
| Available Head | 0.9 m | 0.9 m | 1.2 m |

*Pumps not installed

D. Flow Train 1 Data (Cont.)

Slow Sand Filters

| | |
|---|---|
| Number of Filters | 8 |
| Unit Area | 252 sq m |
| Total Area | 2,016 sq m |
| Nominal Filtration Rate | 2.98 m/d |
| Operating Filtration Rate | 4.96 m/d |
| Media Effective Size | 0.2 mm |
| Media Depth | 0.8 m |
| Effective Head | 1.0 m |

E. Flow Trains 2 and 3 Conversion Data

Treatment Capacity

| | |
|---|---|
| Flow Train 2 | 40,000 cu m/d |
| Flow Train 3 | 40,000 cu m/d |

Chemical Addition

| | | |
|---|---|---|
| Pre chlorination | 2 chlorinators | 0.7 to 14 kg/hr |
| Post chlorination | 1 chlorinator | 0.7 to 14 kg/hr |
| Standby | 1 chlorinators | 0.7 to 14 kg/hr |
| Aluminum Sulfate | 3 dosing pumps | 0 to 982 l/hr |
| Coagulant Aid | 3 dosing pumps | 0 to 1922 l/hr |
| Lime Slurry | 2 dosing pumps | 0 to 393 l/hr |

Flocculation (each flow train)

| | |
|---|---|
| Useful capacity | 6.35 cu m |
| Contact time | 23 min |

Settling Tanks

| | |
|---|---|
| Useful volume | 2,654 cu m |
| Detention time | 96 min |

Filters

| | |
|---|---|
| Number of filters | 6 |
| Unit area | 59 sq m |
| Total area | 354 sq m |
| Nominal filtration rate | 4.73 m/hr |
| Maximum filtration rate | 5.68 m/hr |
| Media effective size | 0.8 to 1.2 mm sand |
| Media depth | 0.90 m |
| Available head | 1.21 m |
| Wash water rate | 5 l/sec/sq m |
| Air scour rate | 18 l/sec/sq m |



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F. Flow Trains 4 and 5 Data

Treatment Capacity

| | |
|---|---|
| Flow Train 4 | 10,000 cu m/d (nominal)<br>23,000 cu m/d (operating) |
| Flow Train 5 | 10,000 cu m/d (nominal)<br>20,000 cu m/d (operating) |

Chemical Addition (each stream)

| | |
|---|---|
| Aluminum Sulfate | One feeder, manually adjusted |
| Coagulant Aid | One feeder, manually adjusted |

Flocculation (each stream)

| | |
|---|---|
| Useful capacity | 218 cu m |
| Contact time | 14 min* |

Settling Tanks

| | |
|---|---|
| Useful volume | 3,875 cu m |
| Detention time | 4 hrs 13 min* |

Roughing Filters (each stream)

| | First Stage | Second Stage | Third Stage |
|---|---|---|---|
| Number of Filters | 3 | 3 | 3 |
| Unit Area | 61 sq m | 128 sq m | 193 sq m |
| Total Area | 173 sq m | 384 sq m | 579 sq m |
| Nominal Filtration Rate | 2.28 m/hr | 1.09 m/hr | 0.72 m/hr |
| Operating Filtration Rate* | 5.00 m/hr | 2.40 m/hr | 1.59 m/hr |
| Media Effective Size | 30 mm | 15 mm | 8 mm |
| Media Depth | 0.4 m | 0.4 m | 0.75 m |
| Available Head | 0.9 m | 0.9 m | 0.9 m |

Slow Sand Filters (each stream)

| | |
|---|---|
| Number of Filters | 4 |
| Unit Area | 544 sq m |
| Total Area | 2,176 sq m |
| Nominal Filtration Rate** | 4.6 m/d |
| Media Effective Size | 0.2 mm |
| Media Depth | 0.9 m |
| Effective Head | 0.75 m |

---

*For low of 22,000 cu m/d
**Maximum rate not applicable; additional flow not run through slow filters.



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G. Existing Bamag Plant Data

| | |
|---|---|
| Treatment Capacity | 35,000 cu m/d |

Chemical Addition

| | | |
|---|---|---|
| Aluminum Sulfate or Ferric Chloride | | |
| Mixing tanks with electric mixer | | 3 at 15 cu m each |
| Flow meters | | One 100 to 1,000 l/hr<br>Two 200 to 2,000 l/hr |
| Lime | Two Feeders | 150 kg/hr (100 gm/cu m) |
| Copper Sulfate | One Feeder | 12.25 kg/hr (8.5 gm/cu m) |
| Carbon | Two Feeders | 0 to 10 kg/hr (79 gm/cu m) |
| Chlorine | One Chlorinator | 200 to 2,000 gm/hr |
| Ammonia | One Feeder | 200 to 2,000 gm/hr |

Rapid Mix Chamber

| | |
|---|---|
| Volume | 15 cu m |
| Detention Time | 1.25 min |
| Mixing | Electric turbo mixer |

Flocculation - Two chambers each with 4 flocculators

| | |
|---|---|
| Volume - each basin | 385 cu m |
| Contact time | 32 min |
| Flocculators - 2.7 RPM, 0.5 HP | 8 |

Filters

| | |
|---|---|
| Number of filters | 8 |
| Unit Area | 43 sq m |
| Total Area | 344 sq m |
| Nominal Filtration Rate | 4.2 m/hr |
| Media Effective Size | 0.8 mm |
| Media Depth | 1.5 m |
| Available Head | 0.6 m |
| Wash Water Rate | 5.2 l/sec/sq m |
| Air Scour Rate | 14.7 l/sec/sq m |
| Valve Operation | Hydraulic |

H. New Bamag Plant

| | |
|---|---|
| Treatment Capacity | 70,000 cu m/d |

Raw Water Pumping

Pumps -

| | |
|---|---|
| Horizontal, centrifugal, electrically driven | 4 |
| Capacity each | 1,080 cu m/hr |
| Delivery head | 10 to 12 m |

H. New Bamag Plant (Cont.)

Chemical Addition

| | | |
|---|---|---|
| Pre and intermediate chlorination | 2 chlorinators | max 33.3 kg/hr |
| Post chlorination | 2 chlorinators | max 6.6 kg/hr |
| Aluminum Sulfate | 2 dosing pumps | 0 to 1,500 l/hr |
| Coagulant Aid | 1 dosing pump | 0 to 1,500 l/hr |

Flocculation

| | |
|---|---|
| Reaction chamber volume | 380 cu m/d |
| Contact time | 13 min |

Settling Tanks - two basins

| | |
|---|---|
| Volume - each basin | 3,040 cu m |
| Detention time | 2 hrs 5 min |

Filters

| | |
|---|---|
| Number of filters | 12 |
| Unit area | 46.5 sq m |
| Total area | 558 sq m |
| Nominal filtration rate | 5.2 m/hr |
| Maximum filtration rate | 6.25 m/hr |
| Media effective size | 1 to 2 mm |
| Media depth | 1.5 m |
| Available head | 0.6 m |
| Wash water rate | 5.9 l/sec/sq m |
| Air scour rate | 19.4 l/sec/sq m |

Finished Water Pumping

Pumps -

| | |
|---|---|
| Horizontal, centrifugal, electrically driven | 4 |
| Capacity each | 922 cu m/hr |
| Delivery head | 50 m |

TABLE C-1

ELECTRIC MOTOR DATA

EL RASWA WATER TREATMENT PLANT

| Location/ Service | Unit No. | Motor Rating | Voltage | Starting Method | Protection | Make & Year of Manufacture |
|---|---|---|---|---|---|---|
| Main Pumping Station A Raw Water Pumps | 1 | 40 HP | 190 | Variable Resistance (VR) | No Direct (ND) motor protection | G.E.M. |
| | 2 | 41 HP | 190 | VR | ND | Tomson Huston 1926 |
| | 3 | 41 HP | 190 | VR | ND | Tomson Huston 1926 |
| | 4 | 50 HP | 190 | VR | ND | Siemens 1950 |
| Main Pumping Station A Finished Water Pumps | 1 | 90 HP | 190 | VR | ND | Orlyken |
| | 2 | 90 HP | 190 | VR | ND | Alcy Tom |
| | 3 | 90 HP | 190 | VR | ND | Alcy Tom |
| | 4 | 90 HP | 190 | VR | ND | Orlyken |
| Raw Water Pumping Station B Raw Water Pumps | 1 | 50 HP | 190 | VR | 100A fuses | G.E.M. |
| | 2 | 22 HP | 190 | VR | 100A fuses | Orlyken |
| | 3 | 22 HP | 190 | VR | 100A fuses | Orlyken |
| | 4 | 45 HP | 190 | VR | 100A fuses | Allin |
| Annex Pumping Station B Finished Water Pumps | 1 | 90 HP | 190 | VR | | Orlyken |
| | 2 | 190 HP | 190 | VR | | Brown Boveri |
| | 3 | 90 HP | 190 | VR | | Alcy Tom |
| | 4 | 190 HP | 190 | VR | | Gimort A.B.N. |
| Bamag Pumping Station C Raw Water Pumps | 1 | 90 HP | 380 | VR | 100A CB | Polish |
| | 2 | 90 HP | 380 | VR | 100A CB | Polish |
| | 3 | 90 HP | 380 | VR | 100A CB | Polish |
| Bamag Pumping Station C Finished Water Pumps | 1 | 130 KW | 380 | VR | 400A CB | Polish |
| | 2 | 130 KW | 380 | VR | 400A CB | Polish |
| | 3 | 130 KW | 380 | VR | 400A CB | Polish |
| Bamag Filter House Air Compressors | 1 | 45 HP | 190 | Y | | Rateau |
| | 2 | 45 HP | 190 | Y | | Rateau |
| | 3 | 45 HP | 190 | Y | | Rateau |
| | 4 | 45 HP | 190 | Y | | Rateau |

TABLE C-2

POWER SUPPLY

EL RASWA WATER TREATMENT PLANT

| Source of Supply | Number and Size of Conductors | Feeding Voltage | Type of Switchgear | Transformers No. | Rating | Voltage | Make & Year | Remarks |
|---|---|---|---|---|---|---|---|---|
| Main Pumping Station | 4 (3 x 70mm$^2$) | 5.5 KV | Open busbar type with bulk oil circuit breakers & single pole noload switches | 1 | 160 KVA | 5.5KV/210V | French/1926 | Transformers No. 1, 2 & 3 are for filtered water pumps. Transformers No. 4, 5 & 6 are for raw water pumps. |
| | | | | 2 | 160 KVA | 5.5KV/210V | French/1926 | |
| | | | | 3 | 160 KVA | 5.5KV/210V | French/1926 | |
| | | | | 4 | 150 KVA | 5.5KV/210V | French/1926 | |
| | | | | 5 | 150 KVA | 5.5KV/210V | French/1926 | |
| | | | | 6 | 90 KVA | 5.5KV/210V | French/1926 | |
| Annex Finished Water Pumping Station | 1 (3 x 95mm$^2$)<br>1 (3 x 70mm$^2$) | 5.5 KV | Open busbar type with bulk oil circuit breakers & single pole noload switches | 1 | 315 KVA | 5.5KV/190V | | |
| | | | | 2 | 315 KVA | 5.5KV/190V | | |
| Bamag Pumping Station | 4 (3 x 95mm$^2$) | 5.5 KV | Open busbar type with bulk oil circuit breakers & single pole noload switch | 1 | 315 KVA | 5.5KV/380V | | Transformer No. 4 was in service. |
| | | | | 2 | 315 KVA | 5.5KV/380V | | |
| | | | | 3 | 315 KVA | 5.5KV/380V | | |
| | | | | 4 | 315 KVA | 5.5KV/380V | | |

APPENDIX D

RECOMMENDED EQUIPMENT SPECIFICATIONS
EL RASWA WTP AND DISTRIBUTION SYSTEM

A. Water Pumps

Horizontal, split-case, single-stage, double suction, self priming with water-lubricated bearings, suction and discharge pressure gauges, complete with 3-phase, 50-hz, 1500 rpm motor with head and capacity and minimum motor HP as indicated under characteristics where specification is referenced. Motor sized to operate pump at any point on its curve without exceeding the name plate HP rating.

B. Impeller Mixer

With plate for mounting on cover of 15 cu m mixing compartment; 2.5 m dia. x 3 m deep.

Mixer speed 70 rpm, designed to impart 2 HP into the water; 1500 rpm, single phase, 220 V, 50-hz, gearmotor.

C. Chlorinators

Cylinder-mounted, vacuum diaphragm type, capacity to 6 kg/hr, complete with injector (designed for 20 m pressure differential) and connecting gas tubing.

D. Insert Parshall Flume

For channel 0.8 m wide x 1.2 m deep, with electronic flow transmitter and indicator, 0-50 ma signal, flow range to 25,000 cu m/day.

E. Electronic Flow Transmitter

For existing venturi meter (calibration to be furnished); two with indicator, one with indicator/recorder (4-in. strip chart); 0-50 ma signal; flow range to 50,000 cu m/day.

F. Venturi Tube

400 mm with electronic flow transmitter and indicator/recorder (4-in. strip chart); 0-50 ma signal; flow range to 75,000 cu m/day. Also same transmitter and indicator/recorder for existing venturi (calibration to be furnished).

G. Transformers

Three-phase, 50-hz, outdoor, oil-filled, self-cooling type, meeting ANSI and IEEE (USA) standards, of KVA rating and voltage ratios as shown on Table 7.6. Furnished with cover and/or wall mounted bushing as needed.



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| For 3300 V Secondaries | For 380Y/220V Secondaries |
|---|---|
| Primary connections: wye | delta |
| Secondary connections: delta | wye |
| Temperature rise: 65°C | 650°C |

Four (4) rated KVA taps (for deenergized operation), two (2) approximately 2-1/2% above and two (2) 2-1/2% below rated voltage.

Oil preservation: sealed tank construction

Minimum standard accessories:

- Magnetic liquid gauge
- Dial type oil thermometer
- Pressure vacuum gauge
- Pressure vacuum bleeder
- Filler and drain valves with sampling device
- Facilities for lifting and/or skidding completed transformer
- Jacking facilities
- Ground pads (two minimum)
- One or more handholes in cover
- Cover mounted pressure relief device
- Diagrammatic name plate

H. Switchgear

Indoor or outdoor type, as required, metal-clad with drawout type air. or vacuum circuit breakers, 13.8 KV with interrupting rating as required.

Breaker operation: 220V AC stored energy with required space heaters.

Continuous bus ratings: of required ampere capacity and adequately supported to withstand the momentary ratings of the switchgear breakers.

Include auxiliary compartments for potential and control power transformers, segregated from the circuit breaker compartments with grounded metal enclosures. Tapered bus not permitted.

BIL ratings shall be as required.

Circuit breaker compartments to include the following components:

Power Circuit Breaker

- Circuit breaker lifing-mechanism mechanism for vertical lift design
- Primary disconnecting devices
- Secondary disconnecting devices
- Control switches with indicating lamps
- 3-phase insulated connections of current carrying capacity equal to that of the power circuit breaker
- Current transformers as required, for metering and protective relays
- Ammeters, voltmeters and protective relays, as required
- Necessary terminal blocks and cable type terminators

- Control buses
- Ground bus
- Automatic shutters to prevent contact with live parts when breaker is withdrawn

I. Motor Control Centers

Indoor type, metal clad, meeting NEMA and ANSI standards, with NEMA Class II type C wiring.

Power supply: 380V or 3300V

Continuous horizontal copper bus of required ampere capacity, and braced to withstand maximum momentary short circuit currents.

Structures: rigid free standing sheet metal assemblies. Each unit with flange-formed doors (concealed hinges) in front and flange-formed covers or doors in the rear. In 3300V units, low voltage wiring isolated from high voltage equipment or wiring by use of grounded metal barriers or raceway.

Individual motor starters: draw-out type combination circuit

- Breaker type units for 380V application and roll-out (or draw-out) type 4160V contractors for 3300V operation

Provide control power transformers in each 3300V motor starter to provide 220V control power.

High voltage starters: Controller rated at 250,000 KVA 3-phase assymetrical at 4000V, 50-hz, including current limiting power fuses mounted on the same carriage as the controller. The controller shall be air break or vacuum type having an interrupting capacity of 50,000 KVA, 3-phase assymetrical 5,000V minimum.

Provision shall be made for reduced voltage start by use of auto transformers with automatic contractors, if required.

380V motor starters shall be provided with circuit breakers of continuous rating and interrupting capacities as required.

J. Valves

Butterfly design, manual gear operated, open counterclockwise, mechanical stops for valves 400 mm and larger. Vertical gate design, bronze mounted, non-rising stem, non-geared manual operated, open counterclockwise for valves smaller than 400 mm.

K. Hydrants

Either standardized hydrant or hydrant components using English hose thread sizes, using valves opening to counterclockwise.

L. Meters

Turbine or Turbo or multi-style plastic case and interiors, magnetic drive, seal register, odometer type dial in cu m. The thread is to conform with that used on service lines and couplings in Port Said.



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APPENDIX E

LEAK SURVEY BY VELOCITY MEASUREMENTS

## A. SCOPE

To perform a velocity leak survey, an experienced, specialized team should conduct the initial program and train the Port Said personnel to maintain a continuing program. The special team would:

1. Familiarize itself with the condition, location, size, capacity, adequacy and operating reliability of the overall distribution system, with particular attention to valving in order to ensure that watertight isolation of sections of mains is possible.

2. Assemble all available information on the distribution system, including as-built construction drawings, shop drawings, distribution maps, meter records, and operation records. On-site field inspections would be required to verify the data.

3. Analyze from available records the patterns of water distribution and consumption for various classes of consumers to determine water demand of various sections of the distribution system.

4. Perform field tests to:

   a) Determine pumping characteristics (including head efficiency and quantity) of all high service discharge pumps at El Raswa Treatment Plant.

   b) Determine the accuracy of venturis or master meters at the plant.

   c) Measure the amount of water flowing through all siphons and major transmission mains; determine pipe friction factors, pressures and leakage quantities.

5. Divide the distribution system into districts, each district to include approximately 16 to 20 km of distribution piping.

6. Valve off one district at a time to obtain flow in one direction; measure the total water consumption over a 24-hour period by taking pitometer readings every half-hour.

7. Analyze the data to determine whether further investigation in the district is needed. Normally, when the night flow rate is 20 percent or less of the average daily flow rate, the district is considered to be in good condition. When the night rate is between 30 to 50 percent of the average rate, further investigation is warranted.

8. Conduct additional studies, where warranted, in subdivisions of the districts, testing when consumption of water is lowest. The flow data obtained will be analyzed to determine the source of leakage.

9. Check all large industrial meters (75 mm or over) and test for accuracy. Defective meters should be replaced and retested.

10. Prepare a detailed report after conclusion of all investigations, to include:

    a) Condition of pipe, valves and appurtenances uncovered.

    b) Any errors found in mapping and records.

    c) Flow charts showing the quantity of flow in each district and subdistrict.

    d) Identification of quantity and location of leaks uncovered.

    e) Maps showing location of permanent district measuring boundaries.

    f) Recommendations for improvements to the distribution system.

    g) An operations manual for conducting continuing measurements as part of a maintenance program.

B. COST

Total cost of the velocity leak survey is estimated at 145,000 LE, of which 37,000 LE is local cost. Required equipment and a breakdown of costs for the complete survey are shown in Table 9.4.

The following personnel will be required to conduct the survey:

1. Two U.S. engineers, skilled in water distribution operation and analysis, to direct the program.

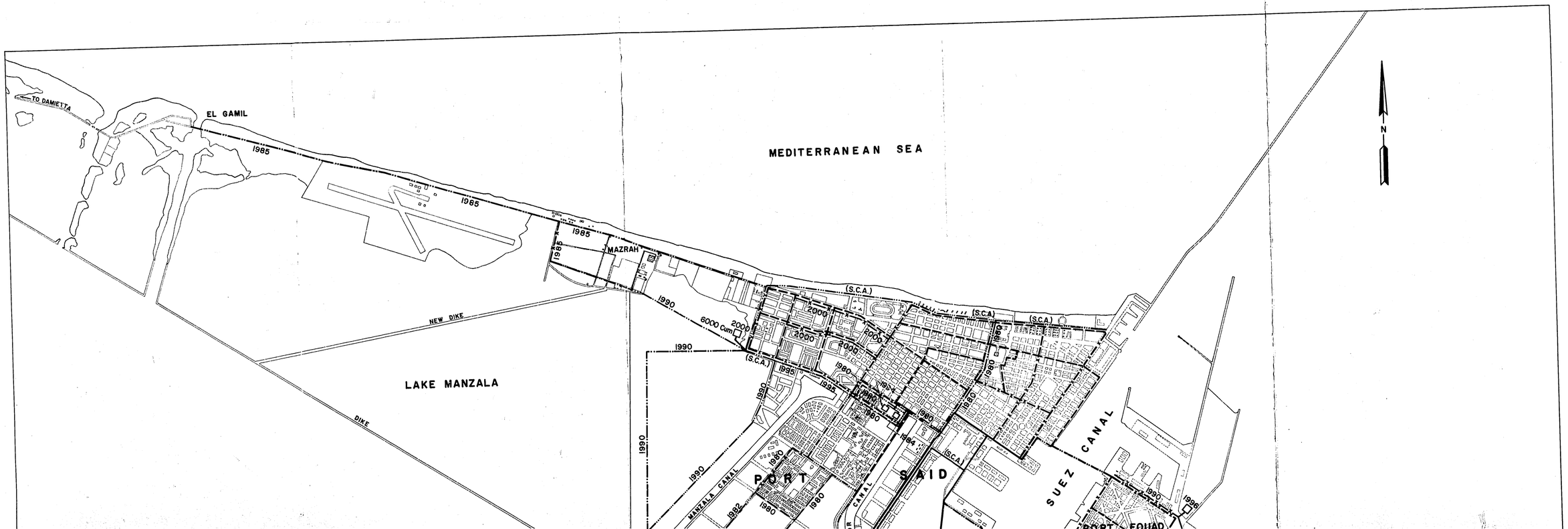
2. One Egyptian engineer, preferably civil (sanitary), to be trained to direct follow-up programs.

3. Two full-time technicians from the SCA, with others as needed, assigned to the continuing program to collect data and perform skilled work.

4. Three or four laborers as needed to excavate for taps and perform other functions.

C. SCHEDULE

The velocity leak survey should be scheduled for 1981 and 1982. Following a sound survey to be done in 1979 and 1980, valve replacement should occur first to ensure watertight isolation of various districts and subdivisions. The proposed work is scheduled to take place within a one-year period, including the training of local personnel for a continuing maintenance and testing program. On completion of the sound survey, the need for the velocity survey should be re-evaluated, based on estimates of the remaining leakage.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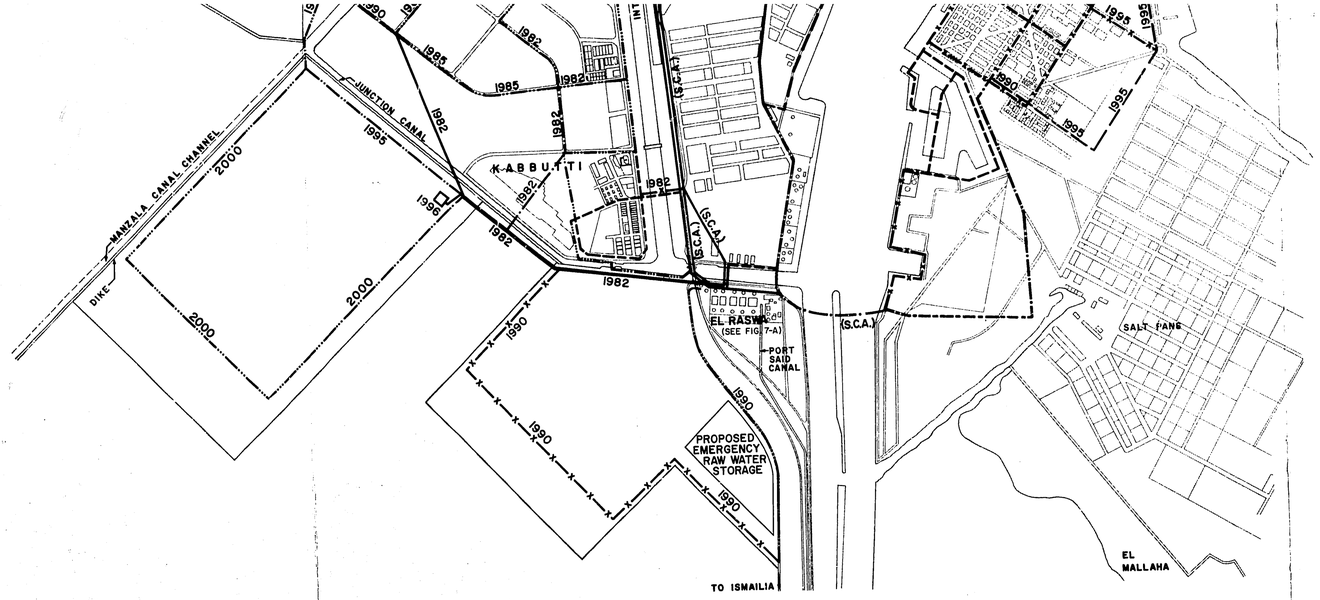


## LEGEND

| EXISTING PIPE | DIA. mm | FUTURE PIPE |
|---|---|---|
| | 1000 | |
| | 800 | |
| | 600 | |
| | 550 | |
| | 500 | |
| | 400 | |
| | 300 | |
| | 200 | |
| | TANK | |

## NOTES

- LATEST YEAR REQUIRED NOTED ON PIPE OR TANK.
- PIPES MARKED S.C.A. ARE PROJECTS IN PROGRESS.
- HIGH PRIORITY LINES ARE MARKED 1980.
- IMMEDIATE PHASE PROJECTS ARE MARKED 1982.
- SECONDARY PIPES SMALLER THAN 200 mm NOT SHOWN.
- TANKS ARE OF CAPACITY 3000 Cum EACH, UNLESS OTHERWISE NOTED.

SCALE 1:20,000

500 0 500 1000 METERS

PN-AAU-849
4 of 4

**Arab Republic of Egypt**

MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION

PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

# STAGED DEVELOPMENT WATER DISTRIBUTION SYSTEM ADDITIONS

| HAZEN AND SAWYER<br>ECO - ENGINEERING CONSULTANTS GROUP | DATE<br>JUNE 1979 | VOLUME 2<br>PLATE No. I |
|---|---|---|