PN-ACJ-032
105395

ARAB REPUBLIC OF
EGYPT

NATIONAL ORGANIZATION FOR
POTABLE WATER AND
SANITARY DRAINAGE

SUEZ CANAL
AUTHORITY

CANAL CITIES WATER AND WASTEWATER PHASE II PROJECT MASTER PLAN

USAID CONTRACT No. 263-C-00-98-00052-00
USAID PROJECT No. 263-0174

VOLUME 6
PORT SAID WASTEWATER MASTER PLAN

September 1999

BLACK & VEATCH INTERNATIONAL

In association with

MONTGOMERY WATSON

SABBOUR ASSOCIATES

PORT SAID

ISMAILIA

SUEZ

PN-ACJ-032
105395

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Canal Cities Water & Wastewater Master Plans
USAID Contract No. 263-C-00-98-00052-00
USAID Project No. 263-0174-3-94145

BVI Project No. 59795
30 September 1999

United States Agency for International Development (USAID)
Zahraa El Maadi
Maadi, Cairo, Egypt

Subject: Canal Cities Water & Wastewater Master Plans

Ladies and Gentlemen:

Black & Veatch International, in association with Montgomery Watson Americas and Sabbour Associates, is pleased to submit three copies of the Canal Cities Water and Wastewater Master Plans. The Master Plan documents consist of eight volumes, as listed below.

- Executive Summary
- Volume 1 – Suez Water Master Plan
- Volume 2 – Suez Wastewater Master Plan
- Volume 3 – Ismailia Water Master Plan
- Volume 4 – Ismailia Wastewater Master Plan
- Volume 5 – Port Said Water Master Plan
- Volume 6 – Port Said Wastewater Master Plan
- Volume 7 – Institutional and Financial Report

Concurrently, we are submitting three copies of the Master Plans to the National Organization for Potable Water and Sanitary Drainage (NOPWASD), one copy to the Suez Canal Authority (SCA), and one copy each to the Governorates of Suez, Ismailia, and Port Said.

This project represents an important achievement in USAID's continuing program to provide sustainable water and wastewater infrastructure in Egypt. We trust that the recommendations presented in the Master Plans will result in a well conceived and manageable program for NOPWASD and SCA as they prepare for development and growth in Suez, Ismailia, and Port Said.

It has been a pleasure working with USAID and we look forward to the next opportunity to be of service.

CANAL CITIES MASTER PLAN # BLACK & VEATCH INTERNATIONAL #

Very truly yours,
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ACKNOWLEDGEMENTS

The Canal Cities Master Plan team wishes to acknowledge the following organizations and individuals whose contributions and cooperation have made this work successful:

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In 1998 the United States Agency for International Development (USAID) contracted with Black & Veatch International (BVI) to prepare water and wastewater master plans for the three Canal Cities. The purpose of these master plans is to guide utility infrastructure development up to the year 2020. Black & Veatch International, in association with Montgomery Watson Americas and Sabbour Associates, conducted the Canal Cities Master Plan project during the period from June 1998 to September 1999. Heath Consultants, a firm specializing in field investigations for water systems, conducted field surveys and training for leak detection, system pressures, and flow measurement during the project

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ABBREVIATIONS, TERMS AND UNITS

Abbreviations

ABB	ABB Susa Dillingham
ARE	Arab Republic of Egypt
B&V	Black & Veatch International
CAPMAS	Central Agency for Public Mobilization and Statistics
CCMP	Canal Cities Master Plan, Prepared by B&V in association with Montgomery Watson and Sabbour Associates
CIP	capital improvements project
CMC	Construction Management Consultants (joint venture of Black & Veatch International and Montgomery Watson)
CTE	Compagnie Europeene de Traitement des Eaux
EEAA	Egyptian Environmental Affairs Agency
EU	European Union
GOPP	General Organization for Physical Planning
MOI	Ministry of Irrigation
NOPWASD	National Organization for Potable Water & Sanitary Drainage
SCA	Suez Canal Authority
USA	United States of America
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
WHO	World Health Organization

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Terms

ADD	average day demands
BOD	biochemical oxygen demand
CADD	computer aided drafting and design
COD	chemical oxygen demand
dia	diameter
DO	dissolved oxygen
D_{60}, D_{10}	sand sizes (based on sieve analysis) for which 60% (10% of grains (by weight) are finer
ea	each
GIS	geographic information system
I/S	infiltration/salinity
JTU	Jackson turbidity unit
LE	Egyptian Pound
LS	lump sum
MDD	maximum day demands
Mld	megaliters/day
MPN	most probable number
N/A	not applicable
NTU	nephelometric turbidity units
O.D.	outside diameter
PHD	peak hour demands
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
S	slope
SS	suspended solids
STDO	salinity, temperature and dissolved oxygen
TDH	total dynamic head
TDS	total dissolved solids
TU	turbidity units
UFW	unaccounted-for water
ug/l	micrograms/liter
WTP	water treatment plant
WWTP	wastewater treatment plant
Y	wye connection

Units

cm	centimeter
d	day
gm	gram
ha	hectare
HP	horsepower
hr	hour
hz	hertz (cycles/sec)
kg	kilogram
km	kilometer
km^2	square kilometer
kV	kilovolt
kVA	kilovolt-ampere
kW	kilowatt
kWH	kilowatt hour
l	liter
lm	linear meter
lpcd	liters per capita per day
lps	liters per second
lpd	liters per day
m	meter
m^2	square meter
m^3	cubic meter
m^3/d	cubic meter per day
m^3/hr	cubic meters per hour
$m^3/d/km^2$	cubic meters per day per square kilometer
mg	milligram
mg/l	milligrams per liter
min	minute
ml	milliliter
mm	millimeters
m/sec	meters per second
m^3/yr	cubic meters per year
p/km^2	people per square kilometer
t	tonne (metric)
v	volt
yr	year

Executive Summary

The City of Port Said is one of three major cities along the Suez Canal. It is situated on the Mediterranean Sea at the northern terminus of the Suez Canal. The City stretches out on the reclaimed land that separates Lake Manzalah from the Mediterranean Sea up to Al Gameel, the only outlet from the lake to the sea. A ring road extends from the southern entrance of the City up to its western border at Al Gameel, traverses Lake Manzalah approximately 2 km from inland, and intersects the Port Said-Damietta coastal road that leads to the Nile Delta.

Port Said suffered considerable damage to utilities and other infrastructure during the 1967-73 war. After the war, massive reconstruction efforts were initiated to bring the original residents back to the City. In 1979, a Water and Wastewater Facilities Master Plan was prepared and completed for the City of Port Said.

The water treatment facilities and distribution system in Port Said are owned and operated by the Suez Canal Authority (SCA). Since 1980, SCA has made significant improvements to the water treatment and distribution system based on the recommendations of the 1979 Water Facilities Master Plan.

The wastewater collection and treatment facilities are owned by the Governorate. Currently the wastewater treatment plant is operated by a contract operator, however ultimate control of the facility remains with the Governorate. During the past few years significant improvements have been made to the Port Said collection and treatment facilities. These improvement have been the result of a cooperative effort between the United States Agency for International Development, the Governorate, the National Organization for Potable Water and Sanitary Drainage and other Egyptian government agencies.

In 1998, Black & Veatch International was selected by the United States Agency for International Development (USAID) to prepare water and wastewater master plans for the three Canal Cities. The purpose of these master plans is to guide utility infrastructure development up to the year 2020. Black & Veatch International in association with Montgomery Watson and Sabbour Associates conducted the Canal Cities Master Plan project during the period from June 1998 to September 1999.

Master Plan Objectives

The primary goal of this Master Plan is to define Port Said's water and wastewater needs for both existing and future conditions. Deficiencies of the existing collection and treatment system are identified, and facilities to rectify these deficiencies are recommended. Deficiencies anticipated in the future have also been identified and facilities needed to accommodate future growth are recommended.

Study Area Boundary

The study area includes both the existing urban built-up area and future build-out areas of Port Said and Port Fouad as allocated by the local and central authorities for

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future urban development projects. The study area boundary is based on ratified boundary coordinates prepared by the Governorate and on planning documents prepared by the General Organization of Physical Planning (GOPP) or the local planning department affiliated with the Ministry of Housing. The study area boundary is shown on Figure V6-ES.1, Port Said Study Area Boundary.

Preparation of the Port Said Water and Wastewater Master Plan included a review of available data, development of land use maps, water demand and wastewater flow projections for existing and future conditions, development of computer hydraulic models, evaluation of hydraulic capacities and development of an improvement implementation plan. The overall objective was to develop a phased, cost-effective plan to meet existing and future needs to accommodate ultimate build-out of the Study Area.

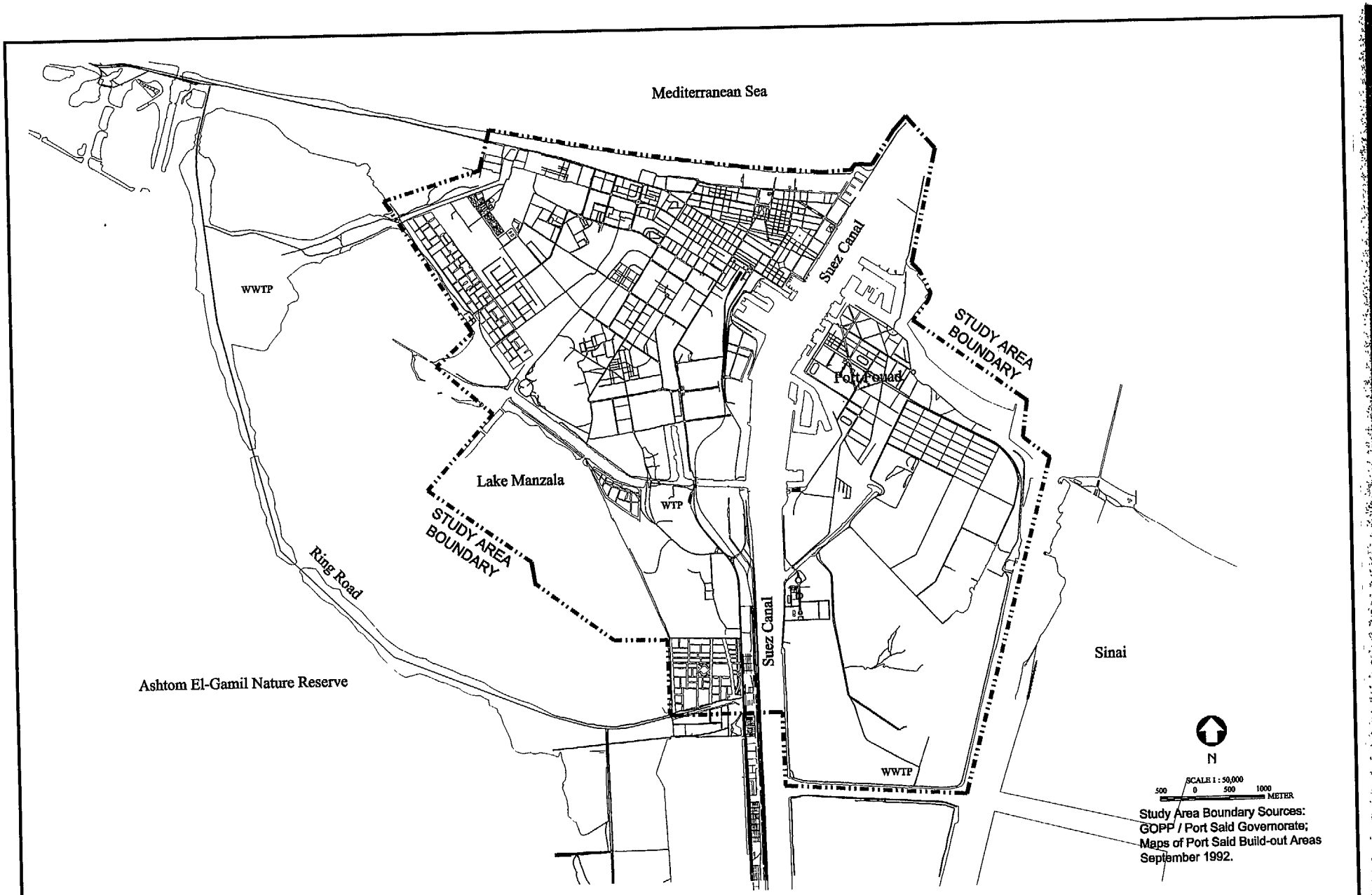
Population and Land Use

Existing and future land uses were developed for the City of Port Said. Water demand factors were applied to the different land use categories to estimate water demands. Similarly wastewater production factors were derived based on historical data and land use data. These wastewater factors were also applied to determine projected wastewater flows. Estimates of existing and projected population to year 2020 were used to obtain per capita water use and wastewater production. This was used to verify estimates for the entire study area.

The most recent topographical maps were purchased from the Central Agency for Public Mobilization and Statistics (CAPMAS) and reflected 1994 land use conditions. In order to portray the current land use conditions, additional site inspections were carried out, particularly in selected fringe areas. The inspection findings, as well as modifications to the land use registered by CAPMAS up to October 1998, were included in the land use plan of existing conditions.

Lists of ongoing and future housing and industrial development projects were compiled with the help of the Housing Department of the Governorate. The size, capacity, location, and progress status of each project were interpreted and then incorporated into the land use plan of existing conditions and, whenever applicable, into the 2020 land use plan.

Preliminary results of CAPMAS 1996 census indicated that the population of Port Said Governorate had reached 469,533. This included people living in both Port Said City and in rural areas of Al Dawahi Qism. This population figure was later revised by CAPMAS in December 1998 to 462,259. The population in the City of Port Said including Port Fouad was estimated at 430,502. This figure was used as the basis for CCMP population projections up to the year 2020. The projections were developed using different growth rates from historical data obtained from CAPMAS and the Port Said Governorate.



ARAB REPUBLIC OF EGYPT SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	INTERNATIONAL ELLIPSOIDE - HAYFORD 1909 U.T.M. PROJECTION - ZONE 36 STEREOPLOTTING BASED ON GEODETIC TRIANGULATION OF EGYPTIAN SURVEY AUTHORITY	USAID CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	PORT SAID STUDY AREA BOUNDARY DATE: AUGUST 1999 FIGURE: V6-ES.1

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The population projections were compared with projections of approved planning studies prepared by official agencies such as the Governorate, NOPWASD, or GOPP. The selected "most likely scenario" is the projection based on CAPMAS population growth rate from 1986 to 1996. This is the closest to GOPP projection in the official report titled "Study of the Urban Boundaries of Port Said," prepared in September 1992 and was used in the Master Plan.

The low occupancy housing rate methodology assumes that new housing developments would have occupancy rates equivalent to 70 percent of their maximum capacity in year 2020. Ultimate condition assumes new housing developments would have a maximum occupancy rate equivalent to 100 percent of their capacity. The projected population figures are listed in five-year increments in Table V6-ES.1, Port Said Existing and Projected Population.

Table V6-ES.1 Port Said Existing and Projected Population

Year	Population
Current	430,502
2000	466,634
2005	509,426
2010	561,465
2015	617,786
2020	692,104
Ultimate	843,594

The recommended development complies with the strategic objectives of the Government of Egypt. Those objectives include reduction in the population concentration of the Nile Valley by encouraging growth in new regions that include Sinai. Therefore, a key recommendation of the Land Use Plan is to orient the growth of Port Said eastward, in the direction of the peninsula and on the eastern bank of the Suez Canal.

The following recommendations are suggestions to improve and, whenever judged feasible, to modify the provisions of the governorate development plans.

1. Governorate Authorities should use the preliminary Port Said Structural Land Use Plan used for this Master Plan. A land use master plan should be prepared and adopted. If deviations from the preliminary land use plan occur, the utilities should take appropriate measures to modify infrastructure plans to meet the revised development needs.
2. Other Land Use principles that are anticipated in this Master Plan are listed below. Changes to this land use approach would result in changes to infrastructure needs and should be dealt with by utility planners.
   - Urban growth should be directed to the eastern side of the Suez Canal. Development should proceed on the available and accessible land in Port Fouad and in the area south of Al Dawahi.

- Reclamation of Lake Manzalah is no longer justified, and should be discontinued, to reduce or reverse the environmental damage and destruction of fishing grounds associated with reclamation.
- Land allocation should be oriented toward development of the Lake Manzalah waterfront, to end the long-standing policy of regarding the lake as an obstacle to development.
- A developed waterfront boulevard should be planned that links the City with much-needed central landscaped recreational grounds. An environmentally friendly landscaped waterfront would attract birds and complement the adjacent Ashtoum El-Gameel Natural Reserve. This would help promote both the City and the Natural Park as ecotourism destinations. The long-term economic benefits associated with this include the ability of Port Said to attract ecotourism vacation market.
- The salt ponds in Port Fouad should be preserved and converted to recreational lagoons bordering the Port Fouad public playgrounds and low-density residential zones. Like the Lake Manzalah waterfront, this type of development would also provide habitat for birds and other wildlife.
- Subdivisions A41, A42, and A43 on the strip of land leading to the Port Said wastewater treatment plant should remain undeveloped. The area surrounding the Port Fouad wastewater treatment plant should also not be developed. This will eliminate potential health hazards and odor nuisances.

3. Population growth should be monitored regularly and utility development adjusted accordingly.
4. Utilities and government agencies should form joint committees to monitor land development and communicate regularly on changing utility needs.

Existing Wastewater Collection Facilities

The Port Said wastewater service area covers approximately 13 square kilometers and is projected to expand to more than 44 square kilometers at ultimate build-out.

The current, modern community of Port Said has its origins in the construction of the Suez Canal. In the 1950s and 1960s, the General Organization for Sewerage and Sanitary Drainage (GOSSD) supervised the design and construction of infrastructure in Port Said, including much of the current wastewater system.

Additional expansion of the wastewater infrastructure occurred as the community grew. During the war between 1967 and 1973, Port Said was evacuated. The wastewater facilities, particularly treatment facilities, were damaged during the conflict. Major reconstruction was needed after the residents returned to Port Said.

The collection system continues to expand and now consists of more than 194 kilometers of 175 mm to 1200 mm wastewater lines, excluding service laterals, and more than 6,000 manholes.

A new wastewater treatment plant with a hydraulic capacity of 190,000 m^3/day was constructed in 1997 with assistance and funding from the United States Agency for International Development (USAID). The plant is located on the northwest edge of town, adjacent to the Ring Road and practically surrounded by Lake Manzala.

During preparation of the Canal Cities Master Plans a number of sources were used to obtain data on the existing wastewater collection system. Information in the form of maps and construction drawings was obtained from, NOPWASD, the Governorate, construction contractors and engineering consultants. It is important to note that no single source could be used to obtain information on the entire system. Additionally the scale of drawings, the reference datum and the level of detail varied from source to source. Ultimately a map of the system was developed by combining the available information. This map was used to plan future work and prepare the wastewater system model.

The map prepared for this project is based on the limited information that was available. Where no maps or as-builts were available, line locations were drawn from field observations. Some areas included horizontal data, but had little or no vertical data. In these areas manhole inverts were estimated using available slope data which was not tied to local or system wide datum. Existing wastewater collection pipes included in the model are shown on Figure V6-9.1, Port Said Wastewater System Recommended Improvements.

Existing Wastewater Treatment Facilities

The Port Said Wastewater Treatment Plant has been in operation since January 1997. The plant is constructed on a filled-in area in Lake Manzala. The plant has a design flow capacity of 190,000 m^3/d.

Although Port Fouad is within the Port Said Governorate, its location makes it appropriate for it to operate its own wastewater treatment plant. The plant is currently being constructed. Construction was started in February 1999 with the erection of the security fence. Piling is scheduled to be in place by January 2000. Work has also started on the first of several pumping stations.

The Port Said wastewater treatment plant has one treatment train and a design capacity of 190,000 m^3/d, average daily flow. The plant was designed to treat wastewater with influent characteristics of 330 mg/l total suspended solids (TSS) and 300 mg/l biological oxygen demand (BOD_5). The plant design calls for effluent quality to meet a standard of 50 mg/l TSS and 60 mg/l BOD_5. This represents an approximate 85% reduction of the TSS load and an approximate 80% reduction of the BOD_5 load.

This wastewater treatment plant has been designed to use a biological process to remove nutrient material from the wastewater prior to discharge. Prior to initial design of the plant, two studies were performed. The *Receiving Waters Study* and the *Basis of Design Report* were used to determine the quality of plant effluent water that could be discharged without detrimental impact to the receiving waters or the native environment. These studies, which were reviewed and approved by all pertinent Egyptian agencies and authorities, showed that plant effluent meeting the 50 mg/l TSS, 60 mg/l BOD_5 standard would not have a negative impact on the receiving waters or on the native environment.

During the 12-month period ending January 1999, average plant influent was approximately 105,000 m^3/d and average TSS and BOD_5 loads were 183 mg/l and 177 mg/l respectively. Compared to plant design capacity this represents approximately 55% of the TSS capacity and approximately 60% of the BOD_5 capacity. Since initial operation the plant has consistently met or exceeded the required effluent standards.

The infiltration during dry weather and high groundwater conditions is estimated from the results of the Infiltration/Salinity study to be 31,300 m^3/day. This represents approximately 28 percent of the average dry weather flow transported for treatment at the time of the study. The principal cause of this infiltration is high groundwater, however Port Said occasionally experiences rainfall. Evaluations of the effects of rainfall on the wastewater system are included in this Master Plan.

Planning Criteria and Methodology

Wastewater flow analyses were conducted to identify current and projected flows. Flows were developed using a land use methodology, with wastewater production factors developed for each land use category based on water records, wastewater records and estimated wastewater return rates. Future land use was based on local and the government's general land use plans. Approximately 36 percent of the existing water service area is not served by the wastewater system and/or the wastewater collected does not receive treatment. This represents approximately 115,000 residents (approximately 27 percent of the existing population) who are without complete wastewater service. Projections are for areas, which currently have water service, but no wastewater service, to be included within the wastewater system by year 2005.

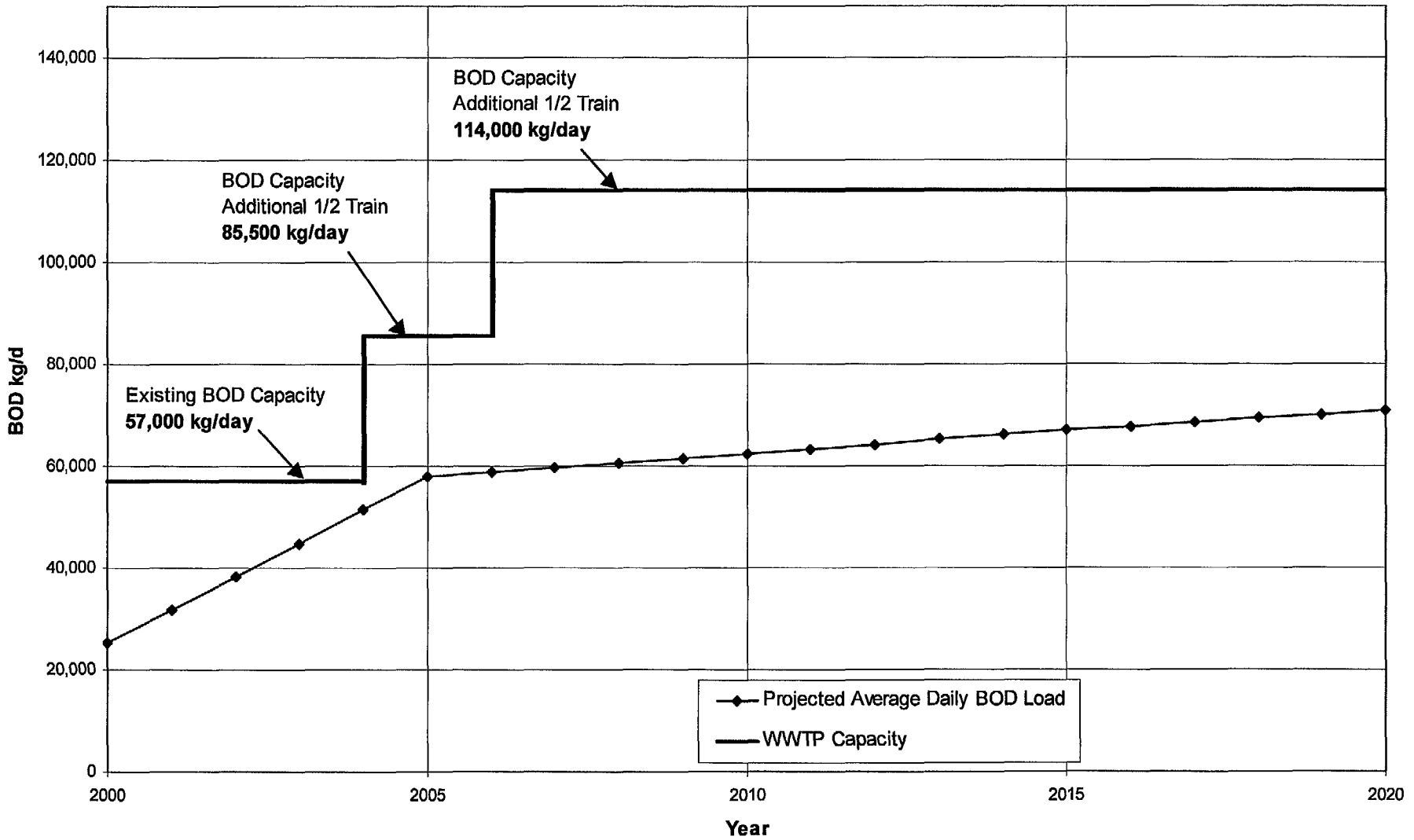
Capacity of a wastewater treatment plant is a combination of flow and BOD_5 concentration. It can be expressed as a BOD_5 mass loading rate. The plant was designed with a capacity to treat 190,000 m^3/d with a BOD_5 influent concentration of 300 mg/l. This is equivalent to 57,000 kg/d BOD_5 loading.

Using anticipated flow into the wastewater treatment plant and using an estimate of wastewater strength, the projected TSS and BOD_5 loading was estimated. A projection of future BOD_5 mass loading is shown in Table V6-ES.2, Port Said Projected Wastewater Flow and BOD_5 Load. Additionally a graphical representation of this data is shown in Figure V6-ES.2, Port Said WWTP Capacity vs. Projected BOD Load.

Table V6-ES.2 Port Said Projected Wastewater Flow and BOD Load

Year	Projected Flow (m^3/day)	Projected BOD Load (kg/day)
2000 [1]	105,000	25,300
2005 [1]	240,000	57,800
2010 [1]	259,000	62,400
2015 [1]	278,000	67,000
2020 [2]	294,000	70,800
Ultimate [2]	335,000	80,700

Notes:
1) Estimated from growth rate curve.
2) Based on an analysis of future land use and wastewater production factors.



ARAB REPUBLIC OF **EGYPT** SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	**USAID** CANAL CITIES WATER AND WASTEWATER MASTER PLAN	**PORT SAID WWTP BOD TREATMENT CAPACITY VS PROJECTED BOD MASS LOADING RATE**	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES DATE: AUGUST 1999 FIGURE: V6-ES.2

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As noted earlier in this report, the Port Said wastewater treatment plant is located on filled land that was formerly a portion of Lake Manzala. Recently the Governorate set aside an additional area in Lake Manzala to facilitate expansion of the plant. This additional land is adjacent to the existing plant and would approximately double the land area of the plant when filled.

If a second treatment train could be constructed on the adjacent land with half the capacity of the existing plant the total BOD_5 treatment capacity would increase to 85,500 kg/day. Projections in the table above show a BOD_5 of 80,700 is anticipated at the ultimate build out of Port Said.

The above table also shows the existing treatment capacity of 57,000 kg/day will be exceeded in the year 2005 if wastewater service area is extended to cover the entire water service area.

A hydraulic model of the Port Said wastewater collection system was developed as part of this project. The hydraulic model was then used to identify system deficiencies and to develop and evaluate potential facility improvements for correcting the deficiencies. The hydraulic model includes wastewater collection lines 300 mm and larger in diameter.

The peak flows in the wastewater collection system parallel water demands. To the extent that infiltration constitutes a significant portion of the average daily flow in Port Said, it reduces the amplitude of peak and low flows. Peaking factors, expressed as a multiple of the average daily flow (ADF), have been developed based on the existing WWTP records and existing water demand patterns. Table V6-ES.3, Port Said Historical Flows and Peaking Factors, presents a summary of the historical peaking factors.

Table V6-ES.3 Port Said Historical Flows and Peaking Factors

	Rate (m^3/d)	Peaking Factor
Annual Average Daily Flow (ADF) (1)	105,200	1.00
Maximum Monthly Flow(2)	110,400	1.05
WWTP Minimum Day(2)	69,400	0.66
WWTP Minimum Night-time Flow (MNF)(3)	59,000	0.85 x Min. day = 0.56
WWTP Maximum Day MDF(2)	204,000	1.95
WWTP Peak Hour PHF(4)	239,500	1.17 x MDF = 2.28

1) The annual average daily wastewater flow to WWTP from 1998 records.
2) Based on treatment plant records.
3) Minimum day on record multiplied by diurnal nighttime minimum hour.
4) Maximum day on record multiplied by diurnal daytime maximum hour.

The recommended improvement plan is based on the following criteria for phasing infrastructure needs:

Phase 1

- Construction of relief lines for hydraulic deficiencies in existing wastewater system.
- Upgrading deficient lift stations.

- Construction of extension lines to serve areas currently served by the water system which do not have wastewater facilities.
- Construction of new lift stations to serve areas currently served by water system which do not have wastewater facilities.
- Wastewater System Management Plan to include an annual program for inspecting, maintaining, and rehabilitating the existing wastewater system.

Phase 2

- Construction of new lift stations to serve growth areas without water or wastewater services.
- Construction of extension wastewater lines to serve growth areas currently without water or wastewater services.

The function and future expansion of the wastewater collection system is directly related to land use. Population and land development should be routinely monitored and appropriate changes made to the wastewater facility plans. The pipe sizes and flow rates for the recommended relief lines should be reviewed prior to construction. Design should be based on flow measurements and actual growth patterns.

Recommendations

It is recommended that the wastewater treatment processes currently used in Port Said be continued. The plant should be expanded by the year 2004 by adding a parallel treatment train of approximately half the capacity of the existing facility.

Design, construction and commissioning of the Port Said wastewater treatment expansion could easily require three to five years. This is especially true in light of the fact that the land must first be filled. It is recommended that design of this important expansion be started as soon as possible.

Intermediate sampling and testing should be conducted to monitor and adjust the performance of the plant. Disinfection should be added if mandated by EEAA; however, it is not currently included in the improvement program. A biosolids testing program should be established to determine the suitability of biosolids for beneficial use. If biosolids test successfully the current biosolids handling practice should continue, with modifications to improve the quality of solid waste added to sludge mixes by excluding glass, plastics, and ceramics.

The total projected capital cost of the Phase 1 Implementation Plan is $92 million. The current value of the Phase 2 Implementation Plan is $88 million. The recommended capital improvement projects are summarized in Tables V6-ES.4, Summary of Probable Capital Cost - Phase 1 and V6-ES.5, Summary of Probable Capital Costs - Phase 2. The approximate location of each project is indicated on Figure V6-9.1, Port Said Wastewater System Recommended Improvements. Construction costs include allowances for mobilization/demobilization, shoring, dewatering, and surface restoration. Costs will vary depending on the actual surface and subsurface conditions. The projected capital costs listed for capital improvement projects include construction

cost plus allowances of 20 percent for contingencies and 20 percent for engineering, legal, and administrative costs. No costs are included for land, rights-of-way, or rock excavation.

Table V6-ES.4 Summary of Probable Capital Cost - Phase 1

CIP No.	Construction Cost US $ (1)	Total Capital Cost US $ (2)
CIP 1 – Existing System Critical Improvements	7,044,000	8,453,000
CIP 2 – A28 Lift Station and Force Main	6,480,000	7,776,000
CIP 3 – El-Raswa Canal Eastern Interceptor	10,044,000	12,053,000
CIP 4 – Central Azmy St. Trunk System	3,720,000	4,464,000
CIP 5 – North Azmy St. Trunk System	1,152,000	1,382,000
CIP 6 – North Coast Trunk System	3,438,000	4,126,000
CIP 7 – Lake Manzala Shoreline Trunk Extension	6,000,000	7,200,000
CIP 8 – Phase 1 WWTP Expansion	33,228,000	39,874,000
Wastewater System Management Plan	NA	7,300,000
Phase 1 Totals	**$71,106,000**	**$92,628,000**

1) Construction cost includes 20 percent construction contingency.
2) Capital Cost includes construction cost and 20 percent engineering and administration cost

Table V6-ES.5 Summary of Probable Capital Cost - Phase 2

CIP No.	Construction Cost US $ (1)	Total Capital Cost US $ (2)
CIP 9 – Existing System Phase 2 Improvements	2,580,000	3,096,000
CIP 10 – Lake Manzala Interceptor/Force Main	17,442,000	20,930,000
CIP 11 – Western Trunk	3,288,000	3,946,000
CIP 12 – South Development Trunk	6,840,000	8,208,000
CIP 13 – Fish Farm Collection System	2,304,000	2,765,000
CIP 14 – South Commercial Zone System	1,920,000	2,304,000
CIP 16 – Southwest Development System	20,196,000	24,235,000
CIP 17 – North and East Development	19,320,000	23,184,000
Phase 2 Totals	**$73,890,000**	**$88,668,000**

1) Construction cost includes 20 percent construction contingency.
2) Capital Cost includes construction cost and 20 percent engineering and administration cost

Recommendations for further studies or preliminary design include the following:

- ***Wastewater System Inventory.*** As noted in the Phase I summary, a complete wastewater system inventory should be prepared. Additionally, and of equal importance, this inventory must be continuously maintained and updated. This inventory should include pipes, manholes, lift stations and force mains. Inventory detail should be added to the GIS data prepared for the Master Plan. Inventory of smaller pipes should be added to the GIS database and used for system maintenance and replacement.
- ***Wastewater Treatment Plant Capacity Analysis.*** The original design of the wastewater treatment plant was based on limited knowledge of influent characteristics. Daily operation of the plant and daily testing of influent has shown the original design was somewhat conservative. A study should be initiated to test chemical and biological characteristics of plant flow at the

influent, the effluent and at several intermediate points in the treatment train. This information should be used to re-rate plant capacity and to accurately target future plant additions and expansions.

- ***Operation and Maintenance (O&M) Cost Evaluation.*** This Master Plan also included an evaluation of Institutional conditions within the wastewater utility. This brief review showed specific financial data was not available for system O&M. A detailed study should be initiated to determine O&M levels required to maintain the collection and treatment systems. Additionally this study should include a determination of the level of funding necessary to maintain the wastewater system.

End of Executive Summary Chapter

1.0 Introduction

This section presents an overview of the work and objectives for the Port Said Wastewater Master Plan as part of the Canal Cities Master Plan Project.

1.1 Background

The City of Port Said is one of three major cities along the Suez Canal. Figure V6-1.1, Port Said Location Map, shows the locations of the three cities studied. Port Said suffered considerable damage to utilities and other infrastructure during the 1967-73 war. After the war, massive reconstruction efforts were initiated to bring the original residents back to the City. In 1979, a Water and Wastewater Facilities Master Plan was prepared and completed for the City of Port Said.

The wastewater treatment facilities in Port Said are owned by the Governorate and operated by the Suez Canal Authority (SCA). Day to day operation of the wastewater treatment plant is under the direction of the Timsah Company which is a subsidiary of SCA. The Port Said collection system is owned and operated by the Port Said Governorate. Since 1980, the National Organization for Potable Water and Sanitary Drainage (NOPWASD) and the Governorate have made significant improvements to the collection system. In 1997, the current wastewater treatment plant was commissioned. Significant portions of the funding for the planning, design and construction of this treatment plant were provided by the United States Agency for International Development (USAID).

In 1998 USAID contracted with Black & Veatch International (BVI) to prepare water and wastewater master plans for the three Canal Cities. The purpose of these master plans is to guide utility infrastructure development up to the year 2020. Black & Veatch International, in association with Montgomery Watson Americas and Sabbour Associates, conducted the Canal Cities Master Plan project during the period from June 1998 to September 1999. Heath Consultants, a firm specializing in field investigations for water systems, conducted field surveys and training for leak detection, system pressures, and flow measurement during the project

1.2 Objectives

The objective of this volume is to provide a wastewater facilities master plan for the City of Port Said from year 2000 to year 2020. The plan includes the following activities:

- Define the Study Area and describe the physical setting.
- Develop 20-year population and anticipated land use projections.
- Define existing and projected wastewater flows and loads.
- Obtain available inventory data for the hydraulic model.
- Describe and evaluate the existing wastewater treatment and collection system.

- Develop a hydraulic model to identify collection system deficiencies and analyze system extensions.
- Recommend system extensions to serve areas of future development.
- Recommend treatment improvements and identify expansion needs.
- Identify and prioritize capital improvement projects.

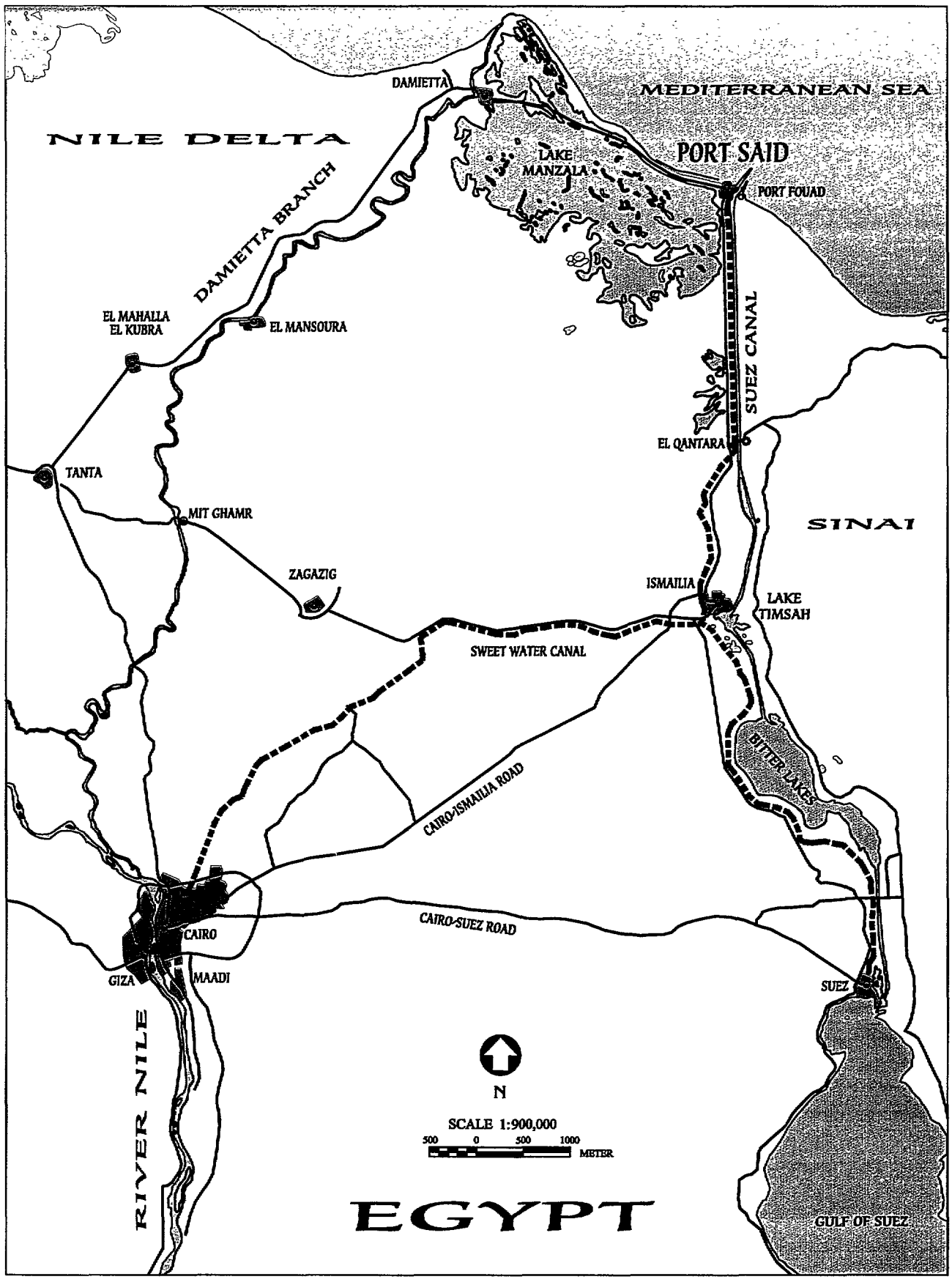
A prioritized list of capital improvement projects was prepared which includes the recommended wastewater treatment plants, lift stations, force mains, and gravity trunk lines, with order-of-magnitude cost estimates that could be used by NOPWASD to establish budgets and funding requirements.

1.3 Organization of the Report

The Port Said Wastewater Master Plan report is one of eight volumes that constitute the Canal Cities Master Plan (CCMP). The CCMP final reports address both the water and wastewater facilities requirements of the three Canal Cities. It consists of the Executive Summary and Volumes 1 through 7, listed below:

Executive Summary
Volume 1 – Suez Water Master Plan
Volume 2 – Suez Wastewater Master Plan
Volume 3 – Ismailia Water Master Plan
Volume 4 – Ismailia Wastewater Master Plan
Volume 5 – Port Said Water Master Plan
Volume 6 – Port Said Wastewater Master Plan
Volume 7 – Institutional and Financial Report

End of Chapter 1: Introduction



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ARAB REPUBLIC OF **EGYPT** SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	**USAID** CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	PORT SAID LOCATION MAP DATE:AUGUST 1999 FIGURE:V6-1.1

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2.0 Physical Conditions, Land Use, and Population

The objectives of this section of the CCMP Report are as follows:

- To present an analysis of physical conditions, land use, and population in the City of Port Said to support development of the city's water and wastewater infrastructure to the year 2020.
- To prepare phased land use plans representative of existing conditions and projections of future conditions up to the year 2020.
- To incorporate the findings and recommendations of present and future urban development plans that are approved by central and/or local government authorities into the land use plan for 2020 and into the projections of ultimate development conditions.

2.1 Study Area

2.1.1 Study Area Boundaries

The primary focus of the Canal Cities Water and Wastewater Master Plan for the communities of Port Said and Port Fouad is on those areas which are proposed for future urban development. Port Fouad is included in the Port Said Governorate and is located immediately across the Suez Canal. The urban area of interest includes approximately 10 km of the Suez Canal and 10 km of the Mediterranean shoreline from the Suez Canal westerly to Al Gameel.

The Study Area Boundary (SAB) for Port Said was determined according to the following criteria:

- The SAB demarcates both existing urban built-up areas and future build-out areas, or land allocated by local or central authorities for future urban development projects. These authorities include the Governorate Housing Department, the Ministry of Defense, the General Authority for Investment, and the General Authority for Free Zones
- The SAB marks urban districts but does not integrate all fringe area villages or rural satellite clusters. Such rural zones are excluded from the SAB even if located within the borders of districts administratively classified as urban. The exclusion is particularly applicable in the case of Port Said Governorate, since it ranks as an Urban Governorate. This jurisdictional classification means that the limits of the capital city are equivalent to the boundaries of the whole Governorate.
- The SAB is based on ratified boundary coordinates prepared by the Governorate. The boundary is defined based on the most recent available map and/or planning documents with precise cartographic coordinates, or is clearly marked on scaled maps. The planning documents have been prepared by an official planning

agency such as the General Organization of Physical Planning (GOPP) or the local planning department affiliated with the Ministry of Housing.

- The National Building Code and the National Urban Planning Code are applicable within the official limits of the city. The application of the Building Code is not compulsory in rural areas.

The Study Area Boundary according to the above criteria is presented in Figure V6-2.1, Port Said Study Area Boundary. The SAB is based on the officially ratified border for development up to the year 2015 and indicates future land uses.

The most comprehensive document establishing the coordinates of the SAB is the map titled "*Urban Limits of Port Said City: The Approbation of Port Said Build-out Area*," issued by the Third Region Planning Department of GOPP in September 1992. The Governor of Port Said approved the urban limits, the President of the City's Local Council, and the President of Port Said Urban Planning Department. The boundary of the Port Said build-out area was used as the outermost extent for planning future facilities.

2.1.2 Administrative Boundary

Study Area Boundaries also relate to administrative boundaries or official district borders. Administrative boundaries are classified as Muhafaza (Governorate); Markaz (District); Madina (Town); Hayy (Quarter); Qism (Police District); and Shiyakha (Neighborhood). These boundaries are used to register the corresponding population data in the survey system established by Central Agency for Public Mobilization and Statistics (CAPMAS). CAPMAS census data and other available information based on the same survey system were used in designating land use and population projections as discussed further in this report.

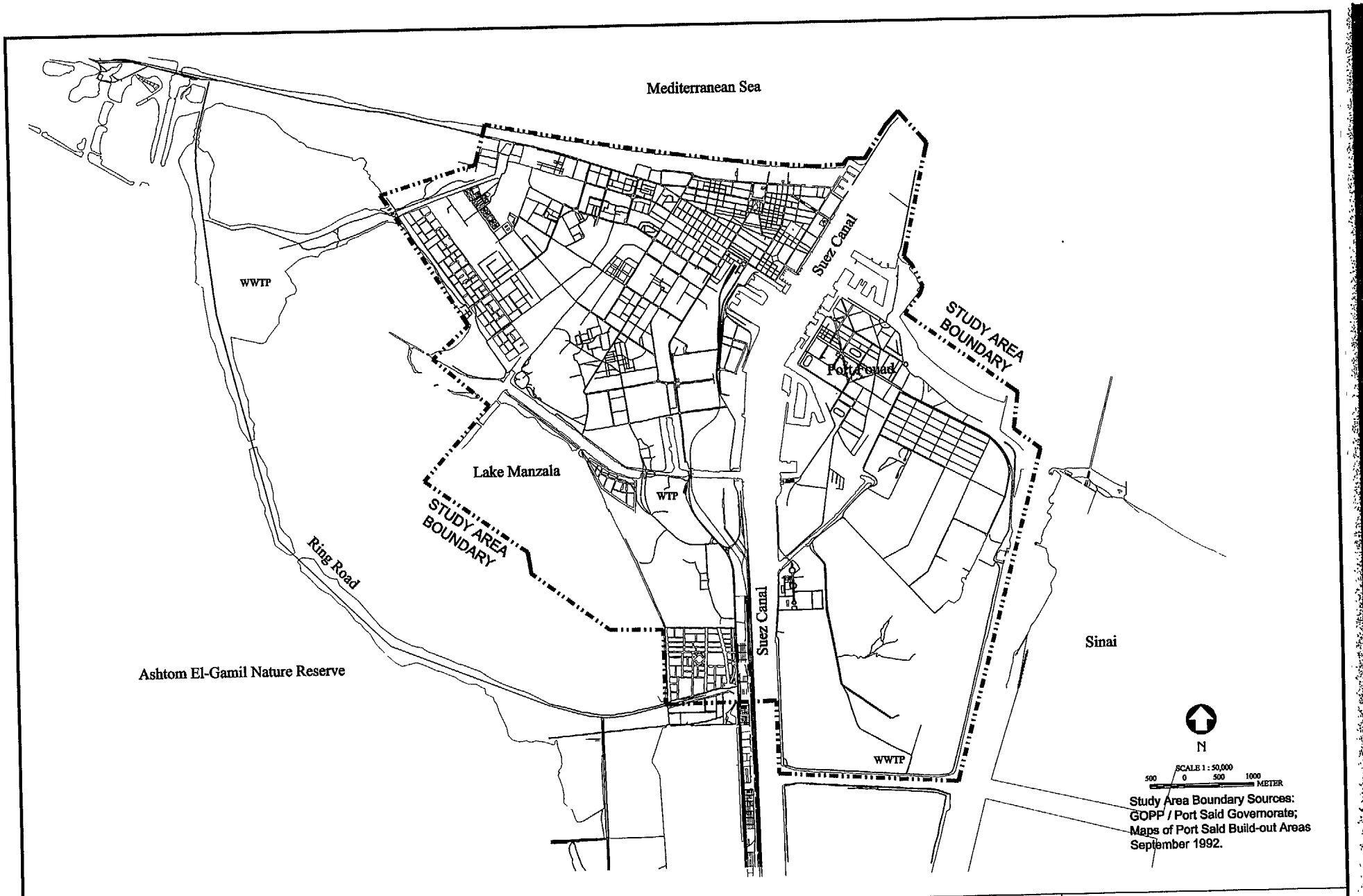
Other administrative boundaries considered in CCMP future land use planning were Natural Reserve Boundaries of protected zones declared as National Parks by official decrees or laws. National Parks are excluded from all forms of development. Ashtoum Al Gameel National Park in Lake Manzala is an example. The park is located within the administrative boundaries of Port Said Governorate in the vicinity of Port Said City, west and south of the Ring Road where it crosses the lake.

The Administrative Boundaries of the City of Port Said according to the above criteria are presented in Figure V6-2.2, Port Said Administrative Boundaries. The area within these boundaries consists of six qisms divided into 19 shiyakhas.

2.2 Physical Conditions

2.2.1 Geography and Topography

Port Said is situated on the shore of the Mediterranean Sea, at the northern terminus of the Suez Canal, on reclaimed land that separates Lake Manzala from the Mediterranean Sea.



ARAB REPUBLIC OF EGYPT SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	INTERNATIONAL ELLIPSOIDE - HAYFORD 1909 U.T.M. PROJECTION - ZONE 36 STEREOPLOTTING BASED ON GEODETIC TRIANGULATION OF EGYPTIAN SURVEY AUTHORITY	USAID CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	PORT SAID STUDY AREA BOUNDARY DATE: AUGUST 1999 FIGURE: V6-2.1

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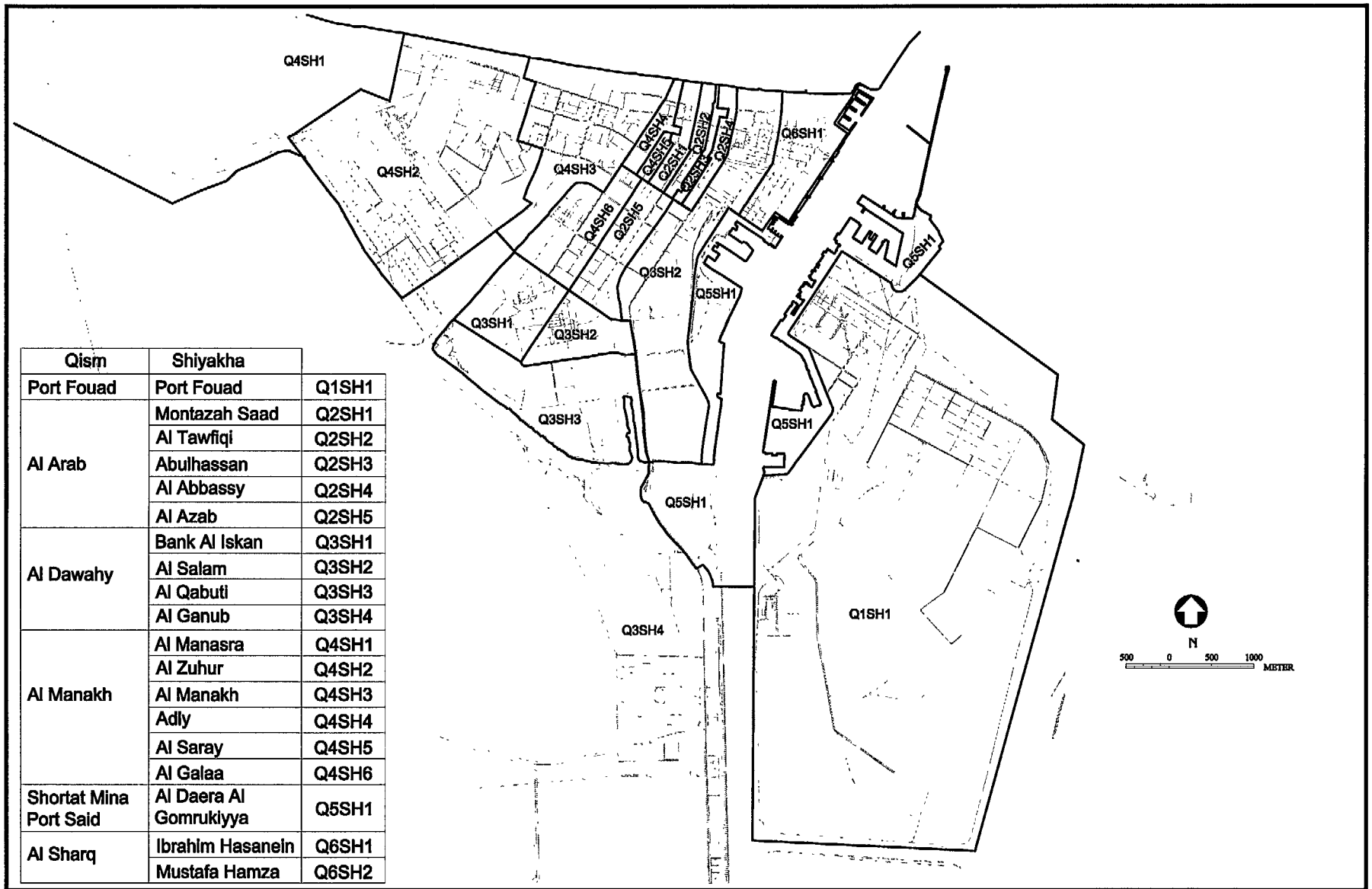

Qism	Shiyakha	
Port Fouad	Port Fouad	Q1SH1
Al Arab	Montazah Saad	Q2SH1
	Al Tawfiqi	Q2SH2
	Abulhassan	Q2SH3
	Al Abbassy	Q2SH4
	Al Azab	Q2SH5
Al Dawahy	Bank Al Iskan	Q3SH1
	Al Salam	Q3SH2
	Al Qabuti	Q3SH3
	Al Ganub	Q3SH4
Al Manakh	Al Manasra	Q4SH1
	Al Zuhur	Q4SH2
	Al Manakh	Q4SH3
	Adly	Q4SH4
	Al Saray	Q4SH5
	Al Galaa	Q4SH6
Shortat Mina Port Said	Al Daera Al Gomrukiyya	Q5SH1
Al Sharq	Ibrahim Hasanein	Q6SH1
	Mustafa Hamza	Q6SH2

ARAB REPUBLIC OF
EGYPT
SUEZ CANAL AUTHORITY
NATIONAL ORGANIZATION FOR
POTABLE WATER AND SANITARY DRAINAGE

USAID
CANAL CITIES
WATER AND WASTEWATER
MASTER PLAN

PORT SAID
ADMINISTRATIVE BOUNDARIES

BLACK & VEATCH INTERNATIONAL
IN ASSOCIATION WITH
MONTGOMERY WATSON SABBOUR ASSOCIATES

DATE: AUGUST 1999 FIGURE: V6-2.2

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A ring road extends from the southern entrance of the city to its western border at Al Gameel, and traverses Lake Manzala approximately 2 km from inland, then intersects the Port Said- Damietta coastal road that leads to the Nile Delta. The Suez Canal, with a total length of approximately 150 km, borders Port Said for about 10 km at its northern end.

The land areas are confined, because Port Said lies essentially on an island bounded on the east by the Suez Canal, on the north by the Mediterranean Sea, and on the south and west by Lake Manzala. Two corridors connect the land areas to the rest of Egypt, one on the south, along the west bank of the Suez Canal, and the other on the west, along the sand bar towards Damietta.

Port Fouad is situated on the east side of the canal, opposite Port Said. Port Fouad has similar physical characteristics and is bounded on the east by Al Tafriaa, the northeast branch of the Suez Canal and on the southeast by Al Mallahah, an area of inundated salt flats.

2.2.2 Climate

As shown in Table V6-2.1, Port Said Climatic Data, the community has a mild, generally agreeable climate. Temperatures range from 11°C to 18°C in winter and from 24°C to 30°C in summer, with an average temperature of approximately 21°C.

Table V6-2.1 Port Said Climatic Data

	Maximum Temperature °C	Minimum Temperature °C	Percent Humidity	Total Rainfall mm
Summer	30	24	72	0
Winter	18	11	71	40

Source: "Port Said Description Book" – Port Said Governorate, December 1997.

Most of the annual rainfall, averaging about 40 mm, occurs between November and March. During this period, storms of 2 to 3 days' duration are not uncommon and can include strong winds and intermittent, sometimes heavy, showers. Interspersed are spells of sunny, pleasant weather with lighter winds. In spring, the temperature contrast between the 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 *khamaseens,* strong south and southwest winds which produce thick dust clouds as they pass over the desert. A *khamaseen* may be accompanied by high temperatures, especially in April and May.

In the summer, conditions are relatively uniform, cooling sea breezes and an absence of rain. Despite the high humidity at the lower levels in the atmosphere, rain almost never occurs from June through September.

Because the Mediterranean waters cool slowly, summer conditions of sunshine and higher temperatures persist well into the autumn. The first winter storm usually does not occur until mid-November.

2.2.3 Geology, Geomorphology, and Soils

The area of Port Said, extended by beach sand accretion and fill from the canal and harbor excavations, is generally flat, between 1 and 2 meters above sea level. To the west, the area extends along a sand bar which separates Lake Manzala from the Mediterranean Sea. Initial development in Port Said was located on this sand bar; however, subsequent development has extended to the reclaimed land resulting from filling the lake with material excavated from the Suez Canal. West of the Suez Canal, accretion of beach sand against the canal breakwater has gradually extended the shoreline northward.

Subsurface layers of soft clay combined with the high water table throughout the area make it necessary to take special precautions in the construction of wastewater lines, water mains, pumping stations, and other deep structures. The bottom of Lake Manzala near Al Gameel is reported to be sandy-silty-clay.

2.2.4 Ground Water and Surface Water

Mean monthly sea levels at Port Said vary throughout the year. The level is lowest during April and highest during August and September. This is attributed primarily to changes in barometric pressure and to the effects of north winds which prevail in the summer. During the summer, mean sea levels at Port Said exceed those at Suez, and may be partially responsible for the southerly net flow in the Canal during the summer.

Predominant coastal currents in the southeastern Mediterranean Sea are from west to east; however, near-shore currents are variable and are influenced by localized winds.

In general, surface and ground water in the vicinity of Port Said is saline or brackish. Lake Manzala influences the ground water level, which averages about 0.5 meter above mean sea level. In the built-up areas of Port Said, water levels are generally 0.5 to 1.5 meters below the ground surface. The saline groundwater contains high concentrations of sulfate and chloride.

Lake Manzala is the largest of the Delta lakes of Egypt. It is approximately 60 km long and 25 km wide. Depths average 1 meter and seldom exceed 1.5 meters. Islands are numerous. The lake is joined to the Damietta branch of the River Nile at its western extremity; however, only small amounts of Nile water flow into the lake at present. The lake receives substantial quantities of agricultural return flow through several large drains along its western and southern extremities.

Ismailia Canal is the main fresh water resource in the Governorate. It brings Nile water to the Suez Canal region, including the cities of Port Said, Ismailia, and Suez. The total flow in the Ismailia Canal is 9.5 million m^3/day. Ismailia Canal is 125 km long and has three main branches:

- Suez Branch: 90 km long, including 50 km inside Suez Governorate.
- Port Said Branch: 77 km long, including 45 km inside Port Said Governorate.
- El Manayef Branch: 24 km long, all inside Ismailia Governorate.

Al Salam Canal, which is under construction, is a major national project to transport Nile water to Sinai. When completed, the Al Salam Canal will pass through the Governorates of Damietta, Daqahlia, Sharqiyya, Port Said, and Ismailia, and under the Suez Canal to the Governorate of North Sinai. The project is being constructed in two phases. The first phase, west of the Suez Canal, has been completed. The second phase, which is 175 km long, is under construction. This portion of the canal starts at the crossing point east of the Suez Canal and ends south of the coastal town of Al Areish. The volume of water conveyed in Al Salam Canal is expected to total about 4.45 billion m^3/year, with an average flow of 12.2 million m^3/day. This water will consist of a mixture of 48 percent Nile water and 52 percent agricultural drainage and is expected to help irrigate up to 620,000 feddans of agricultural land.

2.2.5 Marine Biota, Terrestrial Biota, and Environmental Pollution

Habitat in the vicinity of Port Said is diverse, ranging from the hypersaline waters of Lake Manzala to cultivated agricultural lands.

The terrestrial habitats are limited by the shortage of land and are in a state of flux. Intensive land reclamation, urban development, and activities of the military sector have produced large and often irreversible changes. Only minor areas of habitat remain undisturbed. Some stands of natural vegetation (Phragmites communis), along the shorelines of Lake Manzala and Al Mallahah, function as the interface between the terrestrial and aquatic ecosystems. A distinct feature of the Port Said surroundings is the limited diversity of biological species, especially in the terrestrial environment.

The major aquatic habitats, which include Lake Manzala, Al Mallahah, the Suez Canal, and the Mediterranean Sea, have also been modified by human activities, such as diking and land reclamation, but to a lesser extent than the terrestrial habitats. The Mediterranean Sea rests on a shallow continental shelf and has relatively low biological production. The Suez Canal contains many plant and animal species common to both the Mediterranean and the Red Sea. Lake Manzala, which receives large amounts of agricultural drainage and wastewater, has a high nutrient concentration and supports an active fishing industry. Al Mallahah, with no fresh water inflow, is hypersaline and produces a large share of the mullet caught by Port Said fisheries, although overall, it supports much less fish life than Lake Manzala.

Aquatic life forms are more varied than the terrestrial forms and differ among the four main water bodies. However, plankton in Lake Manzala, the Suez Canal, and the Mediterranean Sea have similar characteristics. In comparison with other locations, such as the salt marshes, where the mixed waters usually is accompanied by highly diverse and productive fauna and flora, the overall variety of aquatic species is limited. The Suez Canal experiences more mixing because it 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.

Productivity of the Suez Canal is highest in the Port Said zone. Many species of plankton and fish found near Port Said in the Suez Canal and the Mediterranean Sea 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 the general decline in fish, which has been observed since the 1960s. Terrestrial species are limited to a few small reptiles, fish-feeding birds, and insects, and flora consisting mainly of sedges and perennial woody shrubs.

2.3 Socio-Economic Conditions

2.3.1 Historical Background

The City of Port Said was established in 1859 at the start of construction of the Suez Canal. The city continued to grow as the importance of the Suez Canal inceased. By 1966, its population had grown to 283,000. Following the outbreak of the 1967 war, Port Said and its eastern neighbor, Port Fouad, were evacuated. The city was reopened in 1974 following the start of the Egyptian-Israeli peace talks, and the Suez Canal was reopened for navigation in 1975.

In 1976, the city acquired the status of a Tax-Free Zone, which made it an important center of transit economy and generated rapid prosperity for the city's inhabitants. Several neighborhoods were transformed into bazaar-like markets for imported goods, with shops occupying the ground floors of apartment buildings. This transit-economy commerce has gradually declined since the mid-1980s, when the Government of Egypt adopted its economic Open Door Policy, which reduced restrictions on export-import trade.

Currently the city remains a Tax-Free Zone, with traditional economic activities such as port operations and related services; construction; food processing; light industry; and domestic tourism. Commercial fishing is pursued in Lake Manzala and the Mediterranean Sea.

In the next 20 years, the importance of Port Said is expected to increase rapidly considering the following:

- The territorial area of the Governorate has gradually expanded from 150 km^2 in the 1960s up to the current 1,351 km^2.
- The completion of Al Salam Canal is expected to result in a major expansion in agricultural and industrial activities, mainly on the east bank of the Suez Canal in Sinai.
- The two important development projects, Al Tafria Industrial Port south of Port Fouad and Port Said New Seaport in Sinai, are expected to generate employment opportunities, which will benefit Port Said.

2.3.2 Socio-Economic Profile

Historical and current data on socio-economic conditions and population statistics required to analyze present conditions and to anticipate future conditions until year 2020 were derived from several official sources, including the following:

- CAPMAS National Census in 1960, 1966, 1976, 1986, and 1996.
- The comparative surveys conducted in 1992, 1995, and 1996 by the Center of Information and Support to Decision Making, a research center affiliated with the Prime Minister Bureau.
- The local Information Center of Port Said Governorate.

Additional information related to the urban environment was obtained through site reconnaissance and interviews with key officials in Port Said.

In the recent past, the Port Said Governorate Center of Information and Support to Decision Making has compiled statistics on a variety of subjects. Table V6-2.2, Comparison of Types of Buildings within Port Said Qisms, represents a comparison of the types of buildings.

Table V6-2.2 Comparison of Types of Buildings within Port Said Qisms

Qism	Residential	Commercial	Residential & Commercial	Vacant	Other	Total Buildings
Al Shark	996	949	332	111	293	2,681
Al Arab	2,673	1,386	44	348	93	4,544
Al Manakh	7,023	2,698	580	1,057	229	11,587
Port Fouad	1,601	430	62	126	33	2,252
Shorat Mina	0	511	0	71	4	586
Al Dawahi	10,192	1,757	215	1,173	101	13,438
Totals	996	7,731	1,233	2,886	753	35,088

The table illustrates that the ratio of residential buildings to commercial buildings is nearly 3 to 1.

Table V6-2.3, Port Said Manpower and Employment, provides basic information on the Port Said work force.

Table V6-2.3 Port Said Manpower Data

Work Force Statistics	
Employed	138,133
Unemployed	3,148
Never been employed	15,883
Total Work force	157,164

Source: Port Said Governorate Center with the Center of Information and Support to Decision Making – Prime Minister Bureau – November 1997.

Table V6-2.4, Port Said Unemployment Rates, provides information on unemployment from several recent reports.

Table V6-2.4 Port Said Unemployment Rates

Unemployment Rates	
1992	9.7%
1995	16.3%
1966	12.1%

Source: Port Said Governorate Center with the Center of Information and Support to Decision Making – Prime Minister Bureau – November 1997.

Hotels and resort facilities in the city have increased to nearly 3,000 beds as shown in Table V6-2.5, Port Said Hotels-1996.

Table V6-2.5 Port Said Hotels-1996

3 to 5 Star Hotel	21
Other Hotels	12
Holiday Resorts	1
Chalets	468
Youth Hostels and Holiday Camps	8
Total Number of Beds	2,725

Source: Ismailia Governorate Information Center with the Center of Information and Support to Decision Making: Prime Minister Bureau – November 1997.

Table V6-2.6, Port Said Hotel Rooms, shows that between 1992 and 1996, the city experienced a nearly 30 percent growth in the number of hotel rooms.

Table V6-2.6 Port Said Hotel Rooms-1996

Total Number of Rooms	
1992	1,021
1995	1,187
1996	1,369

Source: Ismailia Governorate Information Center with the Center of Information and Support to Decision Making: Prime Minister Bureau – November 1997.

2.3.3 Urban Environment

In comparison with most Egyptian cities, Port Said enjoys better zoning and distribution of land uses. Commercial and residential areas are separated from utilities and industrial areas, which are concentrated mostly west of the Suez Canal. Port Said is home to over 250 industrial establishments. Table V6-2.7, Port Said Industrial Establishments, provides a categorical list of these industries.

Table V6-2.7 Port Said Industrial Establishments

Type of Industry	Number of Establishments
Chemical	10
Construction materials	19
Metal work	1
Engineering	63
Wood products	30
Spinning and weaving	19
Paper Products	20
Food processing	90
Miscellaneous	1
Total	**253**

Source: Port Said Governorate Information Center with the Center of Information and Support to Decision Making: Prime Minister Bureau. November 1997.

The morphological patterns of the six most distinct neighborhoods in Port Said are shown and compared in Figure V6-2.3, Port Said Typical Building Densities.

2.3.3.1 Qism Al Arab

Al Arab consists of two distinct residential and mixed residential-commercial districts. The northern district overlooks the Mediterranean coast and contains a concentration of tourism, government, and educational facilities. The southern district, in the heart of the Port Said urban area, is highly active popular market center dealing in inexpensive imported goods and home appliances.

Traditional colonial timber-facade buildings characterize the southern district, an unmistakable feature of Port Said architectural heritage. Building uses are primarily commercial or service-oriented on the ground floor and residential on the upper floors. Average building height is six floors. Over the years, expansion has tended to proceed vertically, with the replacement of old buildings or by the addition of extra floors on concrete buildings.

Urban services are better in the northern part of Al Arab, but need substantial improvement in the southern part. Wastewater overflow and accumulation of solid waste occur. The majority of the traditional timber-facade buildings appear in disrepair. There are no urban rehabilitation or conservation plans, even though the buildings have architectural and historical value.

2.3.3.2 Qism Al Sharq

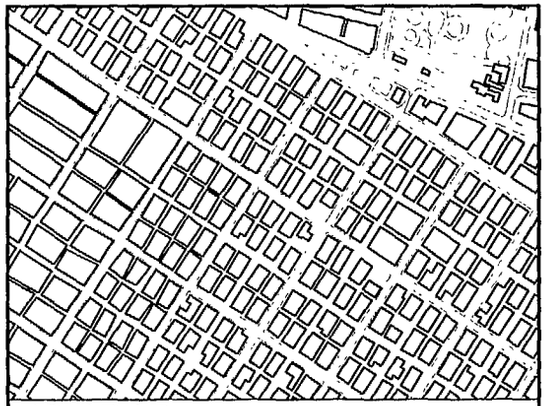
Possibly the oldest part of Port Said, Al Sharq, is the former cosmopolitan area of the city, dealing with international commerce. Al Sharq is also the shopping district for high-priced imported merchandise.

Al Sharq has many large turn-of-the-century and early 20th century buildings, wide boulevards, and landscaped squares. It is generally European in character. As a result of its considerably lower population density, Al Sharq has less street activity and is comparatively quiet. Building uses are similar to those in Al Arab, with commercial and service facilities at ground level and residential accommodations above.

2.3.3.3 *Qism Al Manakh*

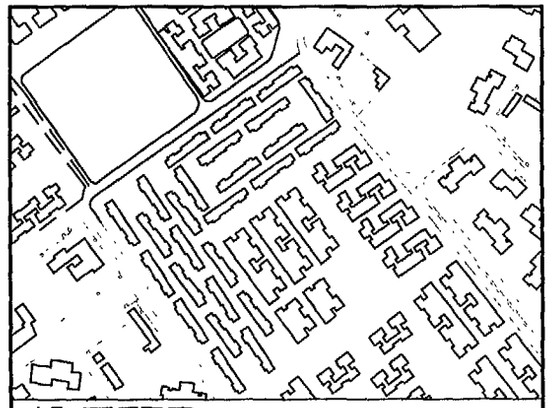
Al Manakh is the most densely populated qism in Port Said, with approximately 220,000 inhabitants. It was first developed in the 1950s as a large government housing estate of five-story apartment buildings separated by large areas of open land and wide roads. There is less activity in this district, as it lacks both the concentrated commercial establishments of Al Arab and the pleasant surroundings of Al Sharq.

Similar to Al Arab, the urban services in the government housing areas require substantial improvement. Wastewater overflows and accumulations of solid waste exist. The majority of the government apartment buildings are in urgent need of repair and maintenance. Spaces between buildings need cleaning and landscaping.

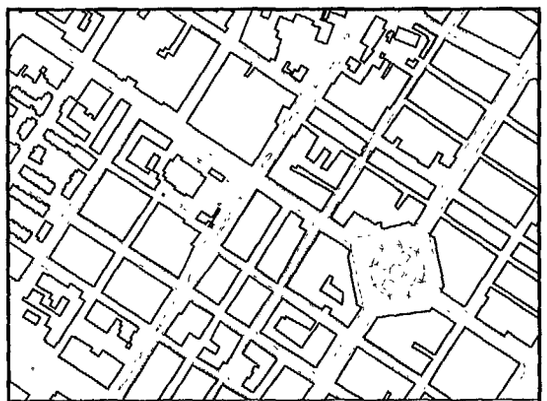


AL ARAB NRD:65,000 ABH: 6

AL MANAKH NRD:40,000 ABH: 5



AL ZUHUR NRD:35,000 ABH: 5



AL SHARQ NRD:25,000 ABH: 6

PORT FOUAD NRD:25,000 ABH: 2-4

AL QABUTI NRD:35,000 ABH: 2

N

SCALE 1:5,000

NRD = NET RESIDENTIAL DENSITY (person/km²)

ABH = AVERAGE BUILDINGS HEIGHT (no. of floors)

ARAB REPUBLIC OF EGYPT SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	INTERNATIONAL ELLIPSOIDE - HAYFORD 1909 U.T.M. PROJECTION - ZONE 36 STEREOPLOTTING BASED ON GEODETIC TRIANGULATION OF EGYPTIAN SURVEY AUTHORITY	USAID CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	PORT SAID TYPICAL BUILDING DENSITIES DATE: AUGUST 1999 FIGURE: V6-2.3

Shiyakha Al Zuhur, west and south from Al Manakh along the Port Fouad and Al Dawahi, is expected to accommodate the largest share of the population increase up to the year 2020. The new private and public housing developments have very high population densities and lack adequate landscaped open spaces. Areas initially planned as public recreation areas or gardens are occupied by contiguous apartment buildings. Many buildings remain unfinished, partly occupied, or still under construction. The ongoing construction has led to accumulations of building debris.

2.3.3.4 Qism Port Fouad

Port Fouad was first developed by the Suez Canal Authority to house its employees and their families. Residential densities in the original northern district are lower than in the new housing developments to the south. Wide thoroughfares, ample landscaped spaces and colonial residential structures, many with gardens or enclosures for plants, characterize the old district. The average height of the individual and semi-detached houses is three stories. In contrast, the new settlements bordering the salt ponds consist of rows of high-density apartment buildings of low-quality construction.

Industrial areas in Port Fouad are generally limited to the shipyard. The salt ponds, which occupy the central core of the qism, are expected to be gradually landfilled. The uninhabited southern and eastern parts of the qism are available for future development.

2.3.3.5 Qism Shortat Mina

Shortat Mina includes five isolated areas on both banks of the Canal. These areas are used for docking facilities, Suez Canal Port Authority offices, fuel storage, and shipyards.

2.3.3.6 Qism Al Dawahi

Al Dawahi consists of three distinct sections. Al Qabuti, a 25,000-inhabitant settlement, is located in the southwestern corner of Port Said adjacent to Lake Manzala. It was originally a fishing village and most of its residents still work in the fishing industry. The housing pattern has remained nearly rural. Average height of buildings is two stories. Streets are narrow and circuitous. Al Qabuti lacks adequate water and wastewater infrastructure.

Shiyakha Al Salam is a residential area north of Al Qabuti consisting of government housing built in the late 1970s. Al Salam is located next to Shiyakha Bank Al Iskan, a large development of high-density, low-cost apartment buildings adjacent to a site of low-quality, single story prefabricated houses known as Masaken Al Ewaa, or emergency houses.

Masaken Al Ewaa is one of several small subdivisions of formal and informal housing, including three slum areas where cattle breeding is a major activity:

- Al Zarayib slums, located northeast of the new WWTP.
- Zarayib Al Qabuti, located east of Port Said southern customs gate.

- Qanal Al Arab, a mostly undeveloped site along Canal Al Arab, an inner-city canal that is being filled with construction debris and domestic waste.

2.4 Current Land Use

The methodology used in developing the land use maps of existing conditions for each of the three cities is summarized below.

2.4.1 Collecting and Interpreting Relevant Cartographic Data

More than 120 maps at different scales and coordinate systems showing land use information were compiled. The maps provide detailed data relative to the following:

- Built-up areas and building utilization.
- Administrative district divisions linked to the corresponding population data for each district.
- Topographical features.
- Soil and land capability.
- Land management organization.
- Agricultural use.
- Build-out areas.

The maps were prepared or published by several institutions and agencies, including the following:

- Central Agency for Public Mobilization and Statistics.
- Centre Français d'Etudes Demographiques et Juridiques.
- Egyptian Geographical Society.
- Egyptian Survey Authority.
- General Organization of Physical Planning.
- Information Centers of Port Said, Ismailia, and Suez Governorates.
- Military Survey Authority.
- Ministry of Agriculture.
- Military Aerial Photographic Authority.
- National Organization for Potable Water and Sanitary Drainage.
- Several national and international consulting firms.

2.4.2 Selection of Standard Mapping System

The mapping system used by CAPMAS was selected as the most appropriate for CCMP for the following reasons:

- It is a comprehensive system that includes all the layers of cartographic data required for CCMP work.
- It covers all the urban areas of the three Canal Cities.
- It is the most up-to-date system identified.
- It is the only map system available in electronic digital format.

- It incorporates the population data from the most recent CAPMAS census.

Following this evaluation, the CCMP project purchased a license from CAPMAS to use a set of 52 electronic maps.

2.4.3 Primary Land Use Categorization

Cartographic data from the maps were used to determine the land use of buildings and open areas. Buildings and areas used for similar activities were grouped into land use polygons. This classification approach was adopted to (a) facilitate water and wastewater master planning and system modeling, and (b) interpret current and projected urban environment conditions. The aim of interpreting urban environments is to develop general land use recommendations for the year 2020.

2.4.4 Site Reconnaissance: Validating Primary Land Use Categorization

The findings of the primary land use classifications were confirmed through six site reconnaissance visits. The site visits examined specific urban characteristics to identify the following:

- Locations of unserved areas.
- Overall major urban rehabilitation requirements and sanitary conditions.
- Urban morphology and housing typologies.
- Future development trends in neighborhoods.
- Environmental constraints.

The most recent maps available reflected 1994 land use conditions. In order to portray 1998 land use conditions, additional inspections were carried out in selected fringe areas. The inspection findings, as well as modifications to the land uses registered by CAPMAS up to October 1998, were included in the land use plan of existing conditions.

Lists of ongoing and future housing and industrial development projects were compiled with the help of the Housing Department of each Governorate. The size, capacity, location, and progress status of each project were interpreted and incorporated into the land use plan of existing conditions and, whenever applicable, into the 2020 land use plan.

2.4.5 Calculating Net Residential Densities

Net residential densities at existing conditions were calculated according to the following steps:

Administrative boundaries of shiyakhas were demarcated on the land use plan of existing conditions.

Residential areas within each shiyakha were marked to form residential polygons.

The area of each residential polygon was computed and calculated.

The Net Residential Density of each residential polygon was calculated by dividing the population of the respective shiyakha by the area of the polygon. Net Residential Density is a value that indicates the number of residents per square kilometer.

Residential polygons with identical or similar net residential densities were combined into larger polygons.

Residential polygons were classified as having Very Low, Low, Moderate, High, or Very High Net Residential Densities.

2.4.6 Land Use Categories

The residential land use categories were derived using ranges of current and projected population densities. Land use categories which reflect water consumption and wastewater flow patterns were utilized in classifying other existing land uses. These land uses categories were used in developing the land use map illustrated in Figure V6-2.4, Port Said Existing Land Uses. The map defines areas, major facilities, and boundaries for both existing and future land uses. Table V6-2.6, Land Use Categories, describes the categories identified in the Land Use Legend on these figures and, where applicable, defines the net residential densities for that category. The same land use categories were utilized for the land use maps of future conditions.

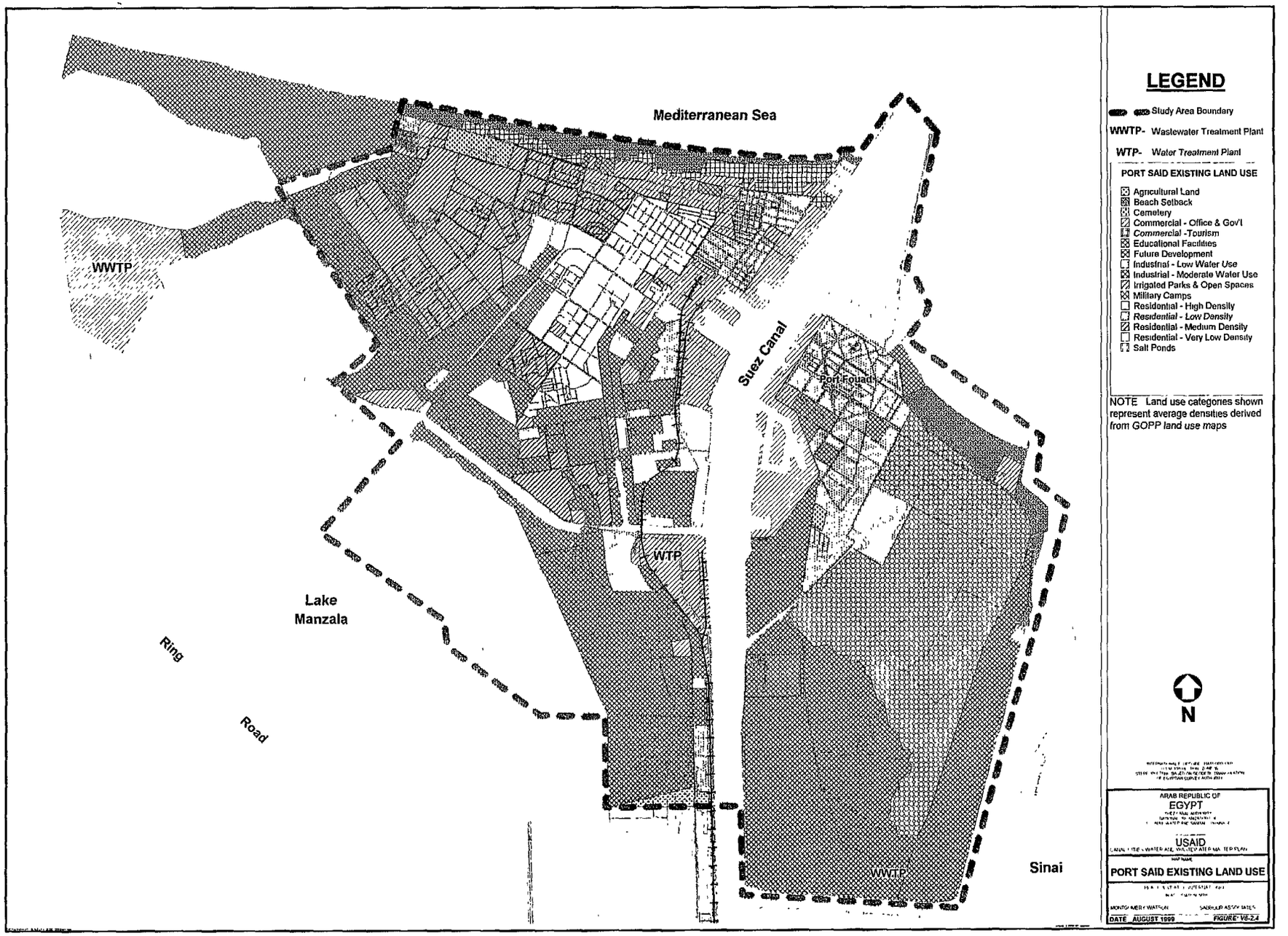
2.5 Current and Future Populations

2.5.1 Current Population

Preliminary results of CAPMAS 1996 census indicated that the population of Port Said Governorate had reached 469,533. This included people living in both Port Said City and in rural areas of Al Dawahi Qism. This population figure was revised by CAPMAS in December 1998 to 462,259.

Following a cartographic and a density analysis of the urban and rural districts of Al Dawahi, it was estimated that 430,502 people were living in the SAB in 1996. This figure was used as the base figure in CCMP population projections up to the year 2020.

At the time of preparing this report, the final results of CAPMAS 1996 census had not been published. Yet, because the preliminary results include socio-economic data relevant to CCMP work and assuming that the difference between the preliminary and final results would be minor, the available preliminary figures were used in CCMP review of the current socio-economic conditions in Port Said.


Mediterranean Sea
WWTP
Suez Canal
Port Fouad
WTP
Lake
Manzala
Ring
Road
WWTP
Sinai
LEGEND
Study Area Boundary
WWTP- Wastewater Treatment Plant
WTP- Water Treatment Plant
PORT SAID EXISTING LAND USE
Agricultural Land
Beach Setback
Cemetery
Commercial - Office & Gov'l
Commercial -Tourism
Educational Facilities
Future Development
Industrial - Low Water Use
Industrial - Moderate Water Use
Irrigated Parks & Open Spaces
Military Camps
Residential - High Density
Residential - Low Density
Residential - Medium Density
Residential - Very Low Density
Salt Ponds
NOTE Land use categories shown represent average densities derived from GOPP land use maps
N
ARAB REPUBLIC OF
EGYPT
USAID
PORT SAID EXISTING LAND USE
DATE AUGUST 1999
FIGURE V8-2.4

2.5.2 Projection Methodology

Methodology used to project inhabitants from 1996 to 2020 and to redistribute this population on future development lands is summarized in the following steps:

1. Compile historical population data by qism and shiyakha according to CAPMAS National Census for 1960, 1966, 1976, 1986, and 1996, and according to the Governorate's surveys for 1992, 1995, and 1996. This data is presented in Figure V6-2.5, CAPMAS Historical Population, and Figure V6-2.6, Port Said Historical Growth Rates.

Table V6-2.8 Port Said Land Use Categories

Land Use Category	Description
Residential – Very Low Density	Predominantly residential area with population density of less than 20,000 people/km^2.
Residential – Low Density	Predominantly residential area with population density of 20,000 to 30,000 people/km^2.
Residential – Medium Density	Predominantly residential area with population density of 30,000 to 45,000 people/km^2.
Residential – High Density	Predominantly residential area with population density of 45,000 to 65,000 people/km^2.
Residential – Very High Density	Predominantly residential area with population density greater than 65,000 people/km^2.
Commercial, Office, and Governmental	Mostly occupied by government administration/office buildings, with some residential use. It may also include services and commercial uses and seaport facilities such as docks and Port Authority's administration buildings.
Irrigated Parks and Open Spaces	High water use irrigated parks, large landscaped gardens, and greenhouses. It may also include lower water use irrigated areas, such as outdoor sports facilities, large school playgrounds, and large parking lots.
Industrial – Low Water Use	Low water use industrial activities such as auto workshops, warehouses, and oil companies, including on-dock seafront areas with fuel storage reservoirs and related equipment.
Industrial – Moderate Water Use	Moderate water use industries, within or outside designated Industrial Zones.
Unique Water Use	Exceptionally high water use industries such as refineries and chemical plants.
Future Development	Land or water surface (to be landfilled) allocated for future development.
Beach Setback	Undeveloped seafront areas and beaches.
Military Camps	Land designated for use by military or security forces. These are controlled by the Armed Forces and may be independently supplied with water and wastewater services.
Commercial Tourism	Areas occupied by hotels, resorts, or camping sites.
Water Bodies	Sea, Suez Canal and major irrigation and drainage canals.
Large Educational Facilities	Group of buildings occupied by large educational facilities, such as universities, schools or vocational training centers.
Fish Farms and Salt Ponds	Aquaculture or salt production.
Agriculture Land	Agriculture land with little or no residential use.
Cemetery	Cemetery and related facilities.

2. Project the population of each qism in 5-year stages, starting with 1996 and through the years 2000, 2005, 2010, 2015, and 2020. Use the following growth rates in three projection scenarios:
   - Population growth rate from 1986 to 1996 according to CAPMAS Census.
   - Average growth rate of the years 1992, 1995, and 1996 according to the surveys conducted by the Governorates.

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- 1996 growth rate assumed by the Governorates.

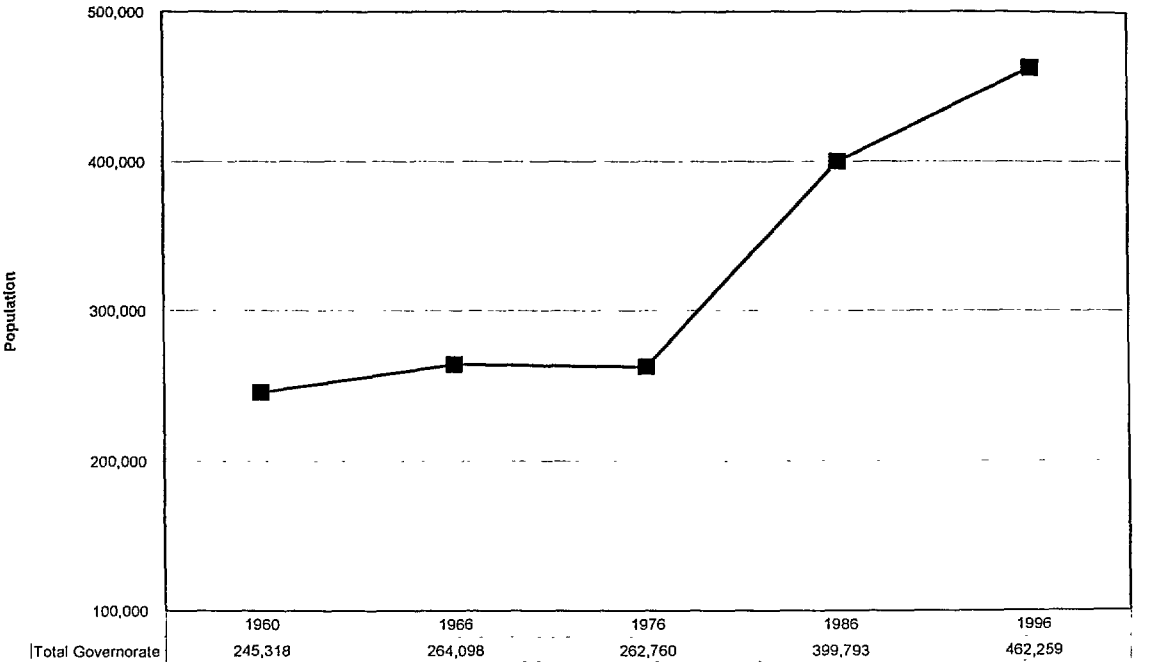
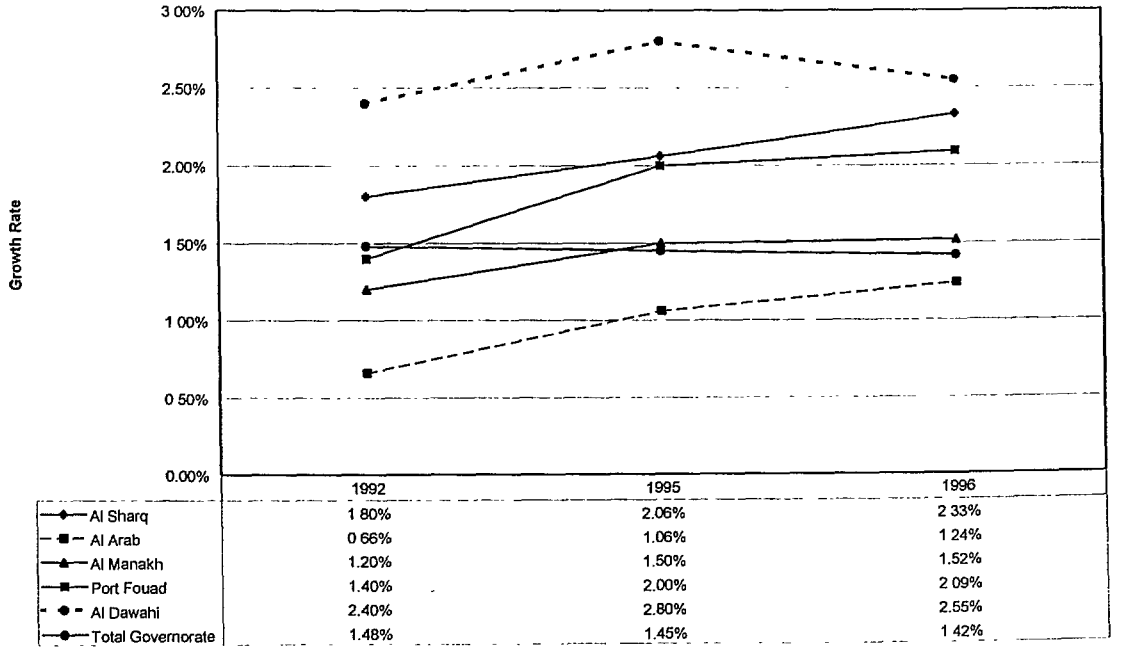


Figure V6-2.5 CAPMAS Historical Population

Source: 1960 – "Statistical Year Book", CAPMAS, June 1964, 1966 – "Statistical Year Book", CAPMAS, June 1970; 1976 – "1976 General Census Final Results: Port Said Governorate," CAPMAS, September 1978; 1986 - "1986 Complete Population Census: Port Said Governorate," CAPMAS, June 1988; 1996 - "1996 Census Report for Port Said Governorate," CAPMAS, July 1977. Note: Al Dawahi includes Ganub rural areas

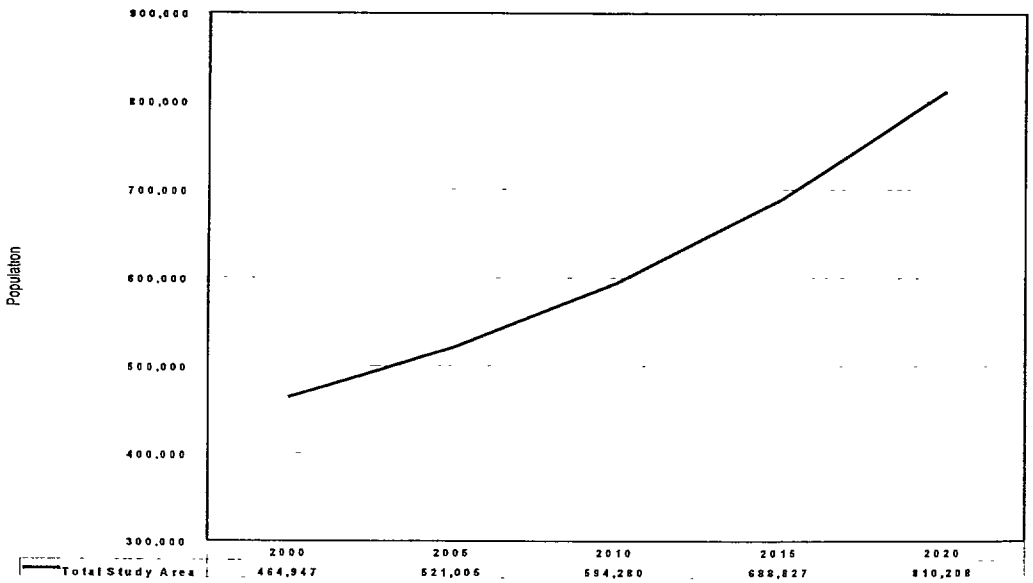
Figure V6-2.6 Port Said Historical Growth Rates



Source: "Port Said Governorate Statistical Yearbook," Governorate Information Center, November 1997. Note: Al Sharq includes Shortat Mina. Al Dawahi includes urban and rural.

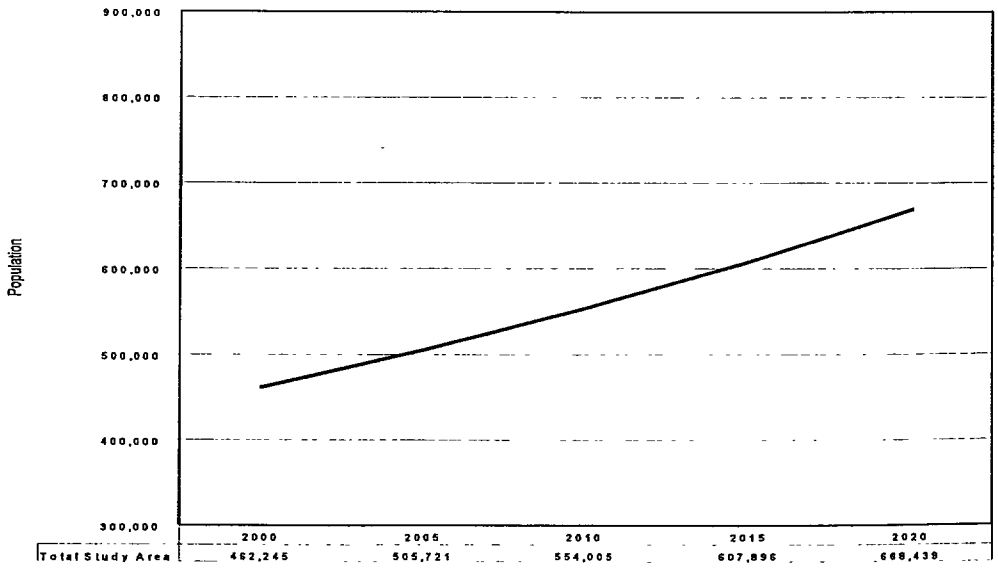
3. Compare the results of the above three scenarios, as illustrated in Figure V6-2.7, Population Projection with CAPMAS '86 and '96 Growth Rates, Figure V6-2.8, Population Projection with Governorate '96 Growth Rate, and Figure V6-2.9, Population Projection with Governorate '92, '95 & '96 Growth Rates, with the population projections of approved planning studies prepared by agencies such as the Governorates, NOPWASD, or GOPP, illustrated in Figure V6-2.10, Population Projections GOPP Study of Urban Boundaries.

Figure V6-2.7 Population Projection with CAPMAS '86 & '96 Growth Rates



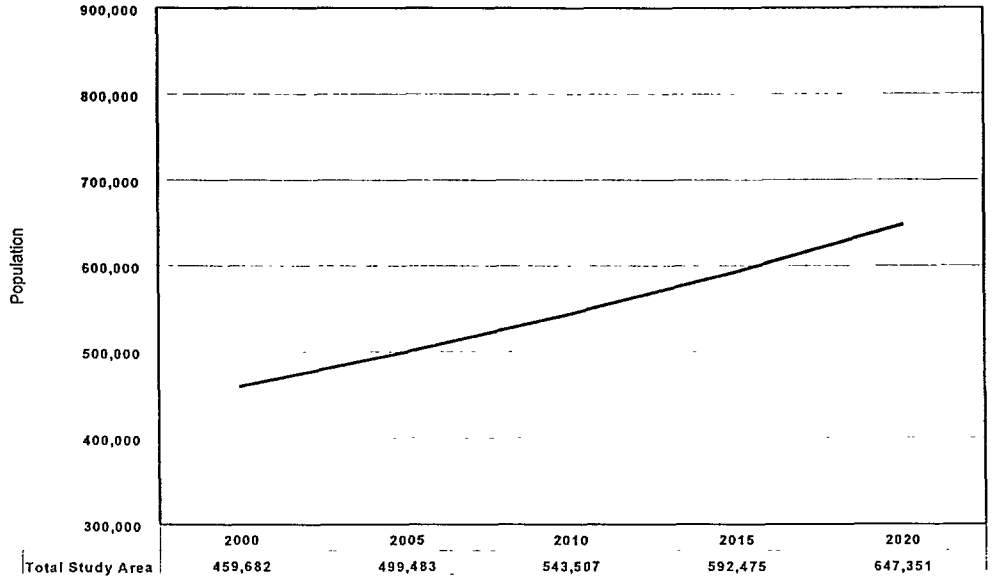
Source: 1986 Base – "1986 Complete Population Census: Port Said Governorate," CAPMAS, June 1988; 1996 Base – "Finalized Results of 1996 Census Report for Port Said Governorate," CAMAS, July 1997.

Figure V6-2.8 Population Projection with Governorate '96 Growth Rate



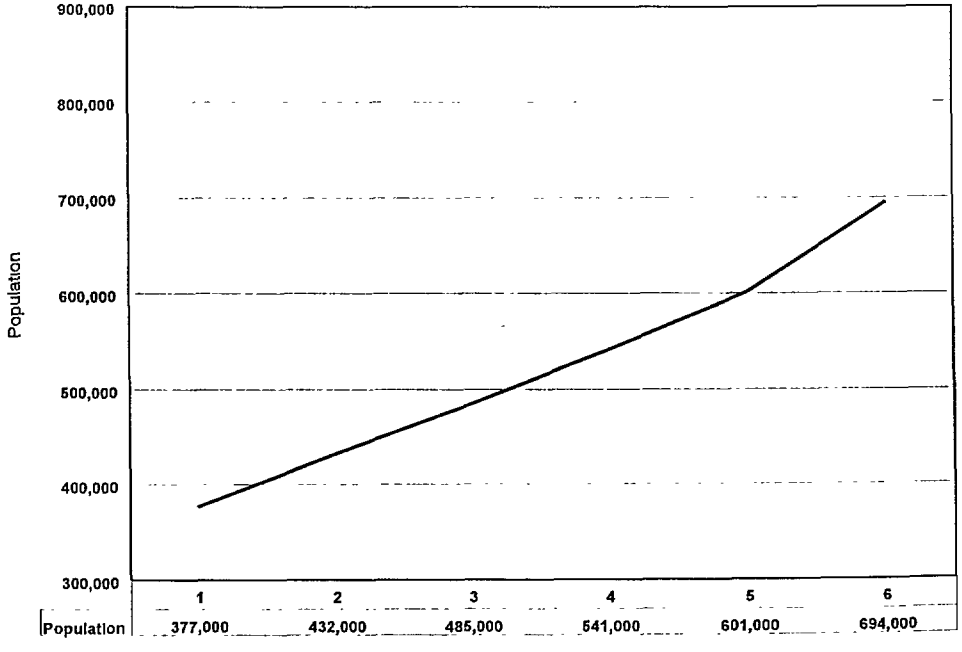
Source – CAPMAS "1996 Census Preliminary Report for Port Said Governorate"; 1996 Growth Rate – "Port Said Governorate Year Book," Governorate Information Center, November 1997; Shortat Mina Base – Growth Rate from 1986 to 1996.

Figure V6-2.9 Population Projection with Governorate '92, '95 & '96 Growth Rates



Source: 1996 Base – "Finalized Results of 1996 Census Report for Port Said Governorate," CAPMAS, July 1997; Average Growth Rates – "Port Said Governorate Year Book," Governorate Information Center, Nov. 1997; Shortat Mina Growth Rate from 1986 to 1996.

Figure V6-2.10 Population Projections GOPP Study of Urban Boundaries



Source: GOPP – "Urban Boundaries of Port Said City," Ministry of State for New Urban Communities, Sept. 1992; Hazen and Sawyer – "WWFMP," Volume 1, 1979; Department of Sanitary Drainage – Water Consumption Tables, Undated.

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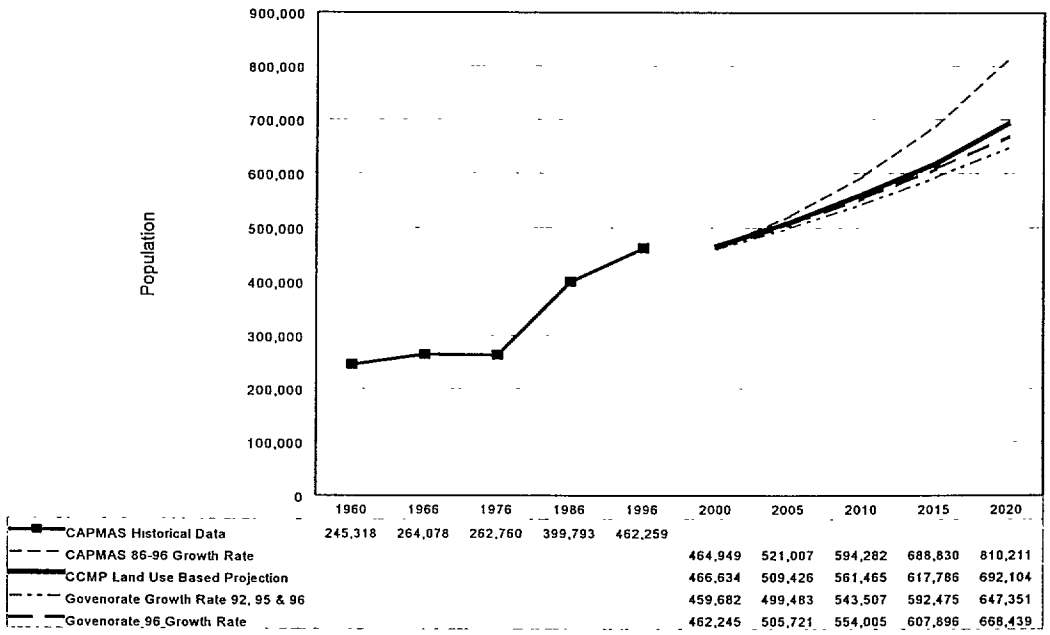
Select the most likely scenario. Ideally this would be the closest to the approved projection described in Item 3 above.

The selected "most likely scenario" is the projection based on CAPMAS population growth rate from 1986 to 1996. It is the closest to GOPP projection in the official report titled "*Study of the Urban Boundaries of Port Said*", prepared in September 1992. Figure V6-2.11, CCMP Population Projection, presents line-chart graphical depictions of population projections based on the three scenarios described in Item 2 above

Figure V6-2.11 CCMP Population Projection



2.5.3 Reconciliation of Future Development Plans

The Third Region Planning Department and GOPP have conducted comprehensive surveys to analyze the future economic development prospects of Port Said, and to project the number of new jobs that would be created in the city up to the year 2015. The studies have assessed future employment opportunities in fisheries, industry, mining, services, port and transport, tourism, and commercial activities. The results were first published by GOPP in 1992 in a report titled "Approbation Report of Port Said Build-out Area." This report was revised in 1996. The GOPP report indicated that in 2015 the total work force in the City of Port Said would reach 200,081, excluding the new urban areas south of Al Dawahi.

This figure agrees with the results of the CCMP population projection, taking into account the following:

- In 1992, the Egyptian work force equaled 30 percent of the whole population.

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- Taking into account technological progress and mechanization, by the year 2015, the work force will be 33 percent of the total population.

This suggests that the total population of Port Said in 2015 would be about 606,300. Adding to this figure the projected year 2015 population of Al Dawahi of 9,000, the total population of the study area will be approximately 615,300. The GOPP total is very close to CCMP projection for the year 2015, which is approximately 617,800.

2.5.4 Reconciliation of Future Development Plans

Urban growth of Port Said does not follow a comprehensive development plan or master plan, although an integrated master plan was prepared in 1976 by a consortium of international firms consisting of Bullen and Partners; Shankland Cox Partnership; Binnie and Partners; Peat Marwick Mitchell and Co.; and Hanna and Partners. Recommendations from this plan were, on the whole, not followed. Instead, urban growth of Port Said has consisted of progressively reclaiming land of Lake Manzala and adding it to the built-up area as new zones or subdivisions designated for residential use (A zones), green areas (B zones), industrial district (C zones), and commercial and public facilities areas (D and E zones). The build-out subdivisions have been indexed and identified graphically on a document titled "Map of Port Said Master Plan, Land Use and Transportation: Year 2000".

According to local officials, the intent of the Governorate is to reclaim and fill Lake Manzala southward and westward to the new Ring Road. To date, no studies have been carried out to assess the environmental impact of this development strategy. However, in following the Governorate strategy, the CCMP did consider the overall feasibility of the above build-out subdivisions (A, B, C, D, and E zones) and integrated appropriate portions of them into future land use plans.

2.6 Land Use Projections

2.6.1 Variations to Residential Area Population Distribution

Through analysis of existing urban conditions, development trends, net residential densities, and experience in similar municipal areas, projections were made to determine the following:

- Future Net Residential Densities of existing residential areas.
- Future Net Residential Densities of future development areas.
- Ultimate housing occupancy, or the highest Net Residential Density, in future development areas.

The future land use plan presents the land use and residential densities in year 2020, based on low housing occupancy rates. This methodology assumes that new housing developments would have occupancy rates equivalent to 70 percent. Ultimate condition differs in that it assumes new housing developments would have an occupancy rate of 100 percent.

Ultimate conditions will not occur in the study area until after 2020 (unless there is a variation to the projected population due to unforeseen factors such as gain in employment rates or change in the prevailing rate of housing occupancy).

The low occupancy rate rationale for new housing developments reflects the following considerations:

- Widespread real estate speculation. Speculators purchase apartments or houses and keep them vacant, assuming that their market value will increase. Some refrain from renting them to avoid leasing regulations that give near-ownership rights to the tenants. Others buy apartments or houses for their young children, and keep them unoccupied until the son or daughter marries and becomes the occupant.
- High market demand for affordable housing. In other terms, excess supply of unaffordable housing generated by developers who cater mostly to high revenue clientele in the formal housing sector. The high sale price places the new residential units out of reach for the majority of Egyptians, and causes them to remain vacant or unfinished for long periods.
- Low housing occupancy rate is encouraged by the low property taxes.
- Working with Governorate officials, an evaluation was conducted according to the following steps:

1. Review and make recommendations regarding approved urban and economic development plans undertaken by central and local governmental authorities.
2. Select the most appropriate location and calculate the land area needed to accommodate additional population up to the year 2020.
3. Distribute the additional population projected for the year 2020 on existing urban areas and selected future development land.
4. Stage population increases in 5-year increments (2005, 2010, 2015, and 2020) as anticipated.

Figure V6-2.12, Port Said Projected Population by Qism, presents in bar graph form the projected population by qism. Figure V6-2.13, Port Said 2020 Land Use, graphically presents the projected land uses for the year 2020, and Figure V6-2.14, Port Said Ultimate Land Use, presents the land uses for ultimate conditions. The CCMP land use is based on these projections and should be reviewed periodically for any changes to the projections, staging, or distribution.

2.6.2 Variations to Other Land Use Areas

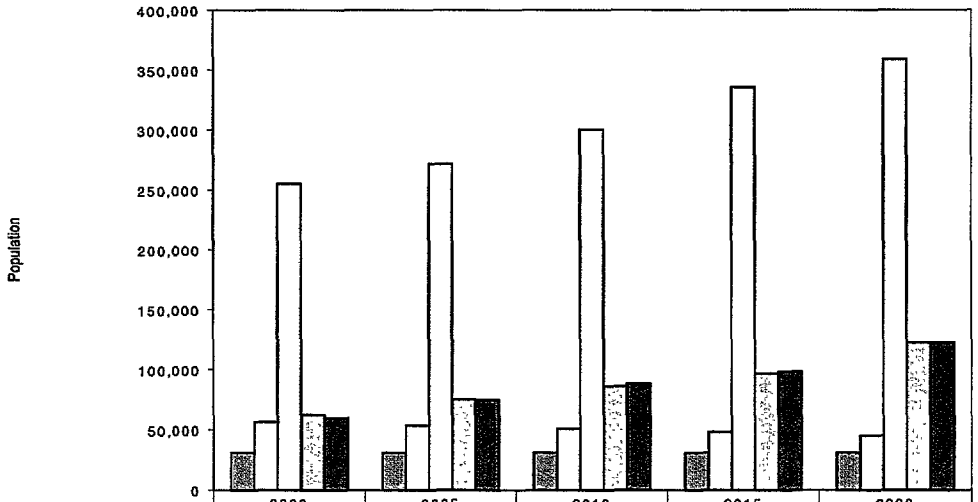
Planning for all other land use categories is assumed to remain approximately the same or to follow the projected residential growth and development trends.

2.6.3 Development of Water and Wastewater Planning

Starting with the land use maps for existing conditions and applying the projections and staging of population growth, future land use polygons were developed to reflect

with projected development. This information was digitized into computerized databases developed for electronic mapping of the study area. Utilizing a Geographical Information System (GIS), the existing and future land use maps were available for water and wastewater planning for the CCMP project.

Figure V6-2.12 Port Said Projected Population by Qism



	2000	2005	2010	2015	2020
Al Sharq TOTAL	30,746	30,746	30,746	30,746	30,746
Al Arab TOTAL	56,333	53,472	50,757	48,179	45,178
Al Manakh TOTAL	255,352	271,927	300,202	335,352	358,857
Port Fouad TOTAL	62,390	75,275	86,190	96,637	122,366
Al Dawahi TOTAL	59,658	74,659	88,375	97,872	122,437

2.6.4 Proposed Modifications to Development Plans

2.6.4.1 Recommended Relocations

As discussed in Section 2.5.3, most of the subdivisions programmed in the short-term expansion scheme of the Governorate have been integrated into CCMP future land use maps. However, it is recommended that the subdivisions identified in Table V6-2.9, Port Said Subdivisions Recommended for Relocation, be reevaluated and relocated. The planning assumptions supporting this recommendation are discussed further in this section.

Table V6-2.9 Port Said Subdivisions Recommended for Relocation

Subdivisions	Current Proposed Location	Recommended Relocation District
A36, A37, A38, A39, A40, A41	Southeast of Port Said built-up area on land to be reclaimed from Lake Manzala.	Port Fouad and south of the built-up area.
B27, B28, B29, B40	Southeast of existing Port Said built-up area on land to be reclaimed from Lake Manzala.	Al Tafria Triangle and south of the built-up area.
A43, A44, A45	Northeast of the built-up area, adjacent to the WWTP.	Port Fouad and south of the built-up area.

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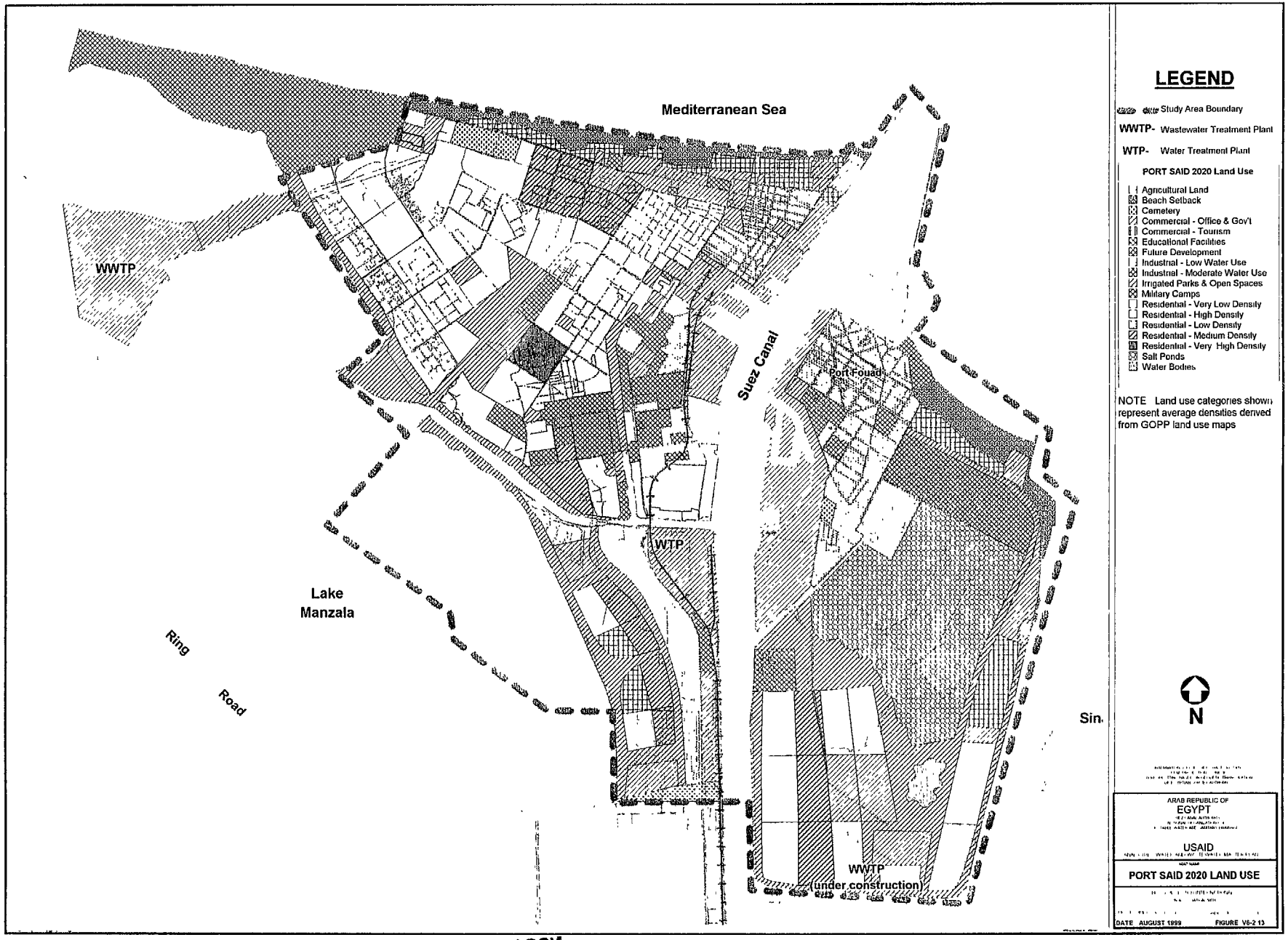

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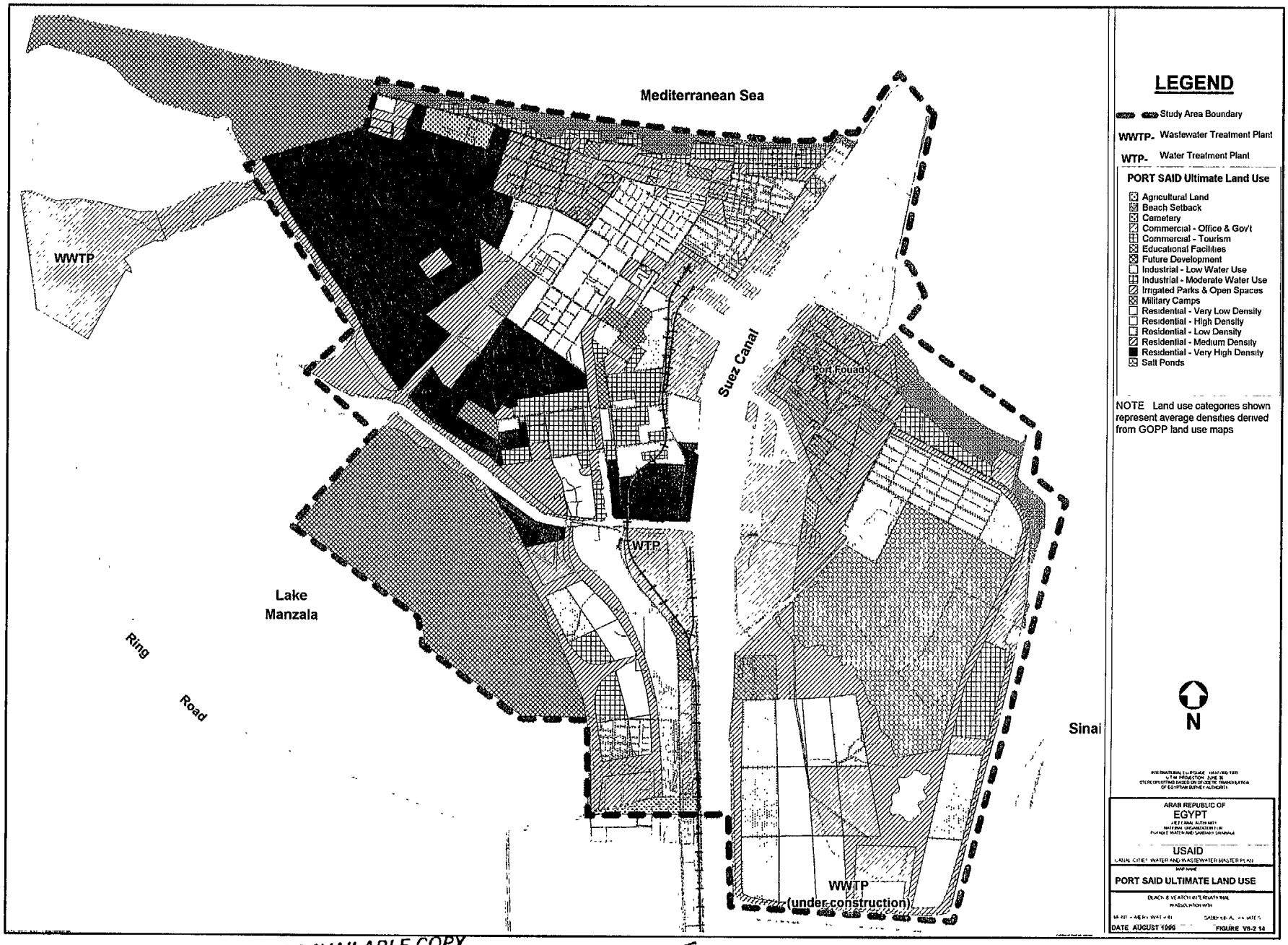

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2.6.4.2 *Planning Assumptions Justifying the Recommended Relocations*

- Major development projects planned for the east side of the Suez Canal include a large industrial area south of Port Fouad on reclaimed land of Al-Tafriaa, which is the delta island formed by the two branches of the Canal, and the new port east of Port Said in Sinai. It is expected that by the year 2020 these east bank developments will generate most of the new jobs in Port Said and North Sinai Governorates. New residential housing will be needed to accommodate the additional workers. The housing should be located as close as possible to work places; ideally, east of the Suez Canal. In the
- case of Port Said, the new residential areas should be developed on the available and accessible land south of Port Fouad.
- Ample development land to accommodate the projected population increase through the year 2020 is available south of Port Said and in Port Fouad. Reclamation of Lake Manzala would therefore no longer be necessary. In any event, reclamation should be avoided to eliminate the related environmental damage and destruction of fishing grounds, which would have adverse effects on the livelihood of the local fishermen, and may prove very costly in terms of the required compensation, relocation, and employment creation programs.
- The Governorate's approach of gradually reclaiming parts of Lake Manzala and providing land for urban development is not supported by any feasibility or environmental impact assessment studies. This approach is neither economically nor environmentally justifiable, since dry land is available in Port Fouad and south of Port Said. Furthermore, considering that Ashtoum El-Gameel Natural Park borders Port Said west of the Ring Road, reclaiming the lake area adjacent to the Park would be incompatible with the Egyptian Environmental Affairs Agency (EEAA) natural preservation objectives and efforts.

Additional land for urban expansion will soon be made available in Port Fouad, as plans are underway to close the sea salt factory and to reclaim the north part of the salt ponds. A portion of this land has already been sold for development.

2.7 General Recommendations

The recommended development complies with the strategic objectives of the Government of Egypt. Those objectives include reduction in the population concentration of the Nile Valley by encouraging growth in new regions that include Sinai. Therefore, a key recommendation of the Land Use Plan is to orient the growth of Port Said eastward, in the direction of the peninsula and on the eastern bank of the Suez Canal.

The following recommendations are suggestions to improve and, whenever judged feasible, to modify the provisions of the Governorate's development plans.

1. The Port Said Structural Land Use Plan used for this Master Plan should be used by Governorate Authorities. If deviations from the land use plan occur, the utilities should modify infrastructure to meet the revised development needs.
2. Other land use principles that are anticipated in this Master Plan are listed below. Changes to this land use approach would result in changes to infrastructure needs and should be dealt with by utility planners.
   - Urban growth should be directed to the eastern side of the Suez Canal. Development should proceed on the available and accessible land in Port Fouad and in the area south of Al Dawahi.
- Reclamation of Lake Manzala is no longer justified, and should be discontinued, to reduce or reverse the environmental damage and the destruction of fishing grounds associated with reclamation.
  - Land allocation should be oriented toward development of the Lake Manzala waterfront, to end the long-standing policy of regarding the lake as an obstacle to development.
- A waterfront boulevard should be developed to link the city with much-needed central landscaped recreational grounds. An environmentally friendly landscaped waterfront that attracts birds and complements the adjacent Ashtoum El-Gameel Natural Reserve would help promote both the city and the Natural Park as ecotourism and vacation destinations, with the associated economic benefits.
  - The salt ponds should be converted to recreational lagoons bordering the Port Fouad public playgrounds and low-density residential zones. Like the Lake Manzala waterfront, this type of development would also provide habitat for birds and other wildlife.
- Subdivisions A41, A42, and A43 on the strip of land leading to the Port Said wastewater treatment plant should remain undeveloped. The area surrounding the Port Fouad wastewater treatment plant should also remain undeveloped, to eliminate the potential for health hazards and odor nuisances.
3. Population growth should be monitored regularly and utility development adjusted accordingly.
4. Utilities and government agencies should form joint committees to monitor land development and to communicate regularly on changing utility needs.

End of Chapter 2: Physical Conditions, Land Use, and Population

3.0 Wastewater Flows

This section describes how wastewater flows were determined for existing conditions and estimated for future conditions in Port Said. Existing and expected flow rates are a critical consideration in planning and design of any wastewater infrastructure.

3.1 Introduction

The analysis of the wastewater collection system and the recommended improvements to transport existing and future flows is based on the wastewater flow projections. Flows from all existing drainage basins were established to the level of detail appropriate for hydraulic modeling.

A land use based approach was used to derive wastewater flows. The land use approach started with the development of existing and future land uses as shown on Figures V6-2.4, Port Said Existing Land Use; V6-2.13, Port Said 2020 Land Use; and V6-2.14, Port Said Ultimate Land Use. Land use categories were identified which reflect differing water consumption and wastewater flow patterns. For example, the different residential land use categories have various ranges of population density and wastewater flow. A wastewater contribution was developed for each of the existing land use categories using a unit of cubic meters per day per square kilometer ($m^3/d/km^2$). The wastewater contributions for various land uses were initially based on measured flows to the existing wastewater treatment plant compared to existing water demand factors. Flows were then adjusted to match total flows received at the wastewater treatment plant.

A land use based approach, rather than a flow per capita approach, was chosen as the method for determining wastewater flows. This approach was chosen because it provides accuracy and because the hydraulic model can be easily updated in the future.

3.2 Determination of Existing Wastewater Flows

The wastewater flow projections were based on land use maps developed as part of this study. In addition, adjustments were made for infiltration. This Master Plan integrates the future water use and wastewater generation projections coordinating implementation programs for both.

The study area was divided into a number of polygons, each of which contributes flows to a given node in the hydraulic model. MapInfo Geographic Information System (GIS) was used to determine the area of each land use category within each polygon. The wastewater return factors were then applied according to the land use category to determine wastewater flow from each polygon. An infiltration allowance is included, based on the findings of the Infiltration/Salinity Survey.

Theoretical wastewater flow rate for the existing system was compared with measured flow into the wastewater treatment plant. A wastewater return factor was

estimated by matching calculated flows with plant records. The return factor was then used to determine current and future wastewater contributions in each polygon. The calculated wastewater contributions for each polygon were added to the hydraulic model at the appropriate entry node (manhole).

3.2.1 Existing Land Use Evaluation

A list of land use categories was prepared to reflect typical land use patterns in the study area. These land use categories are listed in Table V6-2.6, Land Use Categories, and Section 2.4 describes how they were established. Areas of similar wastewater contributions were grouped and assigned to the appropriate categories. To maintain consistency, the same categories were used for both water and wastewater modeling. Some categories which receive no water or wastewater service are included to ensure that the entire study area is accounted for.

The digitized land use maps were used as base maps for existing and future wastewater system overlays. The wastewater drainage basins are individually outlined as wastewater polygons. By overlaying a polygon on the land use base map, the GIS program was used to delineate and extract the land use entities associated with each wastewater polygon. The individual land use entities were sorted and accumulated to provide a cumulative area, by land use, tributary to a given node in the hydraulic model.

3.2.2 Existing Wastewater Return Factors

Recognizing that all water supplied to customers does not return as wastewater, wastewater return factors were established according to the existing water use characteristics of Port Said. The percentage return factor allows for both losses from and additions to the wastewater collection systems.

Losses from the system flow can be attributed to the following causes:

- Water system leakage included in gross water supply, but never physically delivered to users.
- Washing of vehicles.
- Washing sidewalks and streets.
- Watering lawns and gardens.
- Dust abatement on streets in front of shops and commercial establishments.
- Incorporating water into commercial products or construction materials (such as concrete, mortar, or grout).
- Evaporation of cooling or process water.
- Makeup water for evaporation from fountains and pools.
- Water supplied to communal standpipes or areas without wastewater collection.
- Water supplied to industries or organizations which operate their own independent wastewater collection and treatment facilities.
- Leakage from wastewater pipes above groundwater level.

Additions to the system flow come from the following sources:

- Groundwater infiltration through defective joints, pipes, and manholes.
- Groundwater pumped into the wastewater system.
- Independent water production facilities which discharge into the wastewater system.
- Discharges of irrigation drainage to the wastewater system.

Since many such losses and additions occur simultaneously, the only practical estimate is to use a net percentage return factor which takes into account the difference (positive or negative) between the amount of water supplied and the amount of wastewater returned to the collection system. The return factor for Port Said was calculated at 95 percent based on Port Said's current water supply and wastewater collection records. The estimated contributions to the existing wastewater flows and the resulting wastewater return factor are presented in Table V6-3.1, Port Said Wastewater Return Factor.

Table V6-3.1 Port Said Wastewater Return Factor

Estimated Infiltration as a percentage of water Supplied (1)	Wastewater Derived From Water Supplied	Net Wastewater Return Factor
28 %	67 %	95 %

(1) As measured and reported in Phase III Infiltration/Salinity Survey Report, Morrison Knudsen Corp.

The wastewater return rate was applied to existing water use factors for each land use category to develop wastewater factors, which are presented in Table V6-3.2, Port Said Existing Wastewater Contributions by Land Use. The area of each existing land use polygon was calculated using GIS. Wastewater factors were then multiplied by the land use areas and accumulated over the wastewater service areas to determine total system flows. The resulting derived flows were calibrated with plant flow records.

Table V6-3.2 Port Said Existing Wastewater Contributions by Land Use

Land Use Category	Contribution Factors ($m^3/d/km^2$)
Commercial – Office & Government	5,700
Commercial – Tourism	5,320
Educational Facilities	1,330
Industrial – Low Water Use	380
Industrial – Moderate Water Use	9,310
Military Camps	1,710
Residential – Very Low Density	5,035
Residential – Low Density	7,885
Residential – Medium Density	10,640
Residential – High Density	14,060
Residential – Very High Density	Not Applicable

3.2.3 Existing Wastewater Flow Peaking Factors

Peaking factors represent the increase above the ADF experienced during a specified time period. The various peaking conditions are numerical values obtained from historical data and adjusted based on engineering judgment. The peak flows in the wastewater collection system reflects the water supply systems Peak Hour Demand (PHD) of 2.0 times Average Day Demand (ADD). However, the gravity system includes storage capacity, resistance to excessive flow velocities, and a wide range of transmission distances and times from various parts of the system; all of which tend to mitigate the downstream effect of peaks. In addition, infiltration will not increase as flow increases; rather, it will probably decrease as the water level and pressure in the pipe increase. To the extent that infiltration constitutes a significant portion of the average daily flow in Port Said, it reduces the amplitude of peaks and low flows. Peaking conditions that are of particular significance to hydraulic analysis of the wastewater system include the following:

- Peak hourly flow (PHF) is used for sizing collector pipes, lift stations, and force mains. PHF reflects the simultaneous peaks in seasonal and diurnal fluctuations in water use patterns, plus infiltration.
- Average, maximum, and minimum hourly flows are used in determining wet well sizes and pump configurations at lift stations.

Peaking factors, expressed as a multiple of the ADF, have been developed based on the existing WWTP records and existing water demand patterns. Table V6-3.3, Historical Flows and Peaking Factors, presents a summary of the historical peaking factors.

Table V6-3.3 Port Said Historical Flows and Peaking Factors

	Rate (m^3/d)	Peaking Factor
Annual Average Daily Flow (ADF) (1)	105,200	1.00
Maximum Monthly Flow(2)	110,400	1.05
WWTP Minimum Day(2)	69,400	0.66
WWTP Minimum Night-time Flow (MNF)(3)	59,000	0.85 x Min. day = 0.56
WWTP Maximum Day MDF(2)	204,000	1.95
WWTP Peak Hour PHF(4)	239,500	1.17 x MDF = 2.28

1) The annual average daily wastewater flow to WWTP from 1998 records.
2) Based on treatment plant records.
3) Minimum day on record multiplied by diurnal nighttime minimum hour.
4) Maximum day on record multiplied by diurnal daytime maximum hour.

Diurnal curves for Port Said were derived based on the measured hourly flows into the wastewater treatment plant. The maximum hourly peaking factor at the plant was 2.28. To account for the higher peaking factors farther upstream from the wastewater treatment plant, a peaking factor of 2.50 was used for the collection system. This factor appears realistic when compared to the WWTP peak flows derived from operating records.

The peaking factors derived for this project were based on detailed diurnal flow records at the Port Said WWTP for two weeks (one week in winter and one week in summer). The diurnal curve developed for this study is shown in Table V6-3.4, Diurnal Curve. The data is not centered around "1" due to uniform addition of infiltration.

Table V6-3.4 Diurnal Flow

Hour	Peak/Average Ratio	Hour	Peak/Average Ratio
1:00	1.478	13:00	2.011
2:00	1.649	14:00	2.106
3:00	1.008	15:00	2.106
4:00	0.950	16:00	2.501
5:00	0.866	17:00	1.737
6:00	1.649	18:00	2.011
7:00	1.649	19:00	2.501
8:00	1.649	20:00	2.106
9:00	1.827	21:00	2.202
10:00	2.011	22:00	1.918
11:00	1.827	23:00	2.202
Noon	1.918	Midnight	2.106

Data from the Port Said WWTP indicates a diurnal fluctuation as well as a definite seasonal variation in average daily flows, although the timing varies slightly from year to year. The summer average flows are about 5 percent higher than the annual average and generally last from July through October. The winter average flows are about 5 percent lower than the annual average and generally last from February through May.

Since the Port Said wastewater system experiences rainfall-induced infiltration and inflow, a wet weather flow analysis was conducted.

The extreme peak days at the WWTP are apparently associated with rainfall events. During rainfall events, flows to the wastewater treatment plant are approximately 40 percent higher than during peak dry weather conditions. Rainfall records at the Port Said office of the National Meteorological Authority indicate that for the period 1980-1989, the maximum 24-hour precipitation was 79 mm which occurred on 22 January 1987. For no other year was the recorded 24-hour precipitation greater than 24 mm. For the purposes of analyzing, a 24 mm event will be used as the design intensity storm.

The nature of the Port Said storm drain system precludes the majority of the stormwater from reaching the wastewater collection system. Stormwater is absorbed into the dry soil and building materials, ponds until it evaporates, or runs off into watercourses other than the wastewater collection system. For purposes of analyzing peak wet weather flow, a stormwater collection coefficient of approximately 0.4 is used for Port Said.

If a 24 mm rain event covers the entire wastewater collection area of Port Said, and 40 percent of it reaches the treatment plant, it would add 122,000 m^3 to the daily flow; an increase of 116 percent. The maximum recorded flow occurred during June, presumably as a result of a rain event on an average summer day. For this worst case

scenario, if the stormwater flow is added to an average summer daytime flow rate of 107,000 m^3/d, the daily flow would be 229,000 m^3/d or a peak day factor of 2.18; which correlates well with the recorded data. The peak hourly flow in the collection system will be significantly higher during or immediately after the storm, depending on the intensity of the storm and whether it coincides with the peak wastewater flow.

Collection system peaking factors were analyzed using the 1.7 peaking factor, since the design of the water system establishes a limit to the user contribution to the wastewater flow (not including infiltration or storm runoff). The 1.7 multiplied by the ADD is added to the infiltration volume and the sum is divided by the average wastewater return factor. Port Said is a special case, because of the possibility of rainfall. The upstream peak (without rainfall) would be calculated as 1.7 + 0.28/0.95 = 2.0. The highest peak flows in Port Said will be the result of rainfall. The maximum daily flow at the WWTP resulting from a rainstorm would be about 2.25 times ADF. Immediately following the storm, or if the storm occurred during an otherwise peak flow period, the system would be surcharged for a period, but the water on the surface would generally be rainwater, not wastewater. To accommodate a rainstorm during a 1.7 peak period and to carry all the water as it enters the system would require a peaking factor which is considered economically excessive, considering the rarity of such storm events in Port Said. For the purpose of evaluating the upstream Port Said wastewater collection system a collection system peaking factor of 2.5 will be used. Using this PWWF factor, it may take about 18 hours for the surcharging in the collection system to subside and for all flows to be conveyed to the WWTP.

Minimum hourly and daily flows are important for sizing pipes, lift stations, pump configurations, and force mains. The same factors that mitigate the peaking factors also reduce the fluctuations to less than the average. The minimum nighttime flow is generally considered to be the result of infiltration plus fixture leakage, with minimal user contribution. In new development areas, the minimum flow may be extremely low. This may necessitate provisions for flushing gravity systems and either parallel pipes or the use of 'pigging' facilities to regularly clean sediment from force mains.

Research conducted in North America and Europe indicates that the smaller the population served, or the ADF, the lower the minimum flow. The recommended range of minimum flows for analyzing lift stations would be 0.3 to 0.5 of the average. However, operating records for the existing system indicate a much wider range of minimum flows, from 0.0 to 0.8 of average. Analysis indicates lift stations serving relatively small commercial and industrial areas in Port Said receive extremely low minimum nighttime flows and correspondingly high peaks during working hours. At the other extreme are pump stations that serve large residential areas, which have minimum flows up to 80 percent of ADF. These high minimums, indicate hydraulic problems, such as the following:

- Pipelines with extremely flat slopes.

- Backups and surcharging caused by inadequately sized pipes.
- Blockage, sedimentation, and surcharging of pipelines and manholes.
- Excessive leakage from toilets and other fixtures.
- Unacceptably high infiltration rates.

Survey records indicate that many of these conditions are widespread in Port Said. The modeling highlights some of these hydraulic deficiencies, and recommendations are made for their correction.

For analyzing the system and making recommendations for the future, the minimum flow will be in the range of 0.3 for the smallest lift stations, and 0.5 for the largest, but 0.4 will generally be used unless otherwise indicated. When making recommendations for future system development, consideration will be given to the dominant land use and historical trends in wastewater peaks and minimum flows.

The summary of wastewater peaking and minimum flow factors used for this study is listed in Table V6-3.5, Peaking and Minimum Flow Factors.

Table V6-3.5 Peaking and Minimum Flow Factors

Peak Hourly Flow (PHF)	2.50
Minimum Night-time Flow (MNF)	0.40

3.3 Development of Future Wastewater Flows

Future wastewater flows were calculated using a process similar to that used to calculate existing flows. Development of future wastewater flow rates relies on identification of future land use which will receive water and wastewater service. Appropriate return factors were applied to the projected water demand for each future land use to determine the future wastewater contribution. The area of each future land use was calculated for each polygon and the appropriate wastewater contribution was applied to determine wastewater flows for entry into the hydraulic model. Future flows were developed for the year 2020 and for ultimate conditions.

3.3.1 Future Land Use

For both the water and wastewater master plans, future developments are based on the same land use base maps and projected population densities. Areas with development plans or development potential within the study area boundaries were identified, categorized, and mapped. This includes extending the wastewater collection system to areas which currently receive water service, but no wastewater collection, anticipating increases in density and occupancy rates within the existing developed areas, projections of growth in urban fringe areas, and projections of development on currently undeveloped land surrounded by urban uses.

Future land uses were identified using the previously established land use categories . The projected population increases were first distributed to fully utilize dwelling units, followed by allocating the remaining population increase to new developments. Therefore, residential densities in some sections of the city are anticipated to be higher

in the future, which results in existing drainage basin polygons being upgraded to higher density land use categories by year 2020 and at ultimate development.

The life expectancy of most facilities recommended under this Master Plan will extend well beyond the 20-year planning horizon. To avoid premature obsolescence of permanent utilities, it is important to consider the area's ultimate development potential and population density. Many newly developed residential areas are not expected to be fully occupied by year 2020. It is assumed that they would be 70 percent occupied by year 2020 and would reach "ultimate" or "build-out" (100 percent) occupancy by year 2025 or later.

3.3.2 Future Wastewater Return Factors

The wastewater return rate for existing conditions and existing wastewater contribution factors, presented in Tables V6-3.1, Wastewater Return Factor, and V6-3.2, Port Said Existing Wastewater Contributions by Land Use, respectively, were reviewed for use in evaluating year 2020 and Ultimate conditions. It was decided that the net effect of increased return percentage and decreased infiltration would balance each other. Therefore, the return rate of 95 percent derived for the existing system was used for projecting future contributions.

Table V6-3.6, Future Wastewater Contribution Factors, presents the future wastewater contributions used for the analysis of future collection system performance. The sole reason for an increase in future wastewater contribution from a land use category is the assumed increase in water demand resulting from increased water supply, economic improvements, and increased industrial activities.

Table V6-3.6 Future Wastewater Contribution Factors (2020 and Ultimate)

Land Use Category	Contribution Factors ($m^3/d/km^2$)
Commercial – Office & Government	5,700
Commercial – Tourism	6,384
Educational Facilities	1,330
Industrial – Low Water Use	380
Industrial – Moderate Water Use	13,500
Military Camps	1,710
Residential – Very Low Density	5,539
Residential – Low Density	8,674
Residential – Medium Density	12,768
Residential – High Density	16,169
Residential – Very High Density	Not Applicable

3.3.3 Future Wastewater Flow Peaking Factors

The peaking factors used for analyzing the existing systems were used in the analyses of the future systems. Although reductions in infiltration rates may increase peak fluctuations, the longer average travel distances from developing areas to the treatment plant will attenuate the fluctuations. The net effect will probably be about the

same as existing conditions. The existing peaking factors are based on actual data, while the magnitude of future changes could only be estimated. Existing peaking factors as presented in Table V6-3.5, Wastewater Peaking and Minimum Flow Factors, were used when calculating future peak flows, since the future variations will be small compared to the natural differences between drainage basins.

3.3.4 Phasing of Future Wastewater Collection Flows

The increase in future wastewater flows can be attributed to the following three causes: (1) extending wastewater collection to all existing water service areas, (2) population growth within existing service areas and (3) new development.

Currently, various developed areas in Port Said do not have wastewater collection. It is assumed that the initial 5-year construction program will focus on extending wastewater collection to all existing residential and commercial development. The additional flows from these areas have been added to the first 5-year incremental flow increase. After year 2005, the increases in flows reflect only population growth, and increases in per capita consumption. If expansion of the wastewater collection system expansion into existing water service areas is not completed by year 2005, the incremental increase will shift from year 2005 to the year such extensions are completed.

It is assumed that non-residential growth rate would parallel the population growth rate through year 2020. Applying this growth rate to wastewater contributions produces the 5-year incremental wastewater collection volumes presented in Table V6-3.7, Projected Interim Wastewater Flows.

Table V6-3.7 Projected Interim Wastewater Flows

Year	Average Daily Flows (m^3/day)	Peak Flows[5] (m^3/ day)
Current [1]	103,300	235,600
2000 [1]	105,000	239,400
2005 [2]	220,000	501,600
2010 [3]	244,500	557,500
2015 [3]	269,000	613,500
2020 [4]	293,600	669,400
Ultimate [4]	334,600	763,000

1) current based on 1998 WWTP data – 2000 based on recent trends.
2) based on addition of wastewater collection in areas with current water service plus population growth.
3) based on population growth.
4) based on future land, water and wastewater factors.
5) 2.28 peaking factor at the WWTP.

The estimates of future flows in this Master Plan are based on today's conditions, anticipated population growth, and anticipated development of the water supply system. Conditions which could delay the projected increases in wastewater flow include slower than anticipated expansion of wastewater collection service into developed areas and

slow development of water system improvements to meet the projected water demands. Conditions which could accelerate the growth in wastewater flows include higher than anticipated growth rates, intensification of land use beyond that estimated, and development beyond the study area boundaries.

Based on derived wastewater flow factors and associated land use categories, flows were calculated for existing and future conditions. Total wastewater flows by land use category are presented in Table V6-3.8, Projected Wastewater Flows. Actual flows will differ from the projections if the growth of the respective land use differs. It is very important that land use and flow projections be updated regularly.

3.4 Distribution of Wastewater Flows

As a part of developing the hydraulic network model, wastewater collection system contribution nodes and nodal polygons reflecting wastewater flows and tributary boundaries, respectively, were identified. Model nodes and their respective nodal polygons were defined by system characteristics such as piping configurations, topography, minimum grade for various diameters of pipe, and proximity to other existing nodal polygons. Once established, nodal polygons and land use polygons were given various attributes to reflect their state of development at various time frames: existing, 2020, and ultimate development.

The nodal polygons were overlaid on the land use polygons for the time frames of interest to calculate the area of each land use within each drainage basin polygon. Wastewater contributions were applied to the land use areas to determine the average daily flow (ADF) associated with each wastewater drainage polygon. The ADFs were the basic nodal input to the hydraulic model. Diurnal curves were then used in the hydraulic model to obtain peak flows.

Table V6-3.8 Projected Average Daily Wastewater Flows

Land Use Category	Existing	2020	Ultimate
Commercial – Office & Government	6,623	38,202	38,200
Commercial – Tourism	3,713	10,293	10,651
Educational Facilities	270	965	965
Industrial – Low Water Use	226	1,396	1,396
Industrial – Moderate Water Use	10,719	15,910	15,910
Military Camps	341	927	927
Residential – Very Low Density	1,337	11,425	490
Residential – Low Density	6,367	27,517	35,351
Residential – Medium Density	39,173	32,925	42,854
Residential – High Density	34,577	154,038	66,155
Residential – Very High Density			121,732
Total Average Daily Flow	103,345	293,600	334,632

1) Port Said wastewater collection system without Port Fouad.
2) Port Said with Port Fouad.

End of Chapter 3: Wastewater Flows

4.0 Existing Wastewater Collection System

This section contains a description of the existing wastewater collection system in Port Said. The system is owned, operated, and maintained by the Governorate, NOPWASD, and other government agencies, including SCA and the military. Small portions may be controlled by private industry.

The Port Said wastewater service area covers approximately 13 square kilometers and is projected to expand to more 44 square kilometers at ultimate build-out.

The current, modern community of Port Said has its origins in the construction of the Suez Canal. In the 1950s and 1960s, the General Organization for Sewerage and Sanitary Drainage (GOSSD) supervised the design and construction of infrastructure in Port Said, including much of the current wastewater system.

Additional expansion of the wastewater infrastructure occurred as the community grew. During the war between 1967 and 1973, Port Said was evacuated. The wastewater facilities, particularly treatment facilities, were damaged during the conflict. Major reconstruction was needed after the residents returned to Port Said.

The collection system continues to expand and now consists of more than 194 kilometers of 175 mm to 1200 mm wastewater lines, excluding service laterals, and more than 6,000 manholes. A new wastewater treatment plant with a hydraulic capacity of 190,000 m^3/day was constructed in 1997. The plant is located on the northwest edge of town, adjacent to the Ring Road and practically surrounded by Lake Manzala.

4.1 Wastewater Collection Facilities (Pipes)

Figure V6-4.1, Port Said Wastewater Existing Pipe Network and Table V6-4.1, Inventory of Port Said Wastewater Collection Pipes, provide an inventory of collection system pipe as recorded in the survey report prepared in 1995 by Morrison Knudsen (MK) for the Canal Cites Phase II project.

Table V6-4.1 Inventory of Port Said Wastewater Collection Pipes

Total Length (meters) of Wastewater Pipe by Diameter							
125mm	175mm	225mm	300mm	375mm	400mm	450mm	500mm
356	111,437	31,596	14,797	5,690	1,972	3,259	7,838
600mm	700mm	750mm	800mm	900mm	1000mm	1200mm	**Total**
2,319	961	92	1,593	1,824	757	424	**184,915**

4.2 Wastewater Collection Facilities (Lift Stations)

The wastewater collection system of Port Said consists of gravity collector and interceptor lines which transport flow to 16 major lift stations. Eleven of these stations discharge to the Mazrah Lift station. The Mazrah station is the main lift station for the city and occupies a site near the old treatment plant.

The new wastewater facilities of Port Said include the influent pump station (Mazrah), with force main, wastewater treatment facilities, effluent pumping station, and a plant outfall discharging to Lake Manzala. The Mazrah station is equipped with four Archimedes screw type pumps, each is rated at 127,000 m^3/day. A standby generator is provided at the station to assure continuos operation in case of electric power supply failure. Wastewater from the Mazrah station travels through a new 2000 mm force main to the wastewater treatment plant site. Table V6-4.2, Lift Stations Inventory, provides information on the lift stations.

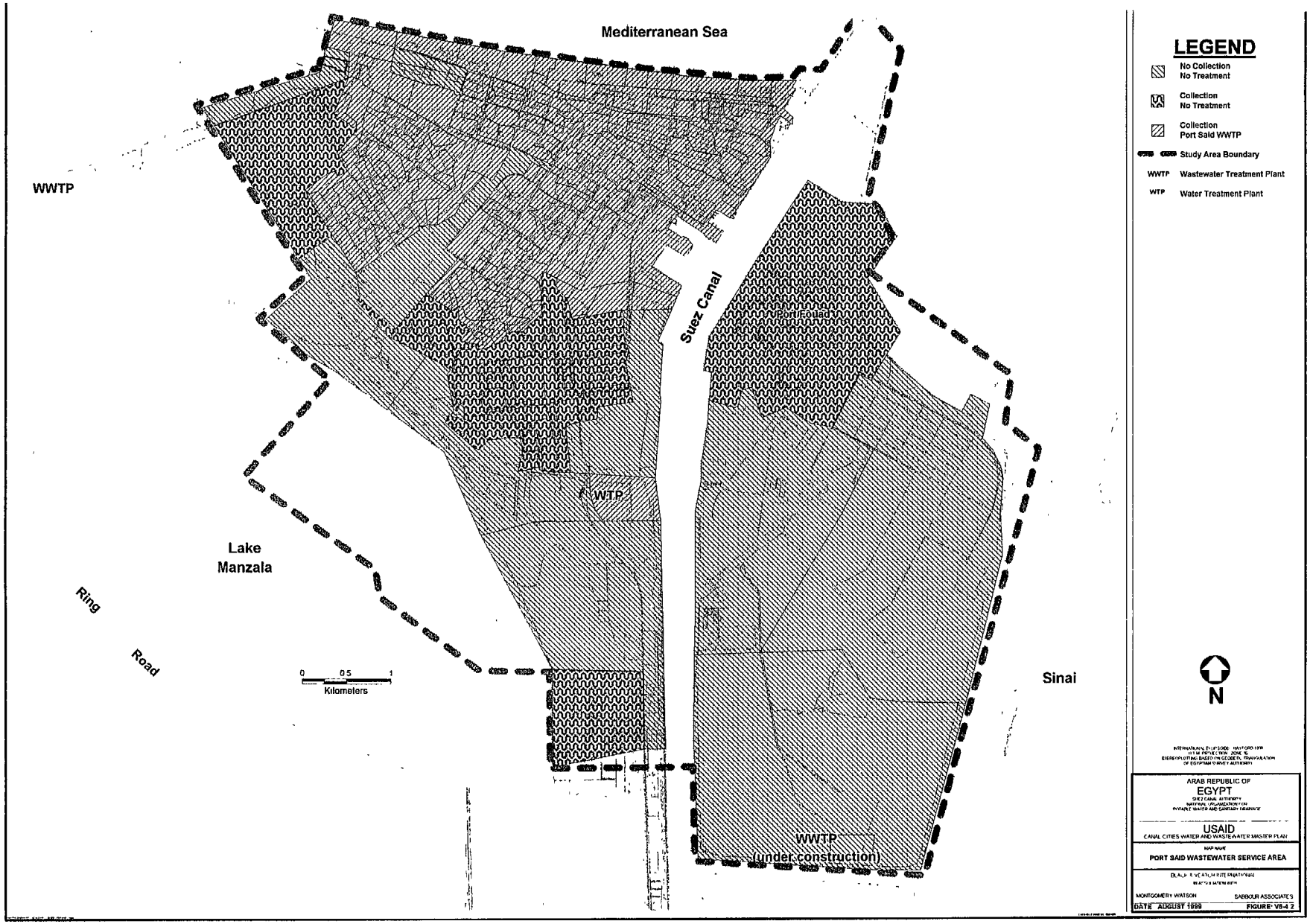
Table V6-4.2 Lift Stations Inventory

Name of Station	No of Pumps	Firm Capacity (m^3/day)(1)	Force Main Diameter (mm)
Lift Stations Included in Hydraulic Model			
Alpijo (4D)	4	25,000	600
Al-Salam (8D)	4	25,200	700
Al-Zohoor (A22) (3)	5	51,840	600
Al-Zohoor (11S) (3)	4	62,200	700
Istismar	3	5,200	350
23rd July (1S) (3)	4	25,900	500
Main (8S) (3)	5	34,500	300
Mazrah	4	127,000	1500
South Metwaly (10S)	6	16,180	900
Tameer (R1) (3)	2	11,200	350
Tameer (R2) (3)	3	38,000	400
Lift Stations Not Included in Hydraulic Model			
Amal	-	-	-
Labana	-	-	-
Saleh Saleem	-	-	-
Stadium	-	-	-

1) Volume 1, Infiltration/Salinity Survey, Revision 3 – February 1998.
2) Force main lengths estimated using MapInfo database.
3) Lift Stations scheduled for upgrade or replacement of pumps – other Lift Stations may have non-pump related rehabilitation.

4.3 Existing Areas Without Wastewater Collection

Elimination of the discharge of untreated wastewater and extending service to areas currently without wastewater collection are a major health concern and are high priority for the Port Said Governorate and NOPWASD. Port Said includes neighborhoods which have water service, but no wastewater collection or wastewater collection but no wastewater treatment. Figure V6-4.2, Port Said Wastewater Service Area, shows the areas where wastewater is currently not collected or is not treated.



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This report identifies these areas and provides information for prioritizing the construction of wastewater facilities. Table V6-4.3, Wastewater Service Areas, lists information on areas without wastewater collection or treatment.

Table V6-4.3 Port Said Wastewater Service Areas

Area With Water Service [1]	24 km^2
Area With Wastewater Collection [1]	13.3 km^2
Water Service Area Without Wastewater Collection and/or Treatment	10.7 km^2
Percentage of Area with Water Service but Without Wastewater Service	55%
Estimated Population Without Wastewater Collection and/or Treatment.	115,000
Percentage of City Population	27%
Potential Additional Wastewater	70,000 m^3/d
Percent Increase at WWTP	67%
Currently Collected Wastewater Flows Discharged Without Treatment [2].	39,000 m^3/day

1) Includes flows from areas without collection and those without treatment.
2) Port Fouad and areas of Port Said.

End of Chapter 4: Existing Wastewater Collection System

5.0 Port Said Wastewater Treatment Plant

This section presents an overview of the background and general condition of the existing wastewater treatment system in Port Said.

5.1 General Description

The Port Said Wastewater Treatment Plant has been in operation since January 1997. The plant is constructed on a filled-in area in Lake Manzala. The plant has a design flow capacity of 190,000 m^3/d. A layout of the plant is presented in Figure V6-5.1, Port Said Wastewater Treatment Plant Site Layout. A schematic of the plant is presented in Figure V6-5.2, Port Said WWTP Schematic.

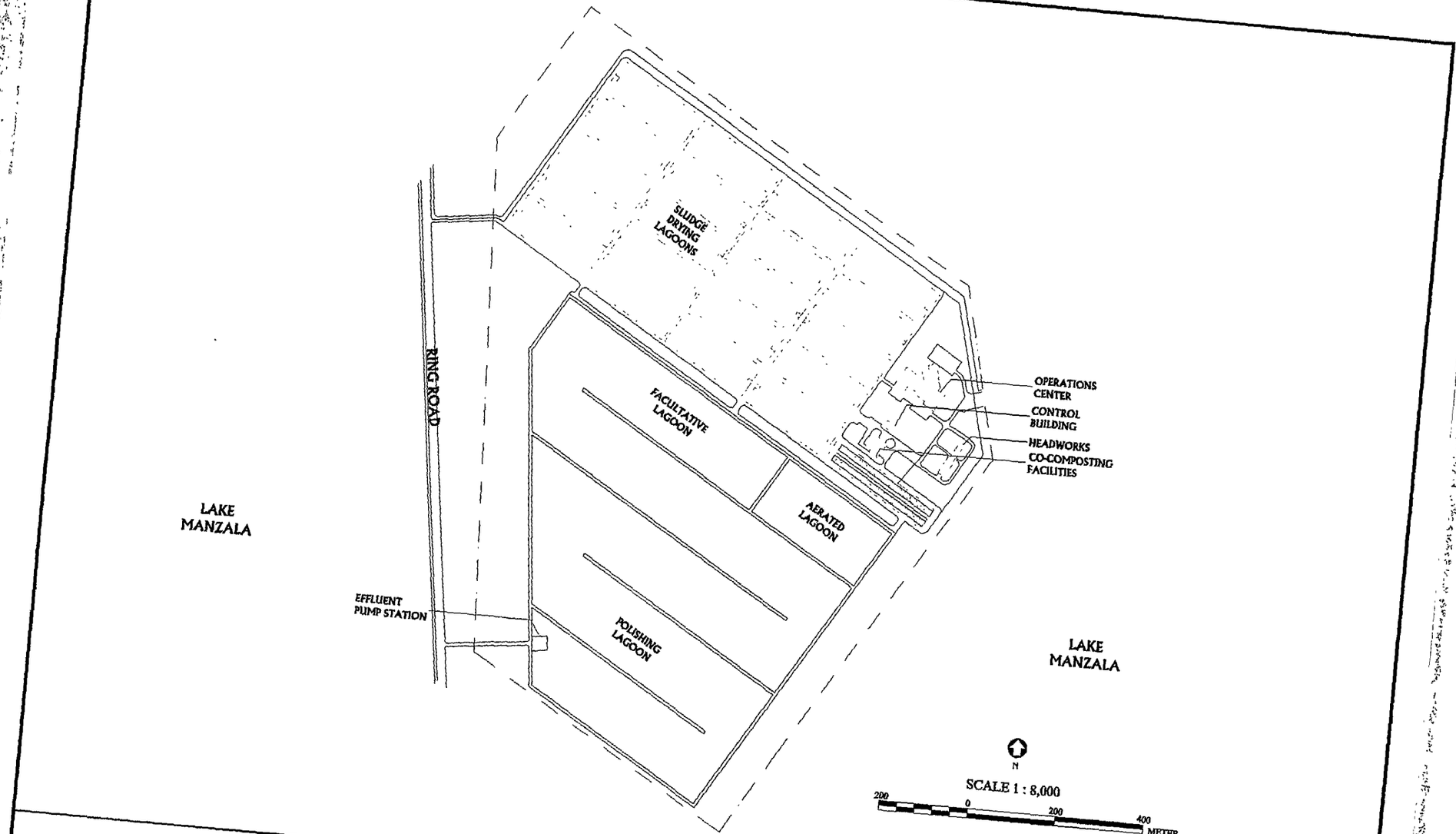
5.2 Treatment Processes

5.2.1 Headworks

The Mazrah Lift Station delivers wastewater to the plant through a 2,000 mm force main which discharges to an influent box at the headworks structure. The equipment at the headworks consists of flow measurement, screening, scum removal and grit removal facilities.

From the influent box, the flow passes through one of two channels, each equipped with a Parshall flume which is sized to measure flows up to 190,000 m^3/d. A staff gage laminated in the wall of each flume channel measures the depth of flow through the Parshall flumes. The depth reading is converted to flow rate using the flow chart developed for each Parshall flume. Each flume channel is designed to pass a peak flow of 380,000 m^3/d without overflowing. Slide gates are available to isolate each flume and to take the channel out of service.

After passing through the Parshall flume, flow enters an effluent box where it is divided among four screening and scum removal channels. Each channel is equipped with a mechanically cleaned bar screen that retains large solids, and a scum barrier that captures floating material. The climber-type, front cleaned screens have 25 mm clear openings between bars. Screenings are raked to a chute that discharges into a 1.5 m^3 screenings receptacle and are eventually hauled to an off-site disposal area. Floating material that collects on the concrete scum barrier downstream from the bar screens, is manually raked up the inclined surface of the scum barrier and hauled to the off-site disposal area. Slide gates are provided to allow one or more channels to be taken out of service for maintenance.



ARAB REPUBLIC OF
EGYPT
SUEZ CANAL AUTHORITY
NATIONAL ORGANIZATION FOR
POTABLE WATER AND SANITARY DRAINAGE

USAID
CANAL CITIES WATER AND WASTEWATER MASTER PLAN

BLACK & VEATCH INTERNATIONAL
IN ASSOCIATION WITH
MONTGOMERY WATSON
SABBOUR ASSOCIATES

PORT SAID
WASTEWATER TREATMENT PLANT
SITE LAYOUT

DATE: AUGUST 1999

FIGURE: V6-5.1

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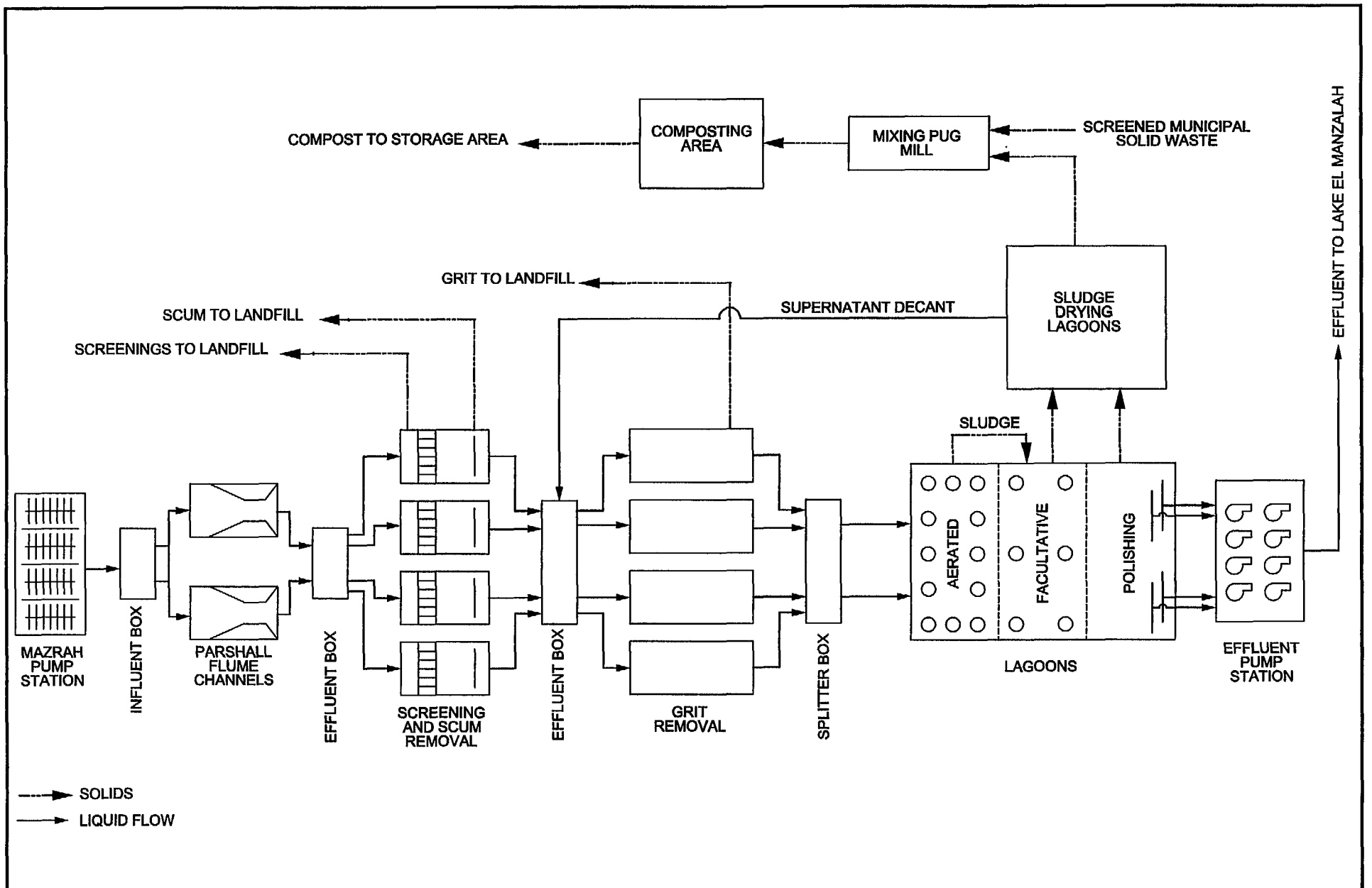

ARAB REPUBLIC OF EGYPT SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	USAID CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	PORT SAID WASTEWATER TREATMENT PLANT PROCESS FLOW DIAGRAM DATE: AUGUST 1999 FIGURE: V6-5.2

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From the four screening and scum removal channels, the wastewater flows into an effluent box to be distributed among four grit removal basins. The basins are velocity-controlled to allow the grit to settle to the bottom. When sufficient grit has settled out, the slide gates are closed, the basin is taken out of service and dewatered, and the grit is removed with a front-end loader and hauled to the disposal site. The basins are sized to allow one basin to be taken out of service during peak flow conditions.

5.2.2 Treatment Process.

A schematic of the treatment plant is presented in Figure V6-5.2, Port Said Wastewater Treatment Plant. Flow from the headworks is conveyed to the treatment system through two 1,500 mm pipes. The treatment system consists of an aerated lagoon, a facultative lagoon, and a polishing lagoon. The lagoon sections are separated by baffle walls constructed of prefabricated concrete panels.

The aerated lagoon is designed to provide 24 hours' detention at design flow. During a 12-month period ending in December 1998, the actual detention time averaged 47 hours. The lagoon contains 92 floating mechanical aerators with draft tubes to aerate the wastewater and to maintain a positive dissolved oxygen concentration for biological activity under aerobic conditions and to keep the organic material and the microorganisms in suspension. In the aerated lagoon, the organic material in the wastewater is converted to cell tissue and gases by aerobic microorganisms. Each two-speed aerator is held in position by three mooring cables attached to mooring posts in the lagoon. Plant operators cycle aerators on and off to maintain to maintain adequate dissolved oxygen concentration in the lagoon.

To distribute the flow equally across the facultative lagoon, a submerged weir constructed of concrete panels, with port openings near the bottom of the lagoon, has been installed across the exit from the aerated lagoon. The facultative lagoon is equipped with 101 floating mechanical aerators with draft tubes. Similar to those in the aerated lagoon, the aerators are designed to satisfy the biochemical oxygen demand of the wastewater as it passes from the aerated lagoon to the facultative lagoon and to maintain an adequate oxygen concentration in the wastewater. In the facultative lagoon, microorganisms convert additional organics to cell tissue and gases, but no attempt is made to keep the material in suspension. Most of the solids in the wastewater settle to the bottom of the facultative lagoon and undergo anaerobic decomposition. From the facultative lagoon, the flow passes into the polishing lagoon, which is not aerated. In this basin, additional solids settle out. Although algae growths in the lagoons occasionally cause an increase in the suspended solids concentration, when the readings are corrected for the algae, the solids concentrations are well within the allowable limits.

5.2.3 Effluent Discharge.

Treated effluent from the lagoons is pumped to Lake Manzala. Four pipes, each with twelve 300 mm orifices, are installed in the polishing lagoon. Two of the pipes are 1,200 mm above the bottom of the lagoon and two are 1,950 mm above the bottom. Treated effluent enters the pipes through the orifices and is conveyed to an influent channel in the pump station. By operating slide gates in the pump station, treated effluent can be withdrawn from either the lower or the higher level in the lagoon. Flow in the channel is discharged into a wetwell over the weirs which control the water level in the lagoons. From the wetwell, the effluent is transferred by eight pumps to a surge channel to flow by gravity through an 1,800 mm pipe to Lake Manzala.

During the 12-month period ending in December 1998, the total suspended solids concentration and the carbonaceous BOD_5 in the treatment plant effluent (after correction for algae) averaged 21 mg/L and 11 mg/L, respectively.

An emergency bypass channel is located in the pump station. At high water levels, the wetwell contents overflow into the emergency bypass channel and discharge into Lake Manzala through a 2,100 mm diameter pipe.

5.2.4 Solids Management

Solids that have settled to the bottom of the facultative and polishing lagoons undergo anaerobic decomposition and are eventually removed by dredging. The dredge discharges to one of 20 sludge drying lagoons. The lagoons are constructed with vertical concrete sidewalls, and each lagoon is equipped with weirs and decant boxes to allow the supernatant to be decanted. The decanted supernatant is returned to the facultative lagoon for treatment. After the sludge has been dewatered to approximately 40 percent solids, it is removed from the beds with front-end loaders and hauled by truck to either the co-composting facility or the sludge holding area. At present, all sludge is hauled to the co-composting area. Sludge that settles in the aerated lagoon is removed by dredging and discharged to the sludge drying lagoons.

Municipal solid waste is delivered to the co-composting facility by trucks which discharge it onto a concrete tipping floor in the solid waste receiving area. There, solid waste is spread over the tipping floor and inspected for large non-compostable objects, which are removed. The accepted material is loaded onto conveyors and transported to the screening and mixing drum, past an observation platform for additional inspections and removal of non-compostable material. The remaining material passes beneath a magnet that removes ferrous metals, and is then fed into a rotary drum where it is ground and mixed into raw compost. The rotary drum discharges the material to a trommel-type reject screen. Reject material that is too coarse to pass through the screen is removed. Plastic and other non-compostable materials in pieces small enough to pass through the reject screen are included in the compost material. This lowers the quality

of the compost for reuse. To reduce the amount of small non-compostable materials in the compost, a screen with a finer mesh has been recommended.

Sludge from the drying lagoons is transported to the receiving area and carried by conveyor to the mixer feed conveyor. The mixer feed conveyor moves raw compost and dried sludge to the mixing pug mill, where the materials are thoroughly mixed.

The co-composted mixture is conveyed to an asphalt pad and placed in windrows for processing. Fans blowing the air through ventilation ducts in the pad aerate the windrows. The windrows are periodically turned by a machine. After approximately four weeks, the composted material is moved to the maturation area, where the windrows are not aerated. The finished compost can be picked up for use as a soil amendment or is transported to a storage area. At present, the compost is usually stored on sludge drying beds. It is reported that the plant has approximately 8,000 tons of compost in storage. Approximately 50 tons has been used by the Governorate as a soil amendment.

Materials rejected from the tipping floor of from the co-composting process are hauled to offsite disposal areas.

The composting facilities have been subject to mechanical problems. The mechanical problems are correctable.

To make the co-composting operation more successful, the quality of the solid waste delivered to the site needs to be improved, with more attention to presorting the material before it reaches the co-composting facilities. At the site, a larger observation platform with more personnel to inspect the material and to remove the non-compostable items would be helpful.

In order to make more efficient use of the finished compost, it may be necessary to revise the regulations to allow users other than the Governorate to have access to the stored material. It may even be advisable to develop a marketing plan for potential sale of the composted material.

5.2.5 Support Facilities

An operations center is located near the plant access road. The operations building consists of an administrative quadrant, a personnel quadrant, a warehouse quadrant, and a maintenance quadrant. The administrative quadrant houses the following:

- Lobby and Visitors Reception Area.
- Public Restrooms.
- Conference Room.
- Central Control Room.
- Laboratory.
- Plant Manager's Office.
- Chief Operator's Office.

The personnel quadrant, which is used by plant staff, has a separate entrance and houses the following:

- Locker Rooms and Restrooms.
- Meeting/Training Rooms.
- Staff Lunchroom.
- General Storage.

The warehouse quadrant is used for storage of spare parts for plant equipment and vehicles, and building maintenance supplies. The maintenance quadrant provides space for repairing vehicles and process equipment.

The plant site is surrounded by a perimeter fence with a manually-operated entrance gate. A guardhouse located at the entrance gate is manned by security personnel who monitor access to the site.

5.2.6 Treatment Plant Summary

Table V6-5.1, Port Said Treatment Plant Design Parameters, presents the design parameters for the Port Said Wastewater Treatment Plant. Table V6-5.2, Port Said Treatment Plant Components, presents the treatment plant components.

Plant operating records for 1998 indicate that the actual concentrations of the various wastewater constituents are less than the values used in the plant design. As a result, the plant may successfully treat a much larger volume of wastewater than initially thought. To better determine when the treatment plant may reach its capacity, additional testing will be necessary. The testing will include influent and effluent BOD_5, soluble BOD_5, total suspended solids, and volatile suspended solids concentrations in each of the lagoons, and dissolved oxygen profile for the aerated lagoon. The results of these additional tests will be used to determine the need for future treatment plant modifications and expansions.

Table V6-5.1 Port Said Treatment Plant Design Parameters

Wastewater Characteristics	Units	Design	Actual 1998 Data
Average Plant Flow	m3/d	190,000	105,200
Peak Plant Flow	m3/d	380,000	204,700*
Influent Total Suspended Solids	mg/L	330	183
	kg/d	62,700	19,220
Influent BOD_5	mg/L	300	177
	kg/d	57,000	17,080
Effluent Total Suspended Solids	mg/L	50	21
	kg/d	9,500	1,990
Effluent BOD_5	mg/L	60	11
	kg/d	11,400	1,040

* 22 July 1998

Table V6-5.2 Port Said Treatment Plant Treatment Components

Treatment Unit	Description	Design
Headworks Facility		
Parshall Flume	Number	2
	Throat Width (mm)	1,528
Bar Screen	Number	4
	Type	Climber
	Channel Width (mm)	1,500
	Clear Opening Between Bars (mm)	25
Grit Basins	Number	4
	Basin Width (m)	3.5
	Basin Length (m)	25.95
Process		
Aerated Lagoon	Number	1
	Width (m)	150
	Length (m)	379
	Side Water Depth (m)	3.5
	Retention Time @ Design Flow (d)	1
Facultative Lagoon	Number	1
	Width (m)	150
	Length (m)	1,850
	Side Water Depth (m)	3.5
	Retention Time @ Design Flow (d)	5
Polishing Lagoon	Number	1
	Width (m)	150
	Length (m)	1,865
	Side Water Depth (m)	3.5
	Retention Time @ Design Flow (d)	5
Effluent Pumping Station	Number	1
	Number of Pumps (constant speed)	8
	Type	Propeller
	Firm Capacity (cmd) (Two Pumps Out of Service)	380,000
	Rated Head (m)	7
Solids Management		
Sludge Drying Lagoon	Number	20
	Width (m)	84
	Length (m)	210
	Liquid Sludge depth (m)	1

5.3 Port Fouad Wastewater Treatment Plant

Although Port Fouad is within the Port Said Governorate, its location makes it appropriate for it to operate its own wastewater treatment plant. The plant is currently being constructed. Construction was begun in February 1999 with the erection of the security fence. Piling is scheduled to be in place by January 2000. Work has also been started on the first of several pumping stations. Figure V6-5.3, Port Fouad (Proposed) Wastewater Treatment Plant Site Layout, presents an overview of the new Port Fouad plant. Figure V6-5.4, Port Fouad (Proposed) WWTP Schematic, presents a diagrammatic view of the new plant.

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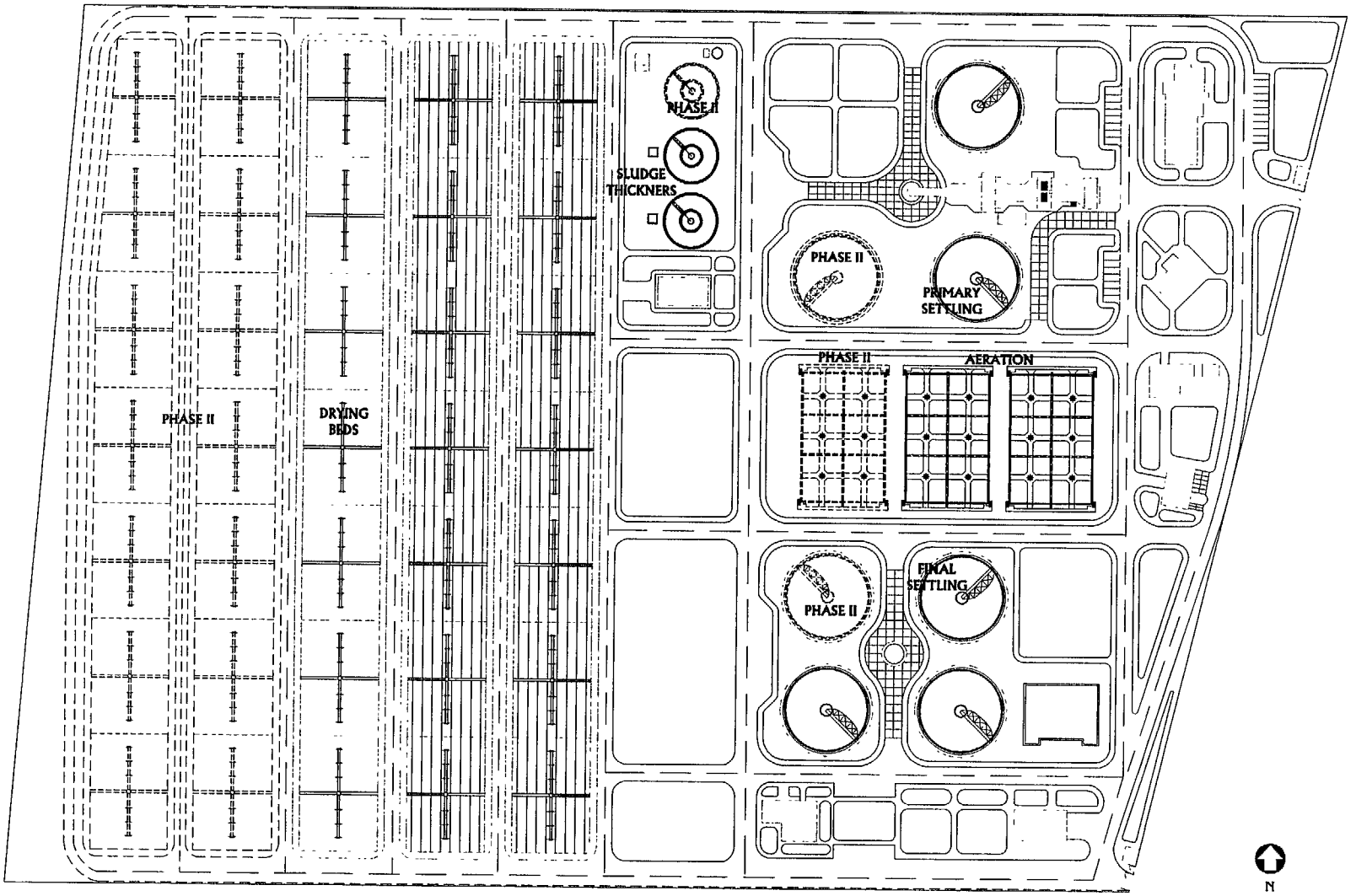

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ARAB REPUBLIC OF
EGYPT
SUEZ CANAL AUTHORITY
NATIONAL ORGANIZATION FOR
POTABLE WATER AND SANITARY DRAINAGE

USAID
CANAL CITIES WATER AND WASTEWATER MASTER PLAN

BLACK & VEATCH INTERNATIONAL
IN ASSOCIATION WITH
MONTGOMERY WATSON SABBOUR ASSOCIATES

PORT FOUAD (PROPOSED)
WASTEWATER TREATMENT PLANT
SITE LAYOUT

DATE: AUGUST 1999 FIGURE: V6-5.3

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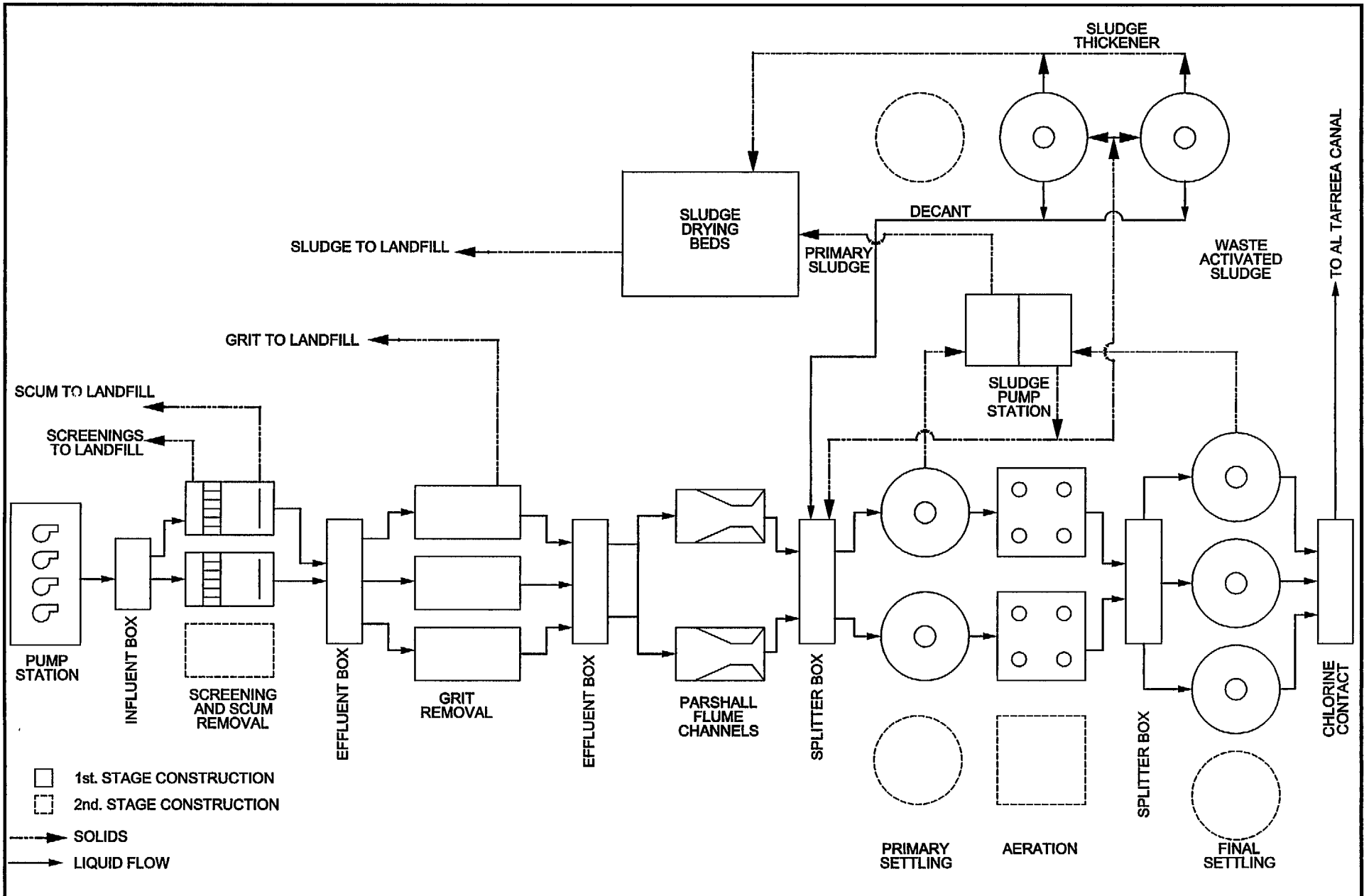

ARAB REPUBLIC OF EGYPT SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	USAID CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	PORT FOUAD (PROPOSED) WASTEWATER TREATMENT PLANT PROCESS FLOW DIAGRAM DATE: AUGUST 1999 FIGURE: V6-5.4

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The plant is located approximately 6.5 km southeast of the City, near the south end of the island. Initial design capacity of the new treatment plant is 22,000 m^3/d, and provisions have been made for future expansion to 37,200 m^3/d. Flow through the plant will be by gravity. Because of the relatively shallow groundwater table at the site, all structures will be elevated above the ground to allow gravity flow through the treatment plant.

Wastewater will be delivered to the site by new pumping stations. The first station, located near an old pumping station, which will be retired, will be equipped with a mechanically cleaned bar screen. A manually cleaned bar screen will be installed in an adjacent channel for use when the mechanically cleaned screen is out of service. Four wastewater pumps installed in a drywell will transfer wastewater through a force main to the treatment plant headworks.

5.3.1 Headworks

Wastewater delivered to the plant will flow to two screening channels equipped with mechanically cleaned bar screens and provisions for scum removal. An additional channel with a manually cleaned bar screen will be constructed in the future. From the screen channels, wastewater will flow to three grit removal channels and then through a Parshall flume for measurement. Screenings, scum, and grit removed from the flow will be stored beneath the structure and periodically removed to disposal sites.

5.3.2 Process

From the headworks structure, wastewater will flow to a distribution chamber designed to split the flow equally between two primary settling basins. Space is provided for adding a third basin in the future, and for splitting the flow accordingly.

Primary basin effluent will flow to aeration basins equipped with surface aerators. In the aerobic environment, microorganisms convert the organic matter in the wastewater to a gaseous end product and cell tissue. In addition to maintaining aerobic conditions, the surface aerators will also keep the contents of the basin mixed to keep the bacteria in suspension and minimize settling of solids. Space is provided for adding a third identical aeration basin in the future.

From the aeration basin, flow will pass through a distribution chamber into the three final settling basins, where suspended solids and biological solids will settle out. Space is provided for a fourth basin to be constructed in the future.

Treated effluent from the final settling basins will be discharged to a chlorine contact basin, where chlorine solution will be injected by a diffuser. The chlorine dosage will be determined by laboratory analysis. The strength of the chlorine residual that must remain in the effluent is dictated by Government regulations and verified by plant operators. Chlorine will be mixed with the effluent at the beginning of the contact chamber. The treated effluent will discharge through an outfall pipe to the Al Tafreea Canal.

5.3.3 Solids Management

The solids that settle out in the primary and final settling basins flow by gravity to separate compartments in the sludge pumping station. Solids from the primary settling basins will be pumped to the sludge drying beds. A portion of the solids from the final settling basins, referred to as return activated sludge, will be returned to the treatment process to enhance the treatment in the aeration basins. Remaining solids, referred to as waste activated sludge, will be pumped to two gravity thickeners. Space is provided for a third thickener in the future. In the sludge thickeners, waste activated sludge will separate from the liquid, and the solids will settle to the bottom of the basin. The decant liquid from the thickeners will flow over a weir to a decant and storm drainage pump station and will be pumped back to the primary basin distribution chamber. The thickened sludge flows by gravity to the sludge drying beds for further dewatering. Dried sludge will be removed from the drying beds and hauled by truck to a land disposal site or to be used as a soil amendment.

5.3.4 Treatment Plant Summary

Table V6-5.3, Port Fouad Treatment Plant Design Parameters, presents a summary of treatment plant design parameters. Where available, design parameters for future expansions are included.

Table V6-5.3 Port Fouad Treatment Plant Design Parameters

Wastewater Characteristics	Units	Design 1st Stage	Design 2nd Stage
Average Plant Flow	m^3/d	22,000	37,200
Peak Plant Flow	m^3/d	46,176	72,540
Influent Total Suspended Solids	mg/L	520	
Influent BOD_5	mg/L	480	
Effluent Total Suspended Solids	mg/L	20	
Effluent BOD_5	mg/L	30	

Table V6-5.4, Port Fouad Treatment Plant Components, presents a summary of treatment plant components. Where available, specifications for future expansions are included.

Table V6-5.4 Port Fouad Treatment Plant Components

Treatment Unit	Description	Design 1st Stage	Design 2nd Stage
Headworks Facility			
Bar Screen	Number	2	1
	Type	Mechanical	Manual
	Channel Width (mm)	1,350	1,350
	Clear Opening Between Bars (mm)	30	50
Grit Basins	Number	3	
	Basin Width (m)	1.2	
	Basin Length (m)	18	
Process			
Primary Settling Basins	Number	2	1
	Diameter (m)	28	28
	Side Water Depth (m)	3.5	3.5
Aeration Basins	Number	4	2
	Side Water Depth (m)	5.0	5.0
	No. of Cells per Basin	3	3
	Cell Dimensions (m)	15 x 14	15 x 14
Final Settling Basins	Number	3	1
	Diameter (m)	28	28
	Side Water Depth (m)	3.5	3.5
Chlorine Contact Basin	Number	1	
	Width (m)	15	
	Length (m)	25	
	Side Water Depth (m)	3	
Solids Management			
Sludge Thickeners	Number	2	1
	Diameter (m)	15	15
	Side Water Depth (m)	5	5
Sludge Drying Lagoon	Number	21	14
	Width (m)	30	30
	Length (m)	40	40

End of Chapter 5: Port Said Wastewater Treatment Plant

6.0 Regulations, Laws, and Treatment

This section presents a review of the institutional and legal impacts on improvements or changes in the environment related to the protection of the Nile River and other waterways. The ability of a waterway to receive a treated wastewater effluent can be a significant factor in the siting of a wastewater system, its points of collection and discharge, and the selection of an appropriate level of treatment.

Responsibility for environmental protection of Egypt is dispersed among many ministries and government agencies. Recent interest in the protection of the environment has led to the formation of the Ministry of State for Environmental Affairs and the Egyptian Environmental Affairs Agency (EEAA) which is empowered to monitor and maintain the laws and decrees associated with the environment. These are the two central institutions concerned with environmental protection in Egypt. However, other ministries, including the Ministry of Health & Population and the Ministry of Public Works & Water Resources, play an important role in the protection of the environment when the discharge of liquid wastes is involved.

6.1 1962 - Law No. 93

Law No. 93 for 1962 was established for the development of public wastewater systems and regulation of the wastes draining into it. Details were provided through the Minister of Housing and Utilities Decree No. 649 of 1962. The Law and its subsequent decree identified requirements for permitting, treating wastes, and establishing collection networks. The main provisions of Law No. 93 and its Executive Regulations can be summarized as follows:

- Defines what constitutes a public wastewater system and establishes who would have authority over the system.
- Establishes criteria for connections to the network, including requirements for permits, applications to connect, and penalties to be applied to violations.
- Establishes criteria and specifications for all liquid wastes discharged into public wastewater collection system.
- Establishes methods and timing for sampling and analyzing liquid waste specimens.

Laws in following years, particularly Law No. 48 for the Year 1982, have superseded or modified some of the treatment standards and criteria.

6.2 1982 - Law No. 48

Law No. 48 for 1982 was established to protect the Nile River and its waterways from pollution. Details were provided through the Ministry of Irrigation Decree No. 8 of 1983. The Law is particularly focused on protecting freshwater resources for both potable and non-potable agricultural uses. Table V6-6.1, Waterways Protected by Law

No. 48 provides a summary of waterways and sources of pollution defined by the Law and its Executive Regulations.

Table V6-6.1 Waterways Protected by Law No. 48

Waterway	Description
Nile River and its Two Branches	The main course of the Nile starting from the international border with Sudan to the mouth of Damietta and Rozetta branches in the Mediterranean Sea.
Bays	Side branches of the Nile, inside islands.
Feeders and Main Canals	Large canals conveying water from the downstream side of the Delta Barrage and feeding canal networks in Northern Egypt.
Canals	Large and small canals, with all their branches, up to field irrigation canals.
Side Channels	Parallel or adjacent distribution canals fed by main connecting canals carrying irrigation water.
Drainage and Drains	Large and small drainage canals, with all their branches, up to field drainage and covered drainage canals.
Lakes	Lakes connected with seas or closed.
Ponds	Closed water surfaces into which waterways discharge.
Closed Water Surfaces	Depressions filled with water and connected with waterways.
Oozes and Swamps	Low ground around lakes in which drainage channels discharge.
Underground Water Reservoirs	Underground water reservoirs inside Egypt's borders.
Solid Wastes	All solid materials, whether they are resulting from refuse, garbage, sweepings, dry rubbish, stone fractures, building and workshop scraps, or any solid material left by persons, housing buildings, and non-housing buildings – governmental or private, whether they were commercial, industrial, tourist, or public, as well as means of transportation.
Fluid Wastes	Wastes resulting from industrial shops and on which the standard measures regarding the industrial liquid wastes are applicable.
Human or Animal Waste	Waste resulting from wastewater purifying operations or from their networks, or from real estate or other establishments, such as public, trading, industrial, and tourist shops, whether immovable, moveable, or floating.
Animal Fluid Wastes	Wastes resulting from slaughtering operations, abattoirs, slaughterhouses, poultry farms, hangers, and the like.
Establishment	All real estate shops, trading, industrial, or tourist structures – whether governmental or non-governmental.

The main provisions of Law No. 48 and its Executive Regulations can be summarized as follows:

- Defines waterway and pollutant sources.
- Establishes standard for treatment prior to discharge of marine vehicles in potable and non-potable water sources.
- Establishes standards for treatment prior to discharge of industrial wastes into potable and non-potable water sources.
- Establishes standards for wastewater discharge.

6.3 1994 - Law No. 4

Environmental Law No. 4 of 1994 and the Prime Minister's Decree No. 338 of 1995 established the mandate of EEAA and provided clarification to discharge limits. Law No. 4 is the outcome of a long process that started with the formation in 1981 of ministerial and technical environmental committees reporting to the Prime Minister. These early initiatives led to the issuance of Presidential Decree No. 631 of 1982 establishing the formation of an Environmental Affairs Authority. The mandate of the Authority was limited; nevertheless, it issued Law No. 102 of 1983 for the protection of natural resources. In 1985, the Authority was reorganized by adding specialized divisions and technical staff positions. Its restricted operating scope led to the realization that there was a need for a much stronger authority with a clear mandate to protect the environment and with effective enforcement backing. This need was further recognized with the issuing of Ministerial Decrees Nos. 30 and 31 of 1991 to restructure and strengthen the Environmental Affairs Authority and with preparation of the Environmental Action Plan (EAP) in 1992. In 1994, Law No. 4 was authorized to deal with major environmental policy issues. Although this law does not address all aspects of environmental protection, it covers the areas of greatest concern including air, land, and marine environment. Details were left to be worked out by executive regulations and ministerial decrees. Decree of the Prime Minister No. 338 of 1995 Promulgating the Executive Statutes of the Law on Environment provided the details. The main provisions of Law No. 4 and its Executive Regulations can be summarized as follows:

- Founding an agency with a clear mandate to protect the environment.
- Establishing and operating environmental information and monitoring networks to guarantee efficient implementation of the Agency's mandate. EEAA becomes the coordinating body responsible for the collection and dissemination of information.
- Establishment of an Environmental Protection Fund with sufficient resources and well-defined expenditure items. The Fund's resources are devoted to research and technical analysis of the environment; environmental assessment studies; establishment of environmental networks; the removal of pollutants; and other activities aiming at environmental protection.
- Establishment of the principles and procedures to be followed in the preparation of environmental impact assessments on new projects and extensions to existing projects which have the potential to adversely affect the environment.
- Establishment of an Environmental Affairs Department (EAD) in each Governorate to help coordinate and implement EEAA's mandate at the local level.

An important provision of Law No. 4 is Article 1, which indicates that the new law does not detract or weaken the provisions of Law No. 48 for the Year 1982 concerning the protection of the Nile River and the watercourses from pollution.

Annex No. 1 of Prime Minister Decree No. 338 of 1995 sets forth the criteria and specifications for certain materials when drained and disposed of in a marine environment. Reference is made in the Annex to the fact that the criteria and specifications also remain subject to the provisions of Law No. 48 of the Year 1982.

Annex No. 2 of Prime Minister Decree No. 338 of 1995 defines installations subject to the provisions of evaluation of environmental impact. Item 6, under the heading "Installations Subject to Environmental Assessment Based on Site Activities," includes all infrastructure projects, including stations for wastewater treatment and reuse of their waters.

6.4 Discharge Limits

The applicable discharge limits set under Law No. 48 and enhanced by Law No. 4 for discharges of treated wastewater effluent are summarized in Table V6-6.2, Wastewater Effluent Limits. There are no specific guidelines in either law indicating how the wastewater specifications are to be measured and to what distance from the point of discharge.

Table V6-6.2 Wastewater Effluent Limits

Description	Ceiling Criteria and Specifications Law No. 48 (mg/L), unless noted	Ceiling Criteria and Specifications Law No. 4 (mg/L), unless noted
Temperature	35 C	≤ 10 C over prevailing
pH	6-9	6-9
Biological Oxygen Demand (BOD_5)	60	60
Chemical Oxygen Demand (Dichromate)	-	100
Chemical Oxygen Demand (Michromate)	80	-
Chemical Oxygen Demand (Permanganate)	40	-
Dissolved Oxygen (DO)	Not Less Than 4	-
Oils and Greases	10	15
Hydrocarbons of Oil Origin	-	0.5
Dissolved Substances	2,000	2,000
Ashes of Solute Solid Materials	-	1,800
Total Suspended Substances (TSS)	50	60
Color	Free of Color	Free of Color
Lees and Dregs	-	NTU 50
Sulfides	1	1
Cyanide	-	0.1
Phosphate	-	5
Nitrates	50	40
Fluorides	-	1
Phenols	-	1
Total of Heavy Metals	1	-
Aluminum	-	3
Ammonia (Nitrogen)	-	3
Mercury	-	0.005
Lead	-	0.5
Cadmium	-	0.05
Arsenic	-	0.05
Chromium	-	1
Copper	-	1.5
Nickel	-	0.1
Iron	-	1.5
Manganese	-	1
Zinc	-	5
Silver	-	0.1
Barium	-	2
Cobalt	-	2
Pesticides of All Types	Non-existent	0.2
Coliform Bacteria (probable count in 100 cm^3)	5,000	5,000

NOTE: Law No. 48 limits as defined in Article 66 of Decree No. 8 of Year 1983; Law No. 4 limits as defined in Annex 1 of Decree No. 338 of Year 1995.

While they are not specified as applying to wastewater, Table V6-6.3, Discharge Standards for Non-Potable Water Sources, shows standards from Law No. 48 that apply to industrial fluid wastes and may also apply to wastewater.

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Table V6-6.3 Discharge Standards for Non-Potable Water Sorces

Description	Standard Measures and Specifications
Temperature	Not more than 5 C over prevailing rate
Dissolved Oxygen (DO)	Not less than 4 mg/L at any time
Hydrogen Exponent (pH)	Not less than 7 and not more than 8.5
Industrial Detergents	Not more than 0.5 mg/L
Phenol	Not more than 0.005 mg/L
Sediment	Not more than 50 units
Dissolved Solid Substances	Not more than 650 mg/L
Coliform Bacteria (Probable count in 100 cm^3)	Not more than 5,000
NOTE: Law No. 48 limits as defined in Article 68 of Decree No. 8 of the Year 1983.	

6.5 General Water Quality Considerations

Oxygen is a key element in the growth of microorganisms and the subsequent stabilization of waste materials in aerobic processes. It is also essential for the survival of fish and other aquatic life. Therefore, when considering a wastewater discharge, it is important to ensure that the oxygen depletion caused by waste assimilation does not result in conditions, which are unfavorable to life.

Oxygen demands are created by the absorption of carbonaceous materials (carbonaceous biochemical oxygen demand or CBOD) and by nitrification of ammonia to the nitrate form (nitrogenous biochemical oxygen demand). Both of these demands need to be considered and weighed against the natural reaeration capacity of the water body, whether by mixing, wind action, photosynthesis by plankton, or other processes.

Eutrophication is the enrichment of water bodies by nutrients (primarily nitrogen and phosphorus). It is usually a major cause of pollution in lakes and other water bodies with poor mixing and circulation. When conditions are suitable, this enrichment increases the growth rate of phytoplankton which are the basic building blocks of the marine ecosystems food chain. The rate of algal biomass growth is dependent on temperature and on the availability of a carbon source and light. Algal biomass is quantified by chlorophyll, a photosynthetic pigment found in algae.

Algae produce oxygen when adequate light is available, but also have a constant oxygen requirement for respiration. In the presence of large algal populations or blooms, oxygen concentrations can be seriously depressed during the night when oxygen production halts, but algal respiration continues. The worst situation occurs when the bloom suddenly collapses, resulting in a tremendous oxygen demand from the decomposition of the dead algal cells. The decline in oxygen concentration can make conditions unsuitable for fish and other aquatic life, impart disagreeable color and odor to the water, and produce substances which are toxic to fish and shellfish.

While such stimulation of the ecosystem can sometimes produce desirable results, the blue-green algae which usually predominate in phytoplankton populations, have poor food characteristics for higher tropic levels, and can create nuisance conditions.

Sustained anoxic (inadequate oxygen concentration) conditions can create a reductive environment which can lead to the formation of hydrogen sulfide and

ammonia, both of which are toxic to fish and other marine life, and place stresses on the aquatic ecosystem. These stresses reduce the diversity of the aquatic community, impede growth rates, and contribute to the incidence of diseases.

Heavy metals and pesticides are also toxic and tend to accumulate and concentrate in the higher trophic levels, which include fish and, ultimately, man. Areas that are highly productive are particularly sensitive to these materials. Every effort must be made to prevent toxic materials from entering the environment.

The aquatic, estuarine, or marine environment will respond to changes in waste and nutrient loadings. The more the system is impacted, the worse water quality will become and the less suitable for certain uses. For example, odors and proliferation of weeds make the environment less suitable for recreation purposes, fish spawning grounds may disappear, human diseases may increase, and so on. Therefore, the use values and requirements of the proposed receiving water body need to be considered in determining the acceptable level of impact.

Each of the receiving water bodies associated with Port Said, Ismailia, or Suez has certain beneficial uses such as fisheries, water-based recreation, and wildlife habitat. These uses need to be preserved through maintaining adequate water quality.

End of Chapter 6: Regulations, Laws, and Treatment

7.0 Wastewater Collection System Design Criteria

This section presents the methodology for evaluating the Port Said wastewater collection system. It presents information on how the wastewater collection system inventory was prepared, the design criteria used in evaluation of the system, and information on the modeling process.

7.1 Preparation of Wastewater System Inventory Database

The inventory contains information on 300-mm and larger wastewater lines and on the system manholes. All inventory information is maintained in Mapinfo database files. Morrison and Knudsen (MK), in cooperation with the CMC office, provided copies of wastewater system maps prepared for CMC projects. Manholes and pipelines shown on CMC and MK drawings have been assigned ID tags, which were used, when possible, in the CCMP work. Construction drawings for approximately 30 percent of the system were also obtained from CMC and MK, and as-built drawings for existing lines were obtained from NOPWASD. Data from these sources varied in accuracy and completeness. Limited information was available for some portions of the system and no elevation data was available for approximately 40 percent of the manholes.

Information compiled in the Mapinfo database was transferred into Black & Veatch's Sanitary Sewer Management System (SSMS). The SSMS program allows operators to make a number of checks on the integrity of the data. Negative slopes , inconsistent diameters, inconsistent manhole elevations, and other features were flagged for checking and correction.

7.1.1 Use of Available Wastewater System Data

To evaluate hydraulic capacity throughout the wastewater system, key physical data on each segment must be known. This information includes pipe diameter, pipe length, manhole invert elevations, and other data. For this project, all available data was collected and entered into a MapInfo, GIS database and later into the SSMS program. Upon inspection, it was revealed that not all manholes included elevation data and those that did were not to a common datum. To produce a functional computer model, the 6,100 plus manholes of the system were simplified to approximately 320 nodes (manholes). The model simplification involves grouping together the pipes with the same diameter and with relatively the same slopes and omitting intermediate manhole information from the reach. Nodes were included in the hydraulic model at change of direction for headloss considerations.

In order to produce the SSMS database for the hydraulic modeling, the following procedures were followed:

- Where no as-built drawings were provided, elevations were interpolated or extrapolated using the line length in the MapInfo database. Missing invert elevations were interpolated between the nearest known manholes with available

elevations. Where no levels were available, minimum pipe slopes from the adjacent manholes were assumed. Minimum pipe slopes were considered a realistic estimate due to the relatively flat terrain throughout the Port Said study area. Interpolation was necessary for approximately 40 percent of the data.

- When it was determined that adjacent wastewater network data was not to a common datum, available topographic information was used to assist in the calculation of a common datum. Caution was exercised to ensure that the relative invert elevations were adequate for modeling purposes. At a minimum, the invert elevations of wastewater lines discharging to a common pumping station were all to the same datum. The model accuracy is likely to be affected by this estimation, in direct proportion to the amount of information that was unavailable.
- Where ground elevation data was missing, it was generally assumed to be 3.0 meters above the pipe invert elevation. Ground elevation values are not needed for the hydraulic program and are not critical to the analysis, except in the case of excessive surcharging.
- Coordinate data, although not vital for hydraulic modeling, are required for production of maps. This information was obtained from the MapInfo database and used to build system maps.

7.1.2 Data Input and Checking

A series of data queries were conducted to identify wastewater lines for which input data was not reasonable. The data queries include the following:

- Invert elevation – Checks were made to identify lines with negative slope. Invert elevations for lines connected to each manhole were also compared.
- Rim elevation – rim elevations were checked against invert elevations.
- Coordinates – Plots of the wastewater system, which depend on the input coordinates, were reviewed for relative accuracy.
- Connectivity – Pipeline reaches that were not connected to downstream lines in the model were identified, investigated, and where appropriate, corrected.

7.2 Collection System Design Criteria

The improvement criteria described in this section pertain to the design of relief lines, lift stations, and force mains. Operating criteria are established for assessing the performance of the wastewater systems, as simulated by the hydraulic models, and for sizing future facilities. The recommended criteria consider specific guidelines recommended by the Egyptian Code for Water and Wastewater Networks; NOPWASD adopted operations; and accepted industry standards for design and operation of efficient and reliable wastewater collection systems. The intent of these criteria is to provide a recommended wastewater system development program with sufficient

capacity to satisfy future peak flow conditions in the collection system and to accommodate maximum month loads at the treatment plant.

Computer models developed for Port Said identify existing deficiencies as well as improvement needed to accommodate future growth. Facility deficiencies were identified by comparing the performance of various elements of the wastewater system to the recommended operating criteria under various scenarios. Specific wastewater collection system components that influence system operation include the following:

- Wastewater pipe size, grade, material, and condition.
- Wastewater line depth.
- Pump station and force main capacity.
- Available storage volume in wetwell and upstream.

7.2.1 Gravity Wastewater Line Design Criteria

The total peak flow determined by the model for each line segment is compared to the full pipe capacity. Parallel relief lines are sized, and costs are assigned for any pipe with a peak flow greater than 100 percent of the pipe capacity. All improvements are sized as parallel relief lines. The wastewater line improvement criteria are summarized below:

- Upgrading of pipelines is not considered if projected peak flows are less than 100 percent of capacity.
- Where total flow exceeds 100 percent of pipe capacity, parallel relief lines are sized to transport the peak flow downstream.
- Relief and extension lines are sized for a design flow-to-capacity ratio of 0.75 using Manning's 'n' of 0.013.
- Minimum recommended pipe diameter is 175 mm.
- For gravity pipes smaller than 700 mm, a minimum velocity of 0.5 m/s and maximum velocity of 0.75 m/s at minimum flows is provided.
- For gravity lines larger than 700 mm and smaller than 2000 mm, a minimum velocity of 0.6 m/s and maximum velocity of 1.0 m/s at minimum flows is provided.

7.2.2 Lift Station and Force Main Evaluation Criteria

The firm capacity of the lift station is assumed as the flow the station can convey with the largest pump out of service. The following criteria are used in evaluating the lift stations:

- Station expansion is recommended when ratio of flow to capacity is between 1.0 and 1.2.
- Station replacement is recommended when flow to capacity ratio is more than 1.2.

7.2.3 Force Main Evaluation Criteria

Replacement force mains are assumed for all force main improvements. The following criteria are used in evaluating the force mains:

- Parallel or replacement force mains are recommended where maximum velocity at peak flow exceeds 1.8 m/s.
- Recommended parallel or replacement force mains have design velocity equal to 1.5 m/s, at maximum capacity of the lift station.

7.2.4 Design Criteria Summary

Table V6-7.1, Recommended System Design and Operating Criteria, presents a summary of the design criteria.

Table V6-7.1 Recommended System Design and Operating Criteria

System Segment	System Operating Conditions	
Gravity Wastewater Collection System Design	Total peak flow determined by the model for each segment is compared to full pipe capacity.	
	Parallel relief pipes are sized for any segment with a peak flow greater than 100% of pipe capacity.	
	All improvements are sized as parallel relief pipes	
	Wastewater Collection Improvement Criteria	Pipe upgrading is not considered if projected flows are less than 100% of capacity.
		Where total flow exceeds 100% of pipe capacity, parallel relief pipes are sized and simulated to transport peak flow.
		Relief and extension pipes are sized for a design-to-flow ratio of 0.75 using Manning's "n" of 0.013.
		Minimum recommended pipe diameter is 175 mm.
		For pipes smaller than 700 mm, provide minimum velocity of 0.5 m/s and maximum velocity of 0.75 m/s at minimum flows.
		For pipes larger than 700 mm and smaller than 2,000 mm, provide minimum velocity of 0.6 m/s and maximum velocity of 1.0 m/s at minimum flows.
Lift Station Design	Pump stations will be sized to handle the peak flow with the largest pump out of service.	
	Lift Station Criteria	Station expansion is recommended when ratio of peak flow/capacity is between 1.0 and 1.2.
		Station replacement is recommended when ratio of peak flow/capacity is greater than 1.2.
Force Main Design	Parallel force mains are assumed for all force main improvements.	
	Force Main Criteria	Force main replaced when maximum velocity at peak flow exceeds 1.8 m/s.
		Design velocity for new force mains at peak flow is 1.5 m/s.

7.3 Collection System Modeling

7.3.1 Hydraulic Model

The hydraulic model of the wastewater system was developed utilizing wastewater network data, flow data, and a flow routing program. Modeling for this Master Plan included only 300 mm and larger trunk lines. The model was developed using HYDRA software (developed by Pizer, Inc., United States), as the hydraulic engine. The data was

processed using Black & Veatch's Sanitary Sewer Management System (SSMS) support modules developed to write to and read from HYDRA.

The average daily dry weather flow (ADDF) determined from the flow monitoring program and land use data was used as the "base" flow component and was input into the model. The monitored diurnal seasonal and daily flow variations observed at Port Said WWTP was input into the hydraulic model to obtain peak flows. Infiltration was considered as a constant flow during high groundwater conditions, as observed infiltration flows were relatively constant over several days. The system was not influenced by rainfall; therefore, stormwater inflow was not modeled.

7.3.2 Model Calibration

A series of analyses were performed to calibrate the model flow data against actual treatment plant flow data to ensure accurate simulation. The collection system peaking factors farther upstream were adjusted to make the simulated hydraulic peak at the treatment plant match the measured peaks. Attempts were made to match model predicted flow with monitored or recorded flows at specific points in the collection system, such as lift stations. However, due to the limited nature of monitored flow data, only general comparisons were made. Detailed model calibration was not conducted, as a thorough flow monitoring program was outside the scope of this project.

7.3.3 Planning Horizon

For purposes of this study, the planning period for the Port Said Wastewater Master Plan is through year 2020; however, hydraulic evaluations were also carried out for ultimate development. Ultimate development was considered full occupancy of developed areas.

7.3.4 Existing System Analysis for Peak Flow Conditions

The purpose of modeling the existing system was to determine how the system would respond to peak dry weather flow conditions.

7.3.4.1 Existing Modeled Flow Rate

The average daily dry weather flow (ADDF) rates and infiltration rates used in the model were determined from the flow projections. The average flow rates were distributed in the model at selected node points. In most cases, the ADDF flow rates were applied to individual manholes receiving the flows from the contributing polygon or contributory area.

7.3.4.2 Peak Wastewater Flow Analysis

The peak wastewater flow analysis simulated the dry weather condition, using peak wastewater production plus infiltration to determine whether any of the existing trunk lines are undersized for current peak wastewater flow. The model indicated that a number of pipes are overloaded during peak dry weather conditions.

Following the hydraulic analyses, parallel relief lines were sized and costs were developed for all lines which currently receive peak flows exceeding 100 percent of their capacity. The analyses and the results of hydraulic modeling are presented in Section 8.

End of Chapter 7: Wastewater Collection System Design Criteria

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8.0 Current and Future Wastewater Needs

This section describes current and future expansion, upgrading and extensions needed for the Port Said wastewater collection and treatment system.

8.1 Wastewater Collection System Analysis

The Port Said wastewater collection system consists of gravity collector and interceptor wastewater lines, and 16 lift stations. The new facilities include an influent pump station (Mazrah), a wastewater treatment plant, an effluent pumping station, and a plant outfall that discharges to Lake Manzala. Recent improvements to the collection system include 11 pumping stations pumping directly to the Mazrah lift station, which pumps through a 2000 m transmission main to the new wastewater treatment plant. The Mazrah station is equipped with four Archimedes screw type pumps, each rated at 127,000 m^3/day. A standby generator is provided to assure continuous operation in case of electric power failure. Table V6-8.1, Modeled Wastewater Pipes Inventory, lists wastewater collection lines modeled. The trunk lines were identified by reviewing drawings and electronic files obtained from Construction Management Consultants' (CMC) and maps provided by other local consultants and drawings provided by NOPWASD. Additional relevant information was obtained through interviews with the Port Said Governorate personnel. The 300 mm diameter and larger trunk wastewater lines and the lift stations modeled are shown on Figure V6-8.1, Port Said Modeled Wastewater System. The collection system model developed for this study consists of over 300 manholes (nodes) and over 27,000 meters of lines ranging from 300 mm to 1200 mm. Some pipes smaller than 300 mm were included in the model if required to reach individual subbasins. The model includes all lift stations, which form part of the existing trunk system.

Table V6-8.1 Modeled Wastewater Pipes Inventory

Diameter (mm)	Length (m)
250	29
300	10,899
375	4,713
450	4,900
500	3,203
600	792
750	287
800	1,721
1000	551
1500	6
Total	27,101

Table V6-8.2, Lift Stations, includes the lift stations in the study area that were analyzed in the hydraulic model.

Table V6-8.2 Port Said Lift Stations

Name	No of Pumps	Firm Capacity (m^3/day)	Force Main Diameter (mm)	Force Main Length (m) (1)
Alpijo (4D)	4	25,000	600	3,300
Al-Salam (8D)	4	25,200	700	4,000
Al-Zohoor (A22)	5	51,840	600	1,500
Al-Zohoor (11S)	4	62,200	700	400
Istismar	3	5,200	350	600
23rd July (1S)	4	25,900	500	1,300
Main (8S)	5	34,500	300	1,300
Mazrah	4	127,000	1500	2,800
S Metwaly	6	16,180	900	700
Tameer (R1)	2	11,200	350	2,000
Tameer (R2)	3	38,000	400	3,000

1) Force main lengths estimated using MapInfo database.

The average dry weather flow monitored during January to October 1997 by the Port Said wastewater treatment plant Parshall flume was 103,000 m^3/day. The maximum hourly dry weather flow rate was 110,000 m^3/day, or 1.1 times the average daily dry weather flow; the minimum hourly flow recorded at the plant during the same period was 96,000 m^3/day. The Port Said wastewater treatment plant was intended to serve Port Said only and was constructed to treat wastewater from a population of approximately 630,000 by year 2005.

8.1.1 Hydraulic Capacity Evaluation for Existing Peak Flow Conditions

A summary of the recommended relief lines is presented in Table V6-8.3, Relief Lines Existing Conditions.

Table V6-8.3 Relief Lines - Existing Conditions

Length of Overloaded Pipes (m)	Total Length of Pipes (m)	Overloaded Pipes Based on Length (%)
648	27,101	2.4

For the peak dry weather flow, approximately 2.4 percent of the modeled wastewater collection system is overloaded under peak dry weather conditions. Table V6-8.4, Overloaded Pipes Existing Conditions, presents a summary of the overloaded lines according to percent utilization.

Table V6-8.4 Overloaded Pipes - Existing Conditions

Percent Utilization (%)	Overloaded Pipes Peak Dry Weather Conditions Total Length (m)
100-125	238
125-150	329
> 150	80
Total	**647**

Lift stations were evaluated based on flow conditions and the station's firm capacity For the purposes of this report "Firm Capacity" is defined as the capacity of the station with the largest pump out of service. Two examples, below illustrate this concept.

Firm Capacity - Example 1

Lift station with four pumps. Two pumps have 500 m^3/day capacity and two pumps have 750 m^3/day capacity.

Station Firm Capacity $= 500 + 500 + 750 + \cancel{750}$

$= 500 + 500 + 750$

$= 1{,}750\ m^3/day$

Firm Capacity - Example 2

Lift station with three pumps each with 500 m^3/day capacity.

Station Firm Capacity $= 500 + 500 + \cancel{500}$

$= 500 + 500$

$= 1{,}000\ m^3/day$

Force mains were evaluated based on flow velocity not exceeding 1.8 m/s. Table V6-8.5, Lift Stations/Force Mains Existing Conditions, shows a summary of the pumping station and force main capacities and the existing peak flows at each station.

Table V6-8.5 Lift Stations/Force Mains - Existing Conditions

Lift Station	Firm Capacity(1) (m^3/day)	Force Main Capacity (m^3/day)	Station Modeled Peak Flow (2) (m^3/day)	Recommendations
Alpijo (4D)	25,000	36,600	23,211	-
Al-Salam (8D)	25,200	59,851	27,135	Replace lift station
Al-Zohoor (A22)	51,840	43,972	21,977	-
Al-Zohoor (11S)	62,200	60,000	21,569	-
Istismar	5,200	15,000	3,417	-
23rd July (1S)	25,900	16,965	9,561	-
Main (8S)	34,500	3,499	3,234	-
Mazrah	127,000	229,000	71,508	-
South Metwaly (10S)	16,180	98,938	20,000	Replace lift station
Tameer (R1)	11,200	4,763	5,123	Parallel force main
Tameer (R2)	38,000	16,800	9,942	-

1) May 1996 Infiltration/Salinity Report, Volume I.
2) Existing Peak, Dry Weather Flow conditions.

As seen in Table V6-8.5, two lift stations (Al Salam (8D), and South Metwaly (10S)) have reached design capacity and should be enlarged or replaced, and one force main (Tammer (R1)) is undersized for current peak flows. The lift stations' rated capacities are greater than the firm capacities used in the analysis; therefore, the stations can periodically handle more flow if all pumps are in service. It should be noted that six lift stations were included in recent rehabilitation and upgrade work under the CMC project. Three of these stations would have appeared on the above table without the recent upgrade and rehabilitation.

8.1.2 Year 2020 Hydraulic Capacity Evaluation for Peak Flow Conditions

This section describes the hydraulic capacity evaluation of the Port Said collection system for year 2020 conditions with projected year 2020 flows.

8.1.2.1 Year 2020 Peak Wastewater Flow Analysis

The initial peak wastewater flow analysis simulated dry weather conditions using peak wastewater production and high groundwater infiltration. Dry weather flow was simulated to determine whether any of the existing pipes are undersized for future peak wastewater flows. Results of the analysis show that approximately 2.5 percent of the system will overload by year 2020.

Table V6-8.6 Relief Lines - Year 2020 Conditions

Length of Overloaded Pipes (m)	Total Length of Pipes (m)	Overloaded Pipes Based on Length (%)
608	27,101	2.5

Table V6-8.7, Summary of Overloaded Lines - 2020 Conditions presents a summary of the overloaded lines according to percent utilization.

Table V6-8.7 Summary of Overloaded Lines - 2020 Conditions

Percent Utilization (%)	Overloaded Lines Peak Dry Weather Conditions Total Length (m)
100-125	283
125-150	87
> 150	197
Total	**567**

Three lift stations (Alpijo (4D), Al Salam (8D), and South Metwaly (10S) and one force main (Tameer (R1)) were found to have inadequate capacity and will require expansion or replacement to convey future peak dry weather flows. As noted in the evaluation of existing conditions above. Several lift stations were included in recent upgrade and improvement under CMC. Three of these stations would have required upgrade for 2020 conditions if they had not been upgraded under CMC. The lift

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stations and force mains that will require expansion or improvements are listed in Table V6-8.8. The force mains were evaluated based on flow velocities not exceeding 1.8 m/s.

Table V6-8.8 Lift Stations/Force Mains - 2020 Conditions

Lift Station	Station Firm Capacity[1] (m^3/day)	Force Main Capacity (m^3/day)	Station Modeled Peak Flow (m^3/day)	Recommendations
Alpijo (4D)	25,000	36,644	27,798	Replace pumping station
Al-Salam (8D)	25,200	59,851	30,567	Replace pumping station
Al-Zohoor (A22)	51,840	43,972	16,592	-
Al-Zohoor (11S)	62,200	60,000	52,975	-
Istismar	5,200	15,000	6,104	-
23rd July (1S)	25,900	16,965	10,138	-
Main (8S)	123,000	3,499	3,506	-
Mazrah	127,000	229,000	110,120	-
South Metwaly (10S)	16,180	98,938	28,165	Replace pumping station
Tameer (R1)	11,200	4,763	6,048	Parallel force main
Tameer (R2)	38,000	16,800	12,181	-

1) May 1996 Infiltration/Salinity Report, Volume 1.

8.1.3 Ultimate Hydraulic Capacity Evaluation for Peak Flow Conditions

This section describes the hydraulic capacity evaluation of the Port Said collection system at ultimate growth conditions. Ultimate peak dry weather conditions were simulated to determine whether any of the existing pipes are undersized for ultimate peak flow conditions.

8.1.3.1 Ultimate Wastewater Flow Analysis

Peak dry weather conditions were simulated to determine whether any of the existing pipes are undersized for ultimate growth conditions.

The results of this analysis showed the same overloaded pipes as at year 2020 conditions.

Lift station capacities were evaluated based on projected peak flow conditions, and the present firm capacity. The same lift stations and force main as were found to have inadequate capacity at the 2020 conditions and will require expansion or replacement to convey projected ultimate peak dry weather flows. The lift stations and force mains are listed in Table V6-8.9, Lift Stations/Force Mains Ultimate Conditions, with recommendations for expansion or improvement for future flow conditions. The force mains were evaluated based on flow velocities not exceeding 1.8 m/s.

Table V6-8.9 Relief Lines Year Ultimate Conditions

Length of Overloaded Pipes (m)	Total Length of Pipes (m)	Overloaded Pipes Based on Length (%)
1,518	27,101	3.7

For ultimate peak dry weather conditions, 3.7 percent, or approximately 1,518 meters, of the modeled system was overloaded.

Table V6-8.10 presents a summary of the overloaded wastewater lines according to percent utilization.

Table V6-8.10 Summary of Overloaded Lines Ultimate Conditions

Percent Utilization (%)	Overloaded Wastewater lines Peak Dry Weather Conditions Total Length (m)
100-125	688
125-150	420
> 150	410
Total	1,518

Three lift stations (Alpijo (4D), Al Salam (8D) and South Metwaly (10S)) and one force main (Main (8S)) were found to have inadequate capacity and will require expansion or replacement, to convey projected ultimate peak dry weather flows. The lift stations and force mains that will require expansion or improvement for future flow conditions are listed in Table V6-7.11, Lift Stations/Force Mains Ultimate conditions. The force mains were evaluated based on flow velocities not exceeding 1.8 m/s.

Table V6-8.11 Lift Stations/Force Mains Ultimate Conditions

Lift Station	Station Firm Capacity[1] (m^3/day)	Force Main Capacity (m^3/day)	Station Modeled Peak Flow (m^3/day)	Recommendations
Alpijo (4D)	25,000	36,600	28,028	Replace pumping station
Al-Salam (8D)	25,200	59,851	39,348	Replace pumping station
Al-Zohoor (A22)	51,840	43,972	40,270	-
Al-Zohoor (11S)	62,200	60,000	59,781	-
Istismar	5,200	15,000	6,200	-
23rd July (1S)	25,900	16,965	10,628	-
Main (8S)	34,500	3,499	3,508	Parallel force main
Mazrah	127,000	229,000	125,944	-
South Metwaly (10S)	16,180	98,938	28,791	Replace pumping station
Tameer (R1)	11,200	4,763	2,728	-
Tameer (R2)	38,000	16,800	12,255	-

1) May 1996 Infiltration/Salinity Report, Volume 1.

The hydraulic modeling of the ultimate growth analysis on the existing system produced system overloading almost identical to the year 2020 analysis. This is the result of no substantial increase in growth within the existing system boundary. The growth that will occur in the Port Said system at ultimate growth is outside the existing system boundary and will be served new extension wastewater lines, as discussed later.

8.2 Wastewater Treatment Plant Analysis

A study of alternative treatment processes for Port Said was conducted in 1989 as part of the Canal Cities Water and Wastewater Phase II Project, USAID Contract 263-0174. The final report presenting the results of the study was submitted on 22 October 1989.

Previous planning studies by others had recommended a primary wastewater treatment plant for Port Said, with discharge of treated effluent to Lake Manzala. In order to avoid further degradation of the lake's water quality, other wastewater treatment processes were considered. To identify the best process, the study of alternative treatment processes was authorized, which included review of the following liquid treatment alternatives:

- Deep shaft activated sludge process with and without primary settling basins.
- Complete mix activated sludge process with and without primary settling basins.
- Aerated lagoons.
- Trickling filters.

Table V6-8.12, Solids Treatment Alternatives, presents a summary of solids treatment alternatives that were also considered for solids treatment for each liquid treatment process.

Table V6-8.12 Solids Treatment Alternatives

Treatment Process	Alternatives
Thickening	Gravity belt filter thickening. Gravity thickening.
Stabilization	Anaerobic digestion. Aerobic digestion. Facultative lagoons.
Dewatering	Belt filter presses. Sludge drying beds. Sludge drying lagoons.
Dry Sludge Storage	Land application on dedicated sites. Land application on agricultural fields. Landfilling.

In the aerated lagoon process, solids in the wastewater settle to the bottom of the lagoons and are stabilized. Unlike the other processes considered, the aerated lagoons require no additional sludge thickening and stabilization facilities.

The study recommended the aerated lagoon process followed by sludge drying lagoons and land application of the dried solids. This recommendation was based on least cost, high treatment reliability, and ease of operation.

These reasons are still valid. The aerated lagoon is highly reliable and is easy to operate. It is recommended that the wastewater treatment process currently used in Port Said be continued.

Early in the design of the new aerated lagoon facilities, concern developed about the proposed land application of dried sludge because of its high concentrations of dissolved solids (salts), pathogens, and heavy metals. Co-composting of the sludge with municipal solid waste was proposed instead, and a study that included a demonstration project was conducted. The results indicated that co-composting was technically feasible and that the resultant product was suitable for use as a soil amendment. Co-composting was therefore adopted as the sludge management method for the Port Said

Wastewater Treatment Plant. The operation has been hampered by equipment failures and shortage of presorted municipal waste.

8.3 Wastewater Effluent Reuse

The acceptability of treated wastewater for reuse depends on a number of factors, including the physical, chemical, and microbiological quality of the water. Making wastewater suitable for reuse is achieved either by (1) removing or reducing the concentrations of microorganisms and chemical constituents of concern through wastewater treatment or (2) eliminating contact between reuse water and edible crops by design or by operational controls.

The constraints on reuse related to physical characteristics, such as pH, temperature, and particulate matter, and chemical constituents (chlorides, sodium, heavy metals, and some trace organic compounds) are well known, and recommended limits have been established for many of these constituents. One chemical constituent for which recommended limits have been established and which is of concern to the Port Said Wastewater Treatment Plant is total dissolved solids (TDS), which cannot be removed by conventional wastewater treatment. Dissolved solids must be removed by desalination which is a very costly method and makes the cost of reuse water prohibitive when compared to the cost of irrigation water from other sources.

A few agricultural crops, such as the date palm and several varieties of grass, are salt tolerant and can survive TDS concentrations equal to 1,000 mg/L in the irrigation water. However, as the plants extract fresh water from the irrigation supply, the salt concentration in the soil will increase and must be leached out of the soil. The leaching process requires greater quantities of water, all of which will flow to waste.

The health risks associated with microorganisms are more difficult to assess. Epidemiological investigations directed at wastewater-contaminated drinking water supplies, the use of partially treated wastewater for food crop irrigation, the health effects of contact with such water on farm workers, and the infections carried by aerosols or windblown spray from spray irrigation sites, have produced considerable evidence on the transmission of infectious diseases. In developing countries, the irrigation of market crops with poorly treated wastewater is a major source of enteric disease.

As a result, water reuse standards and guidelines are concerned principally with the protection of public health and with nonpotable uses such as agricultural irrigation, and are generally based on the control of pathogenic organisms.

Where public contact with reuse water is likely or where the water is used to irrigate edible crops, tertiary treatment is typically required to produce essentially pathogen-free finished water. Recommended guidelines published jointly by the United States Environmental Protection Agency (USEPA), United States Agency for International

Development (USAID), and the World Health Organization (WHO) are presented below.

United States Environmental Protection Agency

The USEPA jointly with the USAID published "Guidelines for Water Reuse" in 1992. The primary purpose of the document is to provide guidelines for utilities and regulatory agencies in the U.S., particularly in states where standards do not exist or are being revised or expanded. The guidelines address water reuse for nonpotable urban, industrial, and agricultural applications as well as indirect potable reuse by groundwater recharge and augmentation of surface water sources of supplies. The USEPA guidelines address important aspects of water reuse and include recommendations on treatment processes, water quality limits, monitoring frequencies, and other controls for various water reuse applications. The recommended treatment processes and water quality limits are given in Table V6-8.13, USEPA Recommended Guideline for Reuse.

Both reuse water quality limits and wastewater treatment unit processes are recommended for the following reasons:

- Water quality criteria involving surrogate parameters do not adequately characterize reuse water quality.
- A combination of treatment and quality requirements known to produce reuse water of acceptable quality obviate the need to monitor the finished water for certain constituents.
- Expensive, time-consuming and, in some cases, questionable monitoring for pathogenic microorganisms is eliminated without compromising health protection; and treatment reliability is enhanced.

Total and fecal coliforms are the most commonly used indicator organisms in reuse water. The total coliform analysis includes organisms of both fecal and non-fecal origins.

Since fecal coliforms are better indicators of fecal contamination than total coliforms, the guidelines use fecal coliforms as the indicator organism.

The USEPA guidelines include limits on fecal coliforms, but not on parasites or viruses. In the U.S., parasites have not been shown to be a problem at the treatment levels and reuse water quality limits recommended in the guidelines, although there has been considerable interest in recent years regarding the occurrence and significance of *giardia* and *cryptosporidium* in reuse water. Where USEPA recommends filtration and high levels of disinfection to produce reuse water that is essentially free of measurable pathogens, addition of chemicals prior to filtration may also be necessary.

Table V6-8.13 USEPA Recommended Guidelines for Wastewater Reuse

Type of Use	Treatment	Reclaimed Water Quality
Urban Uses, Food Crops Eaten Raw, Recreational Impoundments	Secondary; Filtration; and Disinfection	pH = 6-9 ≤ 10 mg/L BOD ≤ 2 NTU No Detectable Fecal Coli/100 mL ≥ 1 mg/L Cl_2 Residual
Restricted Access Area of Irrigation, Processed Food Crops, Aesthetic Impoundments, Construction Uses, Industrial Cooling, Environmental Reuse	Secondary and Disinfection	pH = 6-9 ≤ 30 mg/L BOD ≤ 30 mg/L SS ≤ 200 Fecal Coli/100 mL ≥ 1 mg/L Cl_2 Residual
Groundwater Recharge of Nonpotable Aquifers by Spreading	Site Specific and Use Dependent, Primary (Minimum)	Site Specific and Use Dependent
Groundwater Recharge of Nonpotable Aquifers by Injection	Site Specific and Use Dependent, Secondary (Minimum)	Site Specific and Use Dependent
Groundwater Recharge of Potable Aquifers by Spreading	Site Specific, Secondary and Disinfection (Minimum)	Site Specific, Meet Drinking Water Standards After Percolation Through Vadose Zone
Groundwater Recharge of Potable Aquifers by Injection, Augmentation of Surface Supplies	Includes the Following: Secondary; Filtration; Disinfection; and Advanced Wastewater Treatment	Includes the Following: pH = 6.5-8.5 ≤ 2 NTU No Detectable Fecal Coli/100 mL ≥ 1 mg/L Cl_2 Residual Meet Drinking Water Standards

NOTE: NTU values based on 24-hour average value should not exceed 5 NTU at any time, and should be met prior to disinfection; fecal coli counts for use categories 1 and 6 are based on a 7-day median value, and should not exceed 14 fecal coli/100 ml in any sample; Cl_2 residual measured after a minimum contact time of 30 minutes; industrial cooling use based on recirculating cooling towers; fecal coli count for use category 2 based on a 7-day median value, should not exceed 800 fecal coli/100 ml in any sample.

While viruses are a concern in reuse water, the guidelines do not include virus limits for the following reasons:

- A significant body of information exists indicating that viruses are inactivated or removed to low levels by appropriate wastewater treatment.
- The identification and enumeration of viruses in wastewater is hampered by relative low virus recovery rates.
- The number of facilities having the equipment and personnel necessary to perform the analyses is limited.
- The laboratory analyses can take as long as four weeks to complete.
- There is no consensus among public health officials regarding the health significance of low concentrations of viruses in reuse water.

World Health Organization

The World Health Organization (WHO) published guidelines in 1989 for reclaimed water use in agriculture and aquaculture. The WHO guidelines, which are directed

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mainly at reuse in countries where specific guidelines have not been developed, are less restrictive than water reuse guidelines in the U.S. and many other industrialized countries. The WHO guidelines are generally followed in Egypt.

The report of a WHO Scientific Group on Health Aspects of the Use of Treated Wastewater for Agriculture and Aquaculture that met in Geneva in 1987 was published by WHO as "*Health Guidelines for the Use of Wastewater for Agriculture and Aquaculture*". The recommended microbiological quality guidelines are summarized in Table V6-8.14, WHO Recommended Guidelines for Wastewater Reuse.

Table V6-8.14 WHO Recommended Guidelines for Wastewater Reuse

Category	Reuse Conditions	Exposed Group	Intestinal Nematodes (Arithmetic Mean No. Per 100 ml)	Fecal Coliforms (Geometric Mean No. Per 100 ml)	Wastewater Treatment to Achieve the Required Quality
A	Irrigation of: Crops Likely to be Eaten Uncooked; Sports Fields; Public Parks	Workers, Consumers, Public	< 1	≤ 1,000	Stabilization Ponds to Achieve the Micro-biological Quality Indicated, or Equivalent Treatment
B	Irrigation of: Cereal Crops; Industrial Crops; Fodder Crops; Pasture; and Trees	Workers	≤ 1	No Standards Recommended	Retention in Stabilization Ponds for 8-10 Days or Equivalent Helminth and Fecal Coliform Removal
C	Irrigation of: Crops in Category B if Exposure of the Workers and the Public Does Not Occur	None	Not Applicable	Not Applicable	Pretreatment as Required by the Irrigation Technology, But Not Less Than Primary Sedimentation

NOTE: In specific cases, local epidemiological, sociocultural, and environmental factors should be taken into account, and the guidelines modified accordingly; intestinal nematodes include Ascaris and Trichuris species and hookworms; nematode egg and fecal coliform count during irrigation period; for Category A reuse conditions a more stringent guideline (<200 fecal coliforms per 100 ml) is appropriate for public lawns such as hotel lawns, with which the public may come into direct contact; for Category B reuse conditions in the case of fruit trees, irrigation should cease two weeks before fruit is picked, and no fruit should be picked off the ground. Sprinkler irrigation should not be used.

The guidelines are based on the conclusion that the main health risks are associated with helminthic diseases and therefore, a high degree of helminth removal is necessary for the safe reuse. Intestinal nematodes serve as indicator organisms for the large settable pathogens. The guidelines indicate that other pathogens apparently become nonviable in long-retention pond systems, implying that helminth eggs and protozoan cysts will be removed to the same extent. The guidelines applicable to helminth eggs are intended as a design standard, not as a standard requiring routine testing of the effluent.

The Scientific Group concluded that owing to the lack of evidence indicating a health risk from bacteria, where the only exposed populations are farm workers, no bacterial guidelines are necessary. The recommended guideline of a geometric mean fecal coliform level of 1,000/100 ml is considered technically acceptable. The Scientific Group indicated that the potential health risks associated with the use of treated wastewater for lawn and park irrigation may present greater health risks than those associated with the irrigation of vegetables and, hence, recommended a fecal coliform limit of 200/100 ml for such urban irrigation.

The 1989 WHO guidelines identify waste stabilization ponds as the method of choice for meeting these guidelines in warm climates where land is available at reasonable cost. Based on helminth removal, the guidelines recommend a retention time of 8 to 10 days and state that at least twice that length of time is required in hot climates to reduce the fecal coliforms to the guideline limit of 1,000/100 ml.

The intent of international organizations such as the World Bank and United Nations Development Programme, who sponsored early work in this area, was to introduce at least some treatment of wastewater prior to crop irrigation in developing countries. The WHO guidelines satisfy this intent. The WHO guidelines are appropriate as an interim measure in developing countries until they can produce higher quality reuse water.

Stabilization pond systems have large land requirements and may be appropriate in warm climates. However, experience in the Middle East indicates that most existing stabilization pond systems are unable to consistently meet the WHO guidelines for the irrigation of food crops eaten raw.

8.3.1 Potential Reuse of Port Said Wastewater Treatment Plant Effluent

The characteristics of the effluent from the Port Said Wastewater Treatment Plant indicate that the effluent must have additional treatment prior to being made available for reuse. Two of the most notable characteristics are total dissolved solids and coliform bacteria. The average TDS concentration of the effluent for the 12-month period ending in October 1998 was approximately 2450 mg/L, and for the last three months of the period, it averaged approximately 3300 mg/L. With this high concentration of TDS, the effluent will be suitable for only the most salt-tolerant crops if used without further treatment. These crops include the date palm and some forage crops. Additional testing should be conducted to determine the soil conditions and drainage. It is recommended that desalination be considered if the effluent is to be used for irrigation.

Another possibility for reuse would be as industrial process water. Normally the high TDS would preclude the use of the effluent as cooling water, even for one-pass cooling. If the effluent is used for cooling water, recycling is not recommended. For use as process water, desalination would be recommended for most industrial reuse applications.

The coliform count in the wastewater effluent is another area of concern. The World Health Organization recommends a count of 1000/100 ml for crops likely to be eaten

uncooked, and suggests a count not higher than 200/100 ml for water that will be used for irrigation of parks and playing fields. The coliform count in the effluent of the wastewater treatment plant has been as high as 19,500/100 ml, which occurred in March 1998, and frequently will be over 5000/100 ml. For the effluent to be considered for any reuse, it must be disinfected to reduce the health hazards. The most common disinfectant is chlorine. The effluent contains algae and other suspended solids that will absorb the chlorine before disinfection can take place. It is recommended that the treatment process be followed by filtration prior to adding the chlorine to remove the algae and other suspended solids.

Other constituents of the wastewater, such as heavy metals, will cause problems when trying to reuse the wastewater for irrigation. The metals can be toxic to plants in minute concentrations. Presently wastewater effluent is not tested for metals; however, a testing program should be implemented.

In addition to the tertiary treatment of the wastewater before reuse, other facilities will be necessary. The costs of storage of the treated effluent, pump stations, and transmission lines to the point of use must be considered when comparing the cost of reuse vs. the cost of water from another source.

8.3.2 Port Fouad Wastewater Treatment Plant

The characteristics of the wastewater effluent from the proposed Port Fouad Wastewater Treatment Plant are not available. The discussions above concerning the effluent from the Port Said Wastewater Treatment Plant may be considered applicable to Port Fouad, although a disinfection system has been proposed and, if operated correctly, the coliform count in the effluent may be within the limits recommended by WHO.

8.3.3 Disinfection Evaluation

It has been reported that officials of the Egyptian Environmental Affairs Agency have expressed concern about the coliform bacteria being discharged in the wastewater treatment plant effluent. Fecal coliforms are generally used as indicator organisms for the presence of bacterial pathogens because their survival characteristics and rates of removal in treatment processes are similar to those of pathogens. The removal of bacterial pathogens is one of the objectives of wastewater treatment. A reduction in fecal coliforms is accepted as a reduction in pathogens.

In Port Said, the 1998 average number of coliforms in the wastewater treatment plant effluent was approximately 4,300. The plant effluent is discharged to Lake Manzala. To determine the effect of the discharge, samples of the lake water should be collected near the point of discharge and tested for fecal coliforms. Studies conducted at the start of The Canal Cities Water and Wastewater Phase II Project (USAID Contract No. 263-0174) to establish design requirements for the treatment plant determined the plant effluent would not require disinfection.

If new studies indicate the need for disinfection or if the treatment plant effluent is reused for irrigation, industrial process water, etc., disinfection should be considered. The most common method of reducing the coliform count is by disinfection with chlorine. The existing wastewater treatment plant does not have disinfection facilities, although the hydraulic design includes provisions for adding the process in the future without installing additional pumps. Facilities needed for adding chlorine to the effluent include the following:

- Covered storage area for 30 one tonne containers.
- Chlorine feed building.
- Chlorine feed equipment.
- Chlorine contact basins.
- Instrumentation.

The amount of chlorine to be used on a daily basis will need to be determined. This can be done by a series of tests using different concentrations of chlorine and determining the residual after a period of time and the number of coliform organisms surviving. In order to produce an opinion of the cost of disinfecting the wastewater plant effluent, it is assumed the chlorine concentration required will be between 5 and 10 mg/L. For the average day flow experienced in 1998, the amount of chlorine required each day will be between 380 and 770 kg.

Chlorine is available in Alexandria. The cost to refill a one-tonne container in early 1999 was approximately 980 LE. Therefore, the cost for disinfecting with chlorine will be 370 LE to 750 LE per day. Adding the cost of transportation to and from Alexandria would double the price, bringing the cost to 1,500 LE per day, or nearly 550,000 LE per year. Costs would vary depending on the quality and quantity of the effluent.

8.4 Biosolids

Solids that have settled to the bottom of the facultative and polishing lagoons undergo anaerobic decomposition and are eventually removed by dredging. The dredge discharges to one of 20 sludge drying lagoons. The lagoons are constructed with vertical concrete sidewalls, and each lagoon is equipped with weirs and decant boxes to allow the supernatant to be decanted. The decanted supernatant is returned to the facultative lagoon for treatment. After the sludge has been dewatered to approximately 40 percent solids, it is removed from the beds with front-end loaders and hauled by truck to either the co-composting facility or the sludge holding area. At present, all sludge is hauled to the co-composting area. Sludge that settles in the lagoons is removed by dredging and discharged to the sludge drying lagoons.

Municipal solid waste is delivered to the co-composting facility by trucks which discharge it onto a concrete tipping floor. There, solid waste is spread over the tipping floor and inspected for large non-compostable objects, which are removed. The accepted material is loaded onto conveyors and transported to the screening and mixing

drum, past an observation platform for additional inspection and removal of non-compostable material. The remaining material passes beneath a magnet that removes ferrous metals, and is then fed into a rotary drum where it is ground and mixed into raw compost. The rotary drum discharges the material to a trommel-type reject screen. Reject material that is too coarse to pass through the screen is removed. Plastic and other non-compostable materials in pieces small enough to pass through the reject screen are included in the compost material. This lowers the quality of the compost for reuse. To reduce the amount of small non-compostable materials in the compost, a screen with a finer mesh has been recommended.

Sludge from the drying lagoons or from the dried sludge storage area is transported to the receiving area and carried by conveyor to the mixer feed conveyor. The mixer feed conveyor moves raw compost and dried sludge to the mixing pug mill, where the materials are thoroughly mixed.

The co-composted mixture is conveyed to an asphalt pad and placed in windrows for processing. Fans blowing the air through ventilation ducts in the pad aerate the windrows. The windrows are periodically turned by a machine. After approximately four weeks, the composted material is moved to maturation area, where the windrows are not aerated. The finished compost can be picked up for use as a soil amendment or is transported to a storage area. At present, the compost is usually stored on sludge drying beds. It is reported that the plant has approximately 8,000 tons of compost in storage. Approximately 50 tons has been used by the Govenorate as a soil amendment.

Materials rejected from the tipping floor or from the co-composting process are hauled to offsite disposal areas.

The composting facilities have been subject to mechanical problems. The mechanical problems are correctable.

To make the co-composting operation more successful, the quality of the solid waste delivered to the site needs to be improved with more attention to presorting the material before it reaches the co-composting facilities. At the site, a larger observation platform with more personnel to inspect the material and to remove the non-compostable items would be helpful. The installation of the finer mesh screen to remove more of the ground non-compostable material discharged from the rotary drum should also improve the operation.

In order to make more efficient use of the finished compost, it may be necessary to revise the regulations to allow users other than the Govenorate to have access to the stored material.

8.5 Assessment of WWTP Capacity

The Port Said WWTP has a design capacity of 190,000 m^3/day (average day) with BOD loading of 300 mg/L and TSS loading of 330 mg/L. The plant was constructed with one treatment train and to date has not reached its design capacity. The 1998

average flow was approximately 115,000 m^3/day. The average BOD and TSS concentrations have also not reached design levels. To date, plant effluent has been of acceptable quality and well within the effluent limits.

The flow and loads to the WWTP will increase as the population of Port Said increases and as the number of persons served by the wastewater system increases. As noted above, wastewater treatment plant capacity is often expressed as a flow rate (m^3/day) and as BOD and TSS concentrations (mg/L). This is a useful measure of plant capacity, however another, often more useful, way to express treatment plant capacity is in terms of mass loading rate. Experience indicates that in many types of wastewater treatment plants, the BOD mass loading rate is one of the most critical measures of plant capacity and/or performance.

The design BOD mass loading rate for the Port Said plant is 57,000 kg/day. Operational data from 1998 indicates that the average BOD mass loading rate was just under 29,000 kg/day or approximately 50 percent of the design rate.

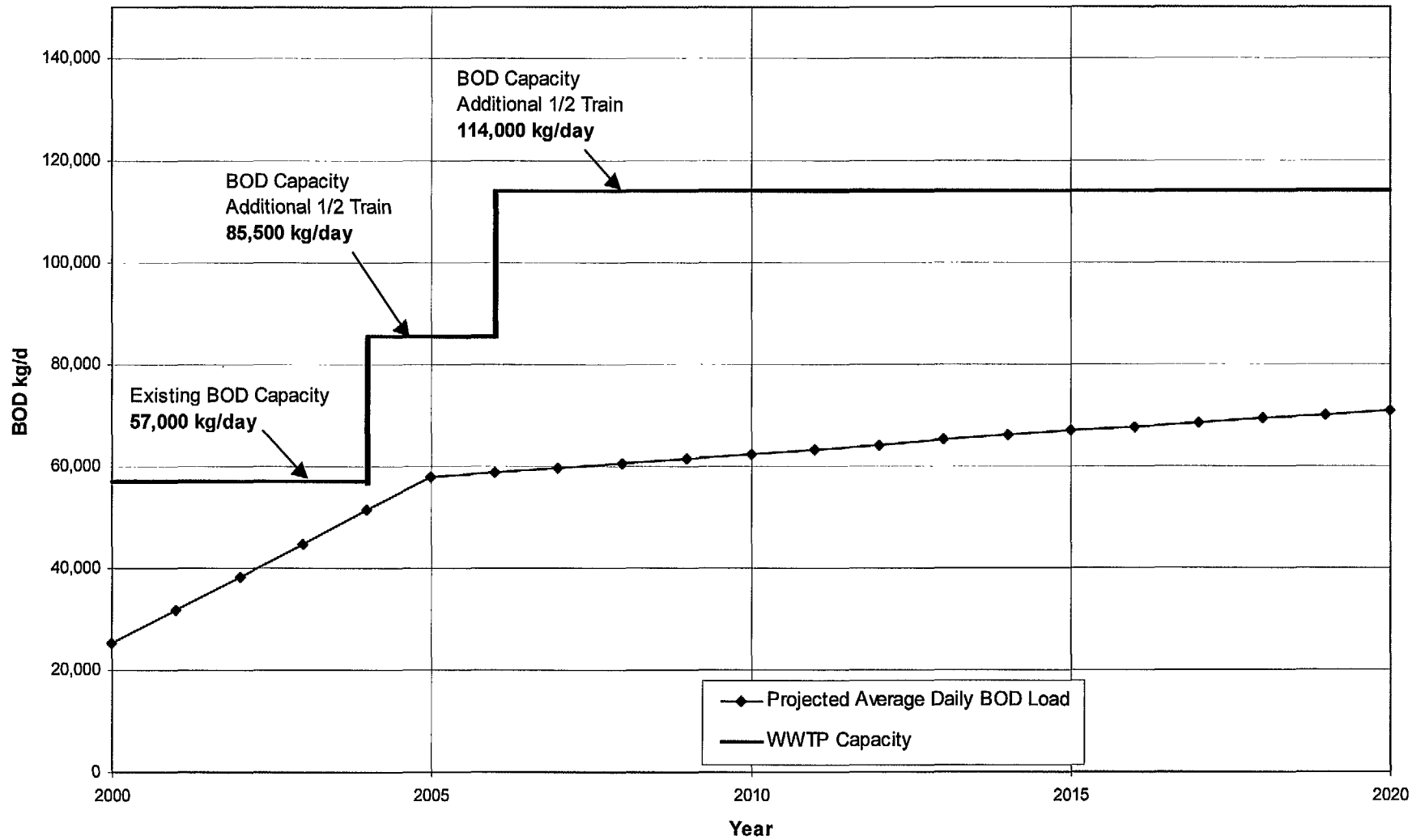
In earlier chapters of this Master Plan, population projections were presented for Port Said. By estimating future flows to the treatment plant as well as future BOD concentrations, a graph like Figure V6-8.2, Port Said WWTP BOD Capacity vs. BOD Load, was generated.

This figure illustrates that using design BOD mass loading rate the BOD treatment capacity of the plant will be exceeded in 2004. This projection is very dependent upon rapid growth in the number of persons and businesses connected to the wastewater system within the next five years. If the wastewater system grows at a lower rate, BOD mass loading capacity will not be exceeded so soon.

Figure V6-8.2 illustrates the effects of construction of one additional treatment train. Addition of a treatment train of approximately half the capacity of the existing plant would be sufficient to treat the Port Said BOD loads beyond 2020.

Chapter 9 of this Master Plan includes the estimated CIP costs this additional treatment train.

End of Chapter 8: Current and Future Wastewater Needs



ARAB REPUBLIC OF **EGYPT** SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	**USAID** CANAL CITIES WATER AND WASTEWATER MASTER PLAN	**PORT SAID WWTP BOD TREATMENT CAPACITY VS PROJECTED BOD MASS LOADING RATE**	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES DATE: AUGUST 1999 FIGURE: V6-8.2

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9.0 Implementation Plan

This section presents the priced Implementation Plan, which includes recommendations for upgrading specific trunk sections, extension of service to currently unserved areas, and expansion of the system to accommodate development by adding treatment facilities to treat the increased flows.

9.1 Introduction

The Implementation Plan was prepared using information from flow monitoring, wastewater line inventory, growth and development projections, and computer modeling described in Chapter 8 of this report. The implementation plan prioritizes improvements into two major construction phases following the criteria given below.

9.1.1 Phase 1

- Construction of relief lines to eliminate hydraulic deficiencies identified by the model under current peak flow conditions.
- Upgrading of lift stations to eliminate hydraulic deficiencies identified by the model under current peak flow conditions.
- Construction of extensions to the wastewater lines to serve areas currently served by water system, which do not have wastewater facilities.
- Construction of new lift stations to serve areas currently served by water system, which do not have wastewater facilities.
- Implementing a wastewater system management plan to include an annual program of wastewater line inspection, maintenance, and rehabilitation.
- Wastewater treatment plant expansion to accommodate the increased flows projected to be collected by the other Phase 1 facilities and population growth to the year 2004.

9.1.2 Phase 2

- Construction of extension lines to serve future development areas currently without water or wastewater service.
- Construction of new lift stations to serve future development areas currently without water or wastewater service.
- Wastewater treatment plant expansion to accommodate the increased flows projected to be collected by other Phase 2 facilities and population growth to the ultimate development conditions.

The capital improvements recommended in the Implementation Plan are based on the following criteria:

- Wastewater line capacity and flow containment for peak wet weather conditions.
- No significant future infiltration removal (the collection system is not influenced by rainfall).

Figure V6-9.1, Port Said Wastewater System Recommended Improvements, shows the facilities included in the implementation plan. The recommended improvements are grouped into two phases. Phase 1 improvements are needed to address immediate or near-term deficiencies and should be constructed within the next 5 years. Phase 2 improvements are additional facilities needed by year 2020 and should be reviewed prior to implementation based on the actual growth and water demand patterns.

9.1.3 Wastewater Collection System Extensions

New interceptor lines, lift stations, and force mains will be required to serve portions of the study area which are currently served with water, but not by wastewater collection, and areas of future development. Currently, all wastewater collected is tributary to the Mazrah Lift Station. This lift station was built specifically to convey wastewater from the old treatment plant to the new treatment plant. Projections indicate the Mazrah Lift Station is fairly well matched to the ultimate peak flow projected from the currently connected tributary area. This is also true of most of the lift stations and force mains within the existing collection system. To avoid overloading and upgrading all existing facilities, this Master Plan recommends that another major lift station be established about 1.3 km south of Mazarah LS and that all interceptor extensions, lift stations, and force mains be made tributary to this lift station.

An additional benefit of this autonomous approach is to minimize the additional construction within the densely developed area of the city. It will reduce not only traffic disruption, but also the construction cost, the number of utility conflicts, public complaints, and duration of construction.

In some cases, extensions to the existing collection system are under construction, or Phase 1 capital improvements may be completed before the Expansion Lift Station and force main are ready for operation. In these cases, the new facilities may be temporarily connected to the network at existing lift stations. Once the Expansion Lift Station is commissioned, all extension works should be made tributary to it.

The new extension lines are indicated on Figure V6-9.1, Port Said Wastewater System Recommended Improvements. The recommended interceptors, lift stations, and force mains were sized to serve ultimate development. The indicated locations are preliminary and should be used only as a guide for planning purposes.

More precise alignments and pump station locations must be defined following a detailed topographic and land availability survey performed under a detailed design contract.

The construction of wastewater collection system extensions is dependent on development within the study area. Phase 1 capital improvement projects focus on serving areas which are currently served with water but do not have wastewater collection or areas currently under development. These Phase 1 interceptors, lift stations, and force mains are sized to accommodate the peak flow under ultimate development conditions.

Savings may be realized by constructing the building to accommodate the ultimate peak flow and only installing pumps adequate for Phase 1 expansions. Pumps can be added as Phase 2 extensions are constructed. Phase 2 projects assume balanced development throughout the study area. Proposed new interceptors are evaluated as future improvements with construction periods to be dictated by actual development. It is recommended that utility authorities maintain regular communication with the planning agencies and periodically reassess wastewater facility needs.

9.1.4 Recommended Pipe Materials

Selection of pipe material depends on local manufacturing and soil conditions. The infiltration and salinity study documented that the soil in Port Said ranges from moderately corrosive to highly corrosive. The salinity and the potential for the presence of hydrogen sulfide gas in the pipes indicate the need for protective measures.

The roughness of the interior surfaces of the pipe has a large impact on velocity and therefore on the recommended grade, to avoid sedimentation. Using longer sections of pipes with smooth surfaces and fewer joints will make it possible to significantly increase the distance between pump stations in flat areas. Recommended pipe materials are based upon price comparisons and performance characteristics. Pipe materials recommended for gravity wastewater lines in Port Said are listed below.

- PVC is recommended for pipes 175 mm and 300 mm diameter.
- Rigid fiberglass reinforced plastic is recommended for 300 to 700 mm pipes.
- Rigid fiberglass reinforced plastic pipe is available in sizes above 800 mm. If the cost is not prohibitive use of FRP would extend pipeline service life.
- Reinforced concrete pipe produced locally is an acceptable material for larger than 800 mm lines.

Pipe materials recommended for force mains in Port Said are listed below.

- PVC pressure pipe is recommended for 75 to 300-mm force mains.
- Ductile iron pipe is recommended for 350 to 1000 mm force mains.
- Prestressed concrete cylinder pipe is recommended for force mains above 1000 mm.

Reinforced concrete pipe must be protected on the inside by an embedded PVC liner similar to T-lock, and coated on the outside with coal tar epoxy to protect it against corrosion by the brackish groundwater. Special consideration must be given to protection at the joints. It may also be prudent to wrap the reinforced concrete pipe with a low-cost taped polyethylene sleeve as is done for large diameter ductile iron pipes.

The installation inspection is as important as the actual choice of materials. In the case of PVC or rigid fiberglass reinforced plastic, damage during handling and jointing can offset their positive attributes. These materials are light and easier to handle. Experience indicates contractors frequently damage these pipes through improper loading, unloading and installation. In the case of reinforced concrete pipe, the interior

or exterior coatings are frequently damaged during installation and must be repaired before backfilling or commissioning. Even pinholes can initiate corrosion of the reinforcement or prestressing steel, leading to cracking of the cover concrete and exposing the pipe to massive corrosion. Pinhole detectors are available and are recommended for inspection of both the coal tar epoxy and PVC linings. Backfilling must be completed before dewatering is stopped to prevent misalignment by floatation.

9.1.5 Recommended Pipe Slopes and Peak Flow Rates

Criteria were established for designing wastewater system extensions. The collection system was designed to carry the ultimate peak flow at a velocity of at least 1.0 m/s and minimum flows at 0.6 m/s to minimize sedimentation. In general, the slopes are slightly steeper than those previously used in Port Said, as dictated by experience with the existing system and sedimentation problems experienced during Canal Cities Phase 2. Table V6-9.1 presents the recommended criteria, based on the Manning's Equation, for both conventional pipe and smooth bore PVC and GRP pipes.

Table V6-9.1 Recommended slopes and design peak flow rates for various pipes

Nominal Size (mm)		Concrete, DIP, or Vitrified Clay ID (mm)	n=0.013 Slope for Velocity of 1 m/s (m/1000m)	n=0.013 100% Dia Gravity Flow (m^3/d)	Flow Rate as Force Main V= 1.5 m/s (m^3/d)	uPVC <300 GRP >300 ID (mm)	n=0.010 Slope for Velocity of 1 m/s (m/1000)	n=0.010 100% Dia Gravity Flow (m^3/d)	Flow Rate as Force Main V= 1.5 m/s (m^3/d)
3"	75					70	22.00	347	575
4"	100	100	22.70	702	1,000				
	110					103	13.00	744	1,080
6"	150	150	13.20	1,577	2,290				
7"	175	175	10.80	2,152	3,117				
8"	200	200	9.00	2,805	4,072	190	5.70	2,531	3,675
9"	225	225	7.70	3,552	5,153				
10"	250	250	6.70	4,388	6,362	238	4.22	3,971	5,766
12"	300	300	5.25	6,316	9,161				
12"	315					300	3.10	6,310	9,161
14"	350	350			13,000				
15"	375	375	3.90	9,871	14,314				
16"	400	400			16,800	380	2.26	10,119	14,698
18"	450	450	3.10	14,310	20,612				
20"	500	500	2.65	17,523	25,447	500	1.57	17,534	25,447
24"	600	600	2.10	25,366	36,644	600	1.23	25,237	36,644
28"	700	700	1.70	34,426	49,876	700	1.00	34,325	49,876
32"	800	800	1.42	44,921	65,144	800	0.84	44,915	65,144
36"	900	900	1.22	57,003	82,448	900	0.72	56,928	82,448
40"	1000	1000	1.05	70,038	101,788	1000	0.62	69,965	101,788
48"	1200	1200	0.83	101,258	146,574	1200	0.49	101,143	146,574
52"	1300	1300	0.74	118,361	172,021				0
56"	1400					1400	0.40	137846	199,504
60"	1500	1500	0.61	157,394	229,022				0
64"	1600					1600	0.34	181447	260,576

When reviewing the existing system in Port Said, and proposed expansion designs available from NOPWASD, there appears to be a general trend to utilize gravity pipes significantly larger than necessary to carry projected peak flows. In theory, larger pipes can be laid on flatter slopes than smaller pipes to obtain the same velocity, if the depth of flow in each is the same percentage of the pipe diameter. However, it appears that oversized pipes are being installed to utilize the flatter recommended slopes, thus requiring fewer lift stations. Unfortunately, the installed pipes will be subject to sedimentation problem unless peak flow depth is 75-80 percent of the pipe diameter and minimum flow depth is at least 30 percent of the pipe diameter. Installation of oversized pipes should be avoided because it is unnecessarily expensive and creates a permanent costly maintenance problem.

9.1.6 Improvement Costs

For purposes of economic evaluation and budget estimates, cost data for the construction of wastewater facilities such as pipelines, lift stations, and force mains were compiled from recent construction costs from the CMC, Phase 2. The basis of construction costs used in preparing budget estimates for capital improvement projects is presented in the tables below. The construction costs represent average planning level costs for mobilization/demobilization, shoring, dewatering, and surface restoration, and construction. These costs should be updated during detailed design to represent current costs based on the inflation index and the method of contracting.

9.1.6.1 Gravity line construction

Table V6-9.2, Wastewater Gravity Line Construction Costs, presents the estimated cost of gravity line construction for relief and extension wastewater lines. The cost per meter of trench including manhole costs is presented for representative invert depths.

Table V6-9.2 Wastewater Gravity Line Construction Costs

Nominal Diameter (mm)	Depth of Wastewater Line			
	Up to 3.0m ($/m)	Up to 4.5m ($/m)	Up to 6.0 m ($/m)	Up to 7.5 m ($/m)
200 uPVC	460	560	670	770
250 uPVC	580	680	790	890
300 uPVC	700	800	910	1010
400 GRP	930	1040	1150	1270
500 GRP	1060	1260	1370	1470
600 GRP	1400	1500	1610	1720
700 GRP	1630	1740	1850	1970
800 RCP	1860	1980	2100	2220
1000 RCP	2320	2430	2550	2660
1200 RCP	2790	2910	3030	3150
1300 RCP	3020	3140	3260	3380
1500 RCP	3490	3610	3740	3870

uPVC = unplasticized poly vinylchloride pipe
GRP = glass reinforced plastic pipe (fiberglass pipe)
RCP = reinforced concrete pipe

9.1.6.2 Force Main Construction

Table V6-9.3 shows the basis of costs for force main construction. The force main improvement costs are based on average costs per meter and an average depth between 1 to 2 meters, and do not take into consideration valve chambers and fittings, or air valves. These appurtenances should be priced individually based upon the detailed design and vertical alignment.

Table V6-9.3 Force Main Unit Construction Costs

Nominal Diameter (mm)	Cost per meter length ($)	Nominal Diameter (mm)	Cost per meter length ($)
75 uPVC	150	500 Di	520
100 uPVC	160	600 DI	620
125 uPVC	180	700 DI	720
150 u PVC	190	800 DI	820
200 uPVC	200	900 DI	930
250 uPVC	250	1,000 DI	1030
300 uPVC	300	1,200 PCCP	1240
350 DI	350	1,300 PCCP	1340
400 DI	410	1,500 PCCP	1550

uPVC = unplasticized poly vinylchloride pipe
DI = ductile iron pipe
PCCP = prestressed concrete cylinder pipe

9.1.6.3 Lift Station Construction

Table V6-9.4, Lift Station Construction Costs, presents the lift station construction costs based on the capacity of the station. Expansion or replacement of the lift station is considered based on the flow to capacity ratio. These costs represent planning level costs and should be updated during detailed design. The decision whether to expand or to replace a pumping station will be made during the detailed design stage, based on the condition and physical configuration of the station.

Table V6-9.4 Lift Station Construction Costs

(Cost per Unit Pump Discharge (m^3/s))

Lift Station Capacity (m^3/day)	Expansion Costs ($)	Replacement Costs ($)
250	40,000	90,000
500	70,000	150,000
1,000	110,000	220,000
2,500	150,000	310,000
5,000	250,000	490,000
10,000	430,000	860,000
20,000	690,000	1,370,000
25,000	770,000	1,530,000
30,000	830,000	1,670,000
50,000	1,290,000	2,580,000
75,000	1,660,000	3,310,000
125,000	2,390,000	4,780,000
250,000	3,800,000	7,600,000

9.1.7 Contracting Procedures

The following sections present a breakdown of the critical capital improvements identified in Chapter 8 into separate capital improvement projects (CIP). The components of each CIP are intended to be implemented at the same time, although components requiring different construction techniques may be contracted separately. Capital improvement projects to be constructed by foreign contractors may be grouped to make a more attractive package and to reduce the mobilization and overhead costs as a proportion of the work to be accomplished. On the other hand, if the project is to be constructed by local contractors, the components may be divided among several contracts to accommodate different capabilities and smaller firms.

Capital improvement projects that depend on another downstream project for proper functioning are so identified. The contracting agency must pay special attention to scheduling, monitoring, and funding of contracts to ensure that the downstream projects are completed first.

Except for relief line construction, all capital improvement projects will require detailed design and site surveying. This can be done under a single contract for all Phase 1 projects or by a separate design team for each project. Detailed design for Phase 1 should begin immediately, and sufficient time should be allocated before bidding is scheduled.

9.2 Phase 1 - Recommended Capital Improvement Projects

9.2.1 CIP 1 – Upgrading of Existing System to Handle Current Peak Flows

9.2.1.1 Relief Wastewater line Improvements

For existing (year 1999) conditions, the model indicates a total of approximately 648 meters of wastewater lines are overloaded during peak dry weather conditions. The overloaded lines are detailed in the CIP 1 cost summary below. The capital improvement projects for relief wastewater lines required to meet existing system needs are shown in red on Figure V6-9.1, Port Said Wastewater System Recommended Improvements, and are identified by a prefix CIP 1.

For planning purposes, relief lines are sized to parallel existing wastewater lines at the slopes as the existing lines. It is recommended that the upstream invert of the relief line be set above the invert of the existing pipe by approximately 60-75% of the diameter of the existing pipe. This configuration will allow the relief wastewater line to begin carrying peak flow before the manhole surcharges, but will maintain the minimum flows in the existing pipe to avoid sedimentation in both pipes during low flows.

9.2.1.2 Lift Station Improvements

Lift station and force main capacities were evaluated based on existing and projected peak flow conditions and the existing firm lift station capacity. When flow/firm capacity ratio is less than 1.0, no improvement is recommended. Expansion is recommended when the peak flow/firm capacity ratio exceeds 1.0, but is less than 1.2. Lift station expansion is defined as increasing the capacity by replacing pumps or modifying existing pumps impellers to obtain additional capacity within the space constraints of the existing pump station and wet well configuration. A 20% increase in capacity was considered a practical limit without causing operational or maintenance problems. Lift Station replacement is recommended when the peak flow/firm capacity ratio is higher than 1.2.

It should be noted that detailed review of whether to expand or replace each lift station should be carried out before or as part of detailed design. Of the eleven lift stations modeled, two are recommended for improvement as Phase 1: Al Salam -8D, and South Metwaly – 10S . The recommended firm capacities of Phase 1 lift station improvements are listed in the CIP 1 detail table below. The recommended firm capacities resulting from Phase 1 improvements are estimated to accommodate peak flows up to ultimate development conditions.

9.2.1.3 Force Main Improvements

Force main capacities were evaluated based on existing and projected peak flow conditions and the existing firm lift station capacity. Proposed force main improvements are assumed to be constructed in parallel; however, whether the existing force mains are paralleled or replaced with a larger pipe will be determined during detailed design considering the physical condition of the existing pipe and available space or alternate alignment for parallel force mains. The model indicates all existing force mains are capable of handling current peak conditions and none need to be upgraded during Phase 1.

9.2.1.4 Existing System Critical Improvements

The components and cost of CIP 1 are detailed below.

CIP 1 – Existing System Critical Improvements			
Facility	**Size**	**Length**	**Estimated Cost**
Tameer (R2) Parallel force main	400	3000	1,230,000
Al Salam (8D) Replacement	39,400 m3/d	NA	2,100,000
South Metwaly (10S) Replacement	28,800 m3/d	NA	1,800,000
CIP1-P1 Parallel Relief Line	500 mm	341 m	500,000
CIP1-P2 Parallel Relief Line	900 mm	116 m	240,000
		Construction Cost Subtotal	$5,870,000
		Construction Contingency 20%	1,174,000
		Subtotal	7,044,000
		Engineering and Administration Cost 20%	1,409,000
		Total Capital Improvement Cost	$8,453,000

9.2.2 CIP 2 – A28 Lift Station and Force Main

The wastewater collection system has been designed for the development area west of Port Said. This is a major expansion of the city covering approximately 2700 hectares which are projected to ultimately become a very high density residential area. The wastewater collection system has been installed over an area of about 500 hectars, but the pump station has not been designed. The collected wastewater currently flows to the Old Treatment Plant Emergency Bypass Drain and into Lake Manzalla. Although the population in the area is currently small, it is highly desirable to transport the collected wastewater to the treatment plant.

CIP 2 is planned to construct this lift station in planning area A28 and connect it to the treatment plant headworks by a forcemain. The lift station and force main are sized to handle the peak flow from the entire area to be developed plus any emergency overflow from the Mazrah Lift Station as described under CIP 11 below. Because of the developing nature of the area, it appears desirable to build the structure for the projected peak flow, but install the pumps and screens for roughly 65% of the peak flow under Phase 1. Additional pumps and screens are to be installed during Phase 2 and are included in CIP 11.

CIP 2 LS, A28 Lift Station, is approximately one kilometer South of the Mazrah Lift Station as shown on Figure V6-9.1, Port Said Wastewater System Recommended Improvements. The 2.0 km force main will follow the same alignment as the existing force main from Mazrah Lift Station to the WWTP and discharge at the same location.

The components and cost of CIP 2 are detailed below.

CIP 2 – A28 Lift Station			
Facility	**Size**	**Length**	**Estimated Cost**
CIP 2 – LS	115,000 m3/d (Pumps & Screens for 80,000 m3/d)		3,400,000
CIP 2 – FM to WWTP	1000 mm	2000 m	2,000,000
		Construction Cost Subtotal	$5,400,000
		Construction Contingency 20%	1,080,000
		Subtotal	6,480,000
		Engineering and Administration Cost 20%	1,296,000
		Total Capital Improvement Cost	$7,776,000

In addition to carrying the expansion trunk flows to the WWTP, CIP 2 serves 70 hectares currently developed or projected for development, which drain to it by gravity. This area will require collectors and laterals smaller than 300 mm, not included in the scope of this report or the costs above.

9.2.3 CIP 3 – El-Raswa Canal Eastern Interceptor

CIP 3 is planned to intercept areas with no wastewater service north of the eastern end of the El-Raswa Canal and serve the proposed development areas both north and south of the El-Raswa Canal. This project is considered a high priority since it specifically responds to the Governorates request to provide wastewater collection for

the proposed development area between Mohamed Ali Street and south Azmy Street. The interceptor also is to intercept the force main from Labana Lift Station which we are advised still flows into Lake Manzalla without treatment.

The CIP 3 lift station, force main and interceptor are sized to accept the upstream peak flows from PH 1 CIP 4, PH 1 CIP 5, and Phase 2 developments south of the El-Raswa Canal. Because of the developing nature of the area, it appears desirable to build the structure for the projected peak flow, but install the pumps and screens for roughly 50% of the peak flow under Phase 1. Additional pumps and screens are to be installed during Phase 2 and are included in CIP 12. The components and cost of CIP 3 are detailed below.

CIP 3 – El-Raswa Canal Eastern Interceptor			
Facility	**Size**	**Length**	**Estimated Cost**
CIP 3 – LS	120,000 m3/d (Pumps & Screens for 60,000 m3/d)		3,100,000
CIP 3 - FM to Existing S10 – LS	1000 mm	600 m	620,000
Gravity Interceptor	1300 mm	350 m	1,100,000
Gravity Interceptor	900 mm	285 m	630,000
Gravity Interceptor	800 mm	555 m	1,100,000
Gravity Interceptor	600 mm	650 m	940,000
Gravity Interceptor	500 mm	200 m	250,000
Gravity Interceptor	400 mm	400 m	420,000
Gravity Interceptor	300 mm	300 m	210,000
		Construction Cost Subtotal	$8,370,000
		Construction Contingency 20%	1,674,000
		Subtotal	10,044,000
		Engineering and Administration Cost 20%	2,009,000
		Total Capital Improvement Cost	$12,053,000

In addition to carrying the expansion trunk flows, CIP 3 serves 140 hectares currently developed or projected for development, which drain to it by gravity. This area will require collectors and laterals smaller than 300 mm, not included in the scope of this report or the costs above.

CIP 3 is to be connected temporarily to LS-10S to carry Phase 1 flows, but is to be connected to Phase 2 CIP 10 for transport to the WWTP when LS-10S becomes overloaded.

9.2.4 CIP 4 – Central Azmy St. Trunk System

CIP 4 is planned to serve the commercial and light industrial area east of Azmy Street and the residential areas west of Azmy Street, which currently have no wastewater collection. This system runs along Azmy Street south from the container harbor through the organized Investment area. This project is considered a high priority since it specifically responds to the Governorates request to provide wastewater collection for the commercial areas along Azmy Street. Currently, most of the effluent

from this commercial area is believed to be discharged directly to the Suez Canal without treatment.

The CIP 4 lift station, force main and trunk are sized to accept the upstream peak flows from PH 1 CIP 5. The components and cost of CIP 4 are detailed below.

CIP 4 – Central Azmy St. Trunk System			
Facility	**Size**	**Length**	**Estimated Cost**
CIP 4 – LS	18,000 m3/d	NA	1,250,000
CIP 4 – FM to CIP 3 Gravity Trunk	400 mm	300 m	120,000
Gravity Trunk	500 mm	1200 m	1,400,000
Gravity Trunk	400 mm	350 m	330,000
		Construction Cost Subtotal	$3,100,000
		Construction Contingency 20%	620,000
		Subtotal	3,720,000
		Engineering and Administration Cost 20%	744,000
		Total Capital Improvement Cost	$4,464,000

In addition to carrying the expansion trunk flows, CIP 4 serves 45 hectares, currently developed as commercial and light industry which are projected for additional development, which drain to it by gravity. This area will require collectors and laterals smaller than 300 mm, not included in the scope of this report or the costs above.

To function properly, CIP 4 depends upon CIP 3 being complete.

9.2.5 CIP 5 – North Azmy St. Trunk System

CIP 4 is planned to serve the commercial, light industrial, and railroad service areas along both sides of Azmy Street; especially the harbor area south of Mustafa Kamel Street. This system runs along Azmy Street collecting wastewater to a lift station east of the container harbor. This project is considered a high priority since it specifically responds to the Governorates request to provide wastewater collection for north Azmy Street. Currently, most of the effluent from this commercial area is believed to be discharged directly to the Suez Canal without treatment. The components and cost of CIP 5 are detailed below.

CIP 5 – North Azmy St. Trunk System			
Facility	**Size**	**Length**	**Estimated Cost**
CIP 5 – LS	7,800 m3/d		670,000
CIP 5 – FM to CIP 4 Trunk	300 mm	425 m	130,000
Gravity Collector	300 mm	250 m	160,000
		Construction Cost Subtotal	$960,000
		Construction Contingency 20%	192,000
		Subtotal	1,152,000
		Engineering and Administration Cost 20%	230,000
		Total Capital Improvement Cost	$1,382,000

CIP 4 serves 40 hectares, currently developed as commercial, light industry, military, and residential, which drain to it by gravity. This area will require collectors and laterals smaller than 300 mm, not included in the scope of this report or the costs above.

To function properly, CIP 5 depends upon CIP 4 and CIP 3 being complete. Although this lift station could pump to an existing lift station on a temporary basis, it would overload the existing system as wastewater flows increase in the future.

9.2.6 CIP 6 – North Coast Trunk System

CIP 6 is planned to serve the north shore area north and east of the old Mazrah WWTP and surrounding the cemetery. The governorate has designed a wastewater collection system for this area. The trunk piping shown on Drawing V6-9.1 is based on the existing design. We understand that some revisions are expected to this design. Although the specific layout and proposed lift station location may changed in the future, but the need to collect the wastewater and convey it to the treatment plant will remain a high priority. This area is developing from random low density housing to a high density residential development area. The area north of the old treatment plant is basically hotel and tourist facilities on the Mediterranean coast.

The CIP 6 force main can be connected immediately to the Mazrah Lift Station. However, under ultimate development peak flow conditions the Mazrah Lift Station appears to just meet the peak flow from the existing connected areas. To avoid overloading the Mazrah Lift Station under 2020 and ultimate development conditions, it is recommended that the CIP 6 Force Main be connected to the PH 2 CIP 10 Bypass Interceptor during Phase 2 construction. The components and cost of CIP 6 are detailed below.

CIP 6 – North Coast Trunk System			
Facility	**Size**	**Length**	**Estimated Cost**
CIP 6 – LS	20,000 m3/d		1,370,000
CIP 6 - FM to Mazrah LS	500 mm	900 m	470,000
Gravity Trunk	600 mm	50 m	75,000
Gravity Trunk	500 mm	180 m	230,000
Gravity Trunk	400 mm	645 m	600,000
Collector	300 mm	165 m	120,000
		Construction Cost Subtotal	$2,865,000
		Construction Contingency 20%	573,000
		Subtotal	3,438,000
		Engineering and Administration Cost 20%	688,000
		Total Capital Improvement Cost	$4,126,000

CIP 6 serves 60 hectares of development, which drain to it by gravity. This area will require collectors and laterals smaller than 300 mm, not included in the scope of this report or the costs above.

CIP 6 depends can be temporarily connected to the Mazrah LS, but should ultimately be connected to PH2 CIP 10.

9.2.7 CIP 7 – Lake Manzala Shoreline Trunk

CIP 7 is a major trunk planned to serve the north shore of Lake Manzala in development areas A21, A28, A29, A30, A31 and A32 which are currently served with

water, but have no wastewater collection system. This trunk and associated large diameter collectors were designed by NOPWASD. Some construction is underway, however it appears that current construction is limited to development areas A24, A25. The information available indicates this area is intended for organized development within the next 5 years, although it may not reach ultimate population density until 2020.

This project is included in Phase 1 due to the active development in the area, the fact it has water service, and potential for untreated wastewater to flow directly to Lake Manzalla. Please note that Figure V6-9.1, Port Said Wastewater System Recommended Improvements, shows most lines in the CIP 7 area in "black" color. As noted above some lines are already in place and others may be under construction, therefore only the CIP 7 lift station and items appurtenant to it are shown in "red" color. The CIP table below may include lines that are scheduled for constructed under the NOPWASD program, however as no specific timetable for construction was available they are included in this CIP package. The components and cost of CIP 7 are detailed below.

CIP 7 – Lake Manzala Shoreline Trunk Extension			
Facility	**Size**	**Length**	**Estimated Cost**
CIP 7 – LS	1,400 m3/d	NA	300,000
CIP 7 – FM to Trunk	125 mm	150 m	30,000
Gravity Trunk	200 mm	200 m	90,000
Gravity Trunk	250 mm	150 m	90,000
Gravity Trunk	300 mm	100 m	70,000
Gravity Trunk	400 mm	100 m	100,000
Gravity Trunk	500 mm	100 m	120,000
Gravity Trunk	600 mm	330 m	500,000
Gravity Trunk	700 mm	815 m	1,500,000
Collectors	300 mm	2,055 m	1,600,000
Collectors	400 mm	500 m	600,000
		Construction Cost Subtotal	$5,000,000
		Construction Contingency 20%	1,000,000
		Subtotal	6,000,000
		Engineering and Administration Cost 20%	1,200,000
		Total Capital Improvement Cost	$7,200,000

CIP 7 serves 150 hectares, currently under development and projected for future development, which drain to it by gravity. This area will require collectors and laterals smaller than 300 mm, not included in the scope of this report or the costs above.

To function properly, CIP 7 depends upon CIP 2 being complete.

9.2.8 CIP 8 –Phase 1 Wastewater Treatment Plant Expansion

CIP 8 is planned to expand the existing treatment plant to carry the increased flows anticipated by year 2004 from expansion of the collection system into areas with water service, but no wastewater collection, population expansion, and industrial expansion. This expansion of the WWTP includes addition of new facilities at the headworks, construction of new lagoons, sitework and addition to the effluent pumping station.

This will result in addition of a second treatment train to the Port Said wastewater treatment plan. No additional drying beds or solids handling areas are considered necessary at this stage. To have these additional facilities on line by 2004, the design and construction should be carried on in parallel with the Phase 1 collectors and pump stations.

The components and cost of CIP 12 are detailed below.

CIP 8 – Phase 1 Wastewater Treatment Plant Expansion			
Facility	**Size**	**Length**	**Estimated Cost**
Mobilization @10%	NA	NA	2,517,000
Ordnance Removal	NA	NA	361,000
Sitework	NA	NA	15,081,000
Lagoons	NA	NA	7,074,000
Headworks	NA	NA	1,177,000
Pumping Station	NA	NA	1,480,000
		Construction Cost Subtotal	$27,690,000
		Construction Contingency 20%	5,538,000
		Subtotal	33,228,000
		Engineering and Administration Cost 20%	6,646,000
		Total Capital Improvement Cost	$39,874,000

9.3 Phase 2 Recommended Capital Improvement Projects

9.3.1 CIP 9 – Upgrading of Existing System to Handle Ultimate Peak Flows

9.3.1.1 Relief Wastewater line Improvements

Additional Phase 2 relief wastewater lines required for future conditions are shown in green on Figure V6-9.1, Port Said Wastewater System Recommended Improvements and Figure V6-9.2 Port Said existing Wastewater System Recommended Improvements.. The additional lines will be needed to convey additional peak flow due to growth by year 2020. These relief lines were sized to carry the projected peak flow under ultimate development conditions. Approximately 1,874 meters of relief lines are required. These additional Phase 2 lines should be constructed before year 2020.

9.3.1.2 Lift Station Improvements

Phase 2 lift station recommended improvements are to accommodate peak flows up to ultimate development conditions. Two lift stations (Alpijo (4D), and Istismar) will require expansion or replacement under Phase 2.

9.3.1.3 Force Main Improvements

Phase 2 force main recommended improvements are to accommodate peak flows up to ultimate development conditions. All existing force mains appear to meet the ultimate flow capacity. The components and cost of CIP 9 are detailed below.

CIP 9 – Existing System Phase 2 Improvements			
Facility	**Size**	**Length**	**Estimated Cost**
Al-Pijo LS Expansion	28,000 m^3/d (3,000 m^3/d expansion)	NA	180,000
Istismar Expansion	6,200 m^3/d (1,000m^3/d expansion)	NA	110,000
CIP 19-P3 Parallel Relief Line	375 mm	1506 m	1,600,000
CIP 9-P4 Parallel Relief Line	300 mm	368 m	260,000
		Construction Cost Subtotal	$2,150,000
		Construction Contingency 20%	430,000
		Subtotal	2,580,000
		Engineering and Administration Cost 20%	516,000
		Total Capital Improvement Cost	$3,096,000

9.3.2 CIP 10 – Lake Manzalla Interceptor/Force Main

CIP 10 is designed to collect wastewater from future development areas A34, A35, and B22. In addition, the interceptor, lift station, and force main are sized to transport the effluent from CIP 3 FM and transport it to the WWTP. The components and cost of CIP 10 are detailed below.

CIP 10 – Lake Manzalla Interceptor/Force Main			
Facility	**Size**	**Length**	**Estimated Cost**
CIP 10 LS	135,000 m^3/d	NA	5,200,000
CIP 10 FM	1100 mm	4000 m	4,500,000
Gravity Trunk	1300 mm	1,400 m	4,200,000
Gravity Collector	500 mm	10 m	15,000
Gravity Collector	400 mm	400 m	460,000
Gravity Collector	300 mm	200 m	160,000
		Construction Cost Subtotal	$14,535,000
		Construction Contingency 20%	2,907,000
		Subtotal	17,442,000
		Engineering and Administration Cost 20%	3,488,400
		Total Capital Improvement Cost	$20,930,400

CIP 10 serves 40 hectares, projected for development to very high density residential, which drain to it by gravity. This area will require collectors and laterals smaller than 300 mm, not included in the scope of this report or the costs above.

Wastewater CIP 10 serves the same area as Water PH 2 CIP 6 and should be installed in conjunction with it.

9.3.3 CIP 11 – Western Trunk

CIP 11 is planned to collect wastewater from the area west of the road to the WWTP and the existing 'Old Treatment Plant Emergency Bypass Canal' and carry it to CIP 2 Lift Station. CIP 11 is sized to carry the ultimate peak flow from this area, plus the ultimate peak flow from the CIP 6 system, which was recommended to be temporarily connected to the Mazrah Lift Station.

Once CIP 2 is complete, and as development continues in the area, the Bypass Canal will undoubtedly be filled. This CIP 11 gravity Trunk can also be connected to the wetwell of the Mazrah Lift Station and act as an emergency bypass during peak flows or during power or pump outages.

CIP 2 recommended Phase 1 installation of pumping and screening capacity for only 65% of the design capacity of A28 Lift Station. Implementation of CIP 11 will substantially increase the tributary flow to this lift station. Therefore the cost of upgrading the CIP 2 LS mechanical installation is included in this CIP 11 and should be accomplished at the same time, although not necessarily under the same contract.

The components and cost of CIP 11 are detailed below.

CIP 11 – Western Trunk			
Facility	**Size**	**Length**	**Estimated Cost**
CIP 3 LS Equipment Expansion	115,000 m^3/d) (35,000m^3/d expansion)		1,000,000
Gravity Trunk	600 mm	400 m	560,000
Gravity Trunk	700 mm	500 m	820,000
Gravity Trunk	800 mm	120 m	220,000
Collector	300 mm	200 m	140,000
		Construction Cost Subtotal	$2,740,000
		Construction Contingency 20%	548,000
		Subtotal	3,288,000
		Engineering and Administration Cost 20%	658,000
		Total Capital Improvement Cost	$3,946,000

CIP 11 serves 50 hectares, projected for development as very high density residential, which drain to it by gravity. This area will require collectors and laterals smaller than 300 mm, not included in the scope of this report or the costs above.

To function properly, CIP 11 depends upon CIP 2 being complete.

9.3.4 CIP 12 – South Development Area Trunk

CIP 12 is planned to serve the new development area planned south of the El-Raswa Canal. This area is projected for substantial development of commercial tourism and low density residential on the Lake Manzallah side and commercial / light industrial development along the highway and the Suez Canal. CIP 12 will serve as a wastewater collection trunk for the entire area and is sized to receive flows from four pump stations built under CIPs 13, 14, 15, and 16.

CIP 3 recommended Phase 1 installation of pumping and screening capacity for only half the design capacity of the station. Implementation of CIP 12 will substantially increase the tributary flow to this lift station. Therefore, the cost of upgrading the CIP 3 LS mechanical installation is included in this CIP 12 and should be accomplished at the same time, although not necessarily under the same contract.

The components and cost of CIP 12 are detailed below.

CIP 12 – South Development Area Trunk			
Facility	**Size**	**Length**	**Estimated Cost**
CIP 3LS Equipment Expansion	120,000 m^3/d (60,000m^3/d expansion)	NA	1,500,000
Gravity Trunk	1000 mm	200 m	500,000
Gravity Trunk	900 mm	600 m	1,300,000
Gravity Trunk	800 mm	600 m	1,200,000
Gravity Trunk	600 mm	865 m	1,200,000
		Construction Cost Subtotal	$5,700,000
		Construction Contingency 20%	1,140,000
		Subtotal	6,840,000
		Engineering and Administration Cost 20%	1,368,000
		Total Capital Improvement Cost	$8,208,000

CIP 12 serves 135 hectares, projected for development as low density residential, which drain to it by gravity. This area will require collectors and laterals smaller than 300 mm, not included in the scope of this report or the costs above.

To function properly, CIP 12 depends upon PH1 CIP 3 and PH2 CIP10 being complete.

9.3.5 CIP 13 – Fish Farm Collection System

CIP 13 is planned to serve the area south east of Port Said known as the Fish Farm. At the time of writing the master plan, there was some development in the area, but no authoritative plan for wastewater collection could be obtained. This CIP is a proposal of how the area can be collected to a lift station and wastewater pumped to the CIP 12 trunk. If the area is developed otherwise, including a lift station, a force main similar to what is shown below will still be needed to connect it to the NOPWASD collection system. The components and cost of CIP 13 are detailed below.

CIP 13 – Fish Farm Collection System			
Facility	**Size**	**Length**	**Estimated Cost**
CIP 13 – LS	17,200 m^3/d	NA	1,200,000
CIP 13 – FM	400 mm	650 m	270,000
Gravity Collector	500 mm	10 m	15,000
Gravity Collector	400 mm	220 m	250,000
Gravity Collector	300 mm	200 m	185,000
		Construction Cost Subtotal	$1,920,000
		Construction Contingency 20%	384,000
		Subtotal	2,304,000
		Engineering and Administration Cost 20%	461,000
		Total Capital Improvement Cost	$2,765,000

CIP 13 serves 55 hectares, projected for development as low density residential, commercial, and tourism, which drain to it by gravity. This area will require collectors and laterals smaller than 300 mm, not included in the scope of this report or the costs above.

To function properly, CIP 13 depends upon CIP 12 being complete.

9.3.6 CIP 14 – South Commercial Zone Collection System

CIP 14 is planned to collect wastewater in the area 2.5 km south of the El-Raswa Water Treatment Plant from the Suez Canal to 300 feet west of the highway. The extent of the system and locations of the three (3) lift stations are representative and must be located by the designers based upon the extent of development and water use patters at the time of detailed design. If there is a significant piped discharge of wastewater from this area directly to the Suez Canal, then the system may need to be constructed as an interceptor along the edge of the Suez Canal, which could increase the length of the force mains. In all cases, CIP 14 lift station force mains are designed to discharge directly or indirectly into the CIP 12 trunk, which is located near the center of projected future water consumption. The flow from CIP 14 is helpful to increase the flow and allow the trunk to use larger pipe at a flatter slope. If CIP 14 wastewater is discharged into the system elsewhere, CIP 12 pipe sizes and grades will be different. The components and cost of CIP 14 are detailed below.

CIP 14 – South Commercial Zone Collection System			
Facility	**Size**	**Length**	**Estimated Cost**
CIP 14/1 – LS	5,700 m^3/d		600,000
CIP 14/2 – LS	2,000 m^3/d		250,000
CIP 14/3 – LS	3,000 m^3/d		370,000
CIP 14/1 - FM	200 mm	700 m	140,000
CIP 14/2 - FM	150 mm	700 m	130,000
CIP 14/3 - FM	175 mm	550 m	110,000
		Construction Cost Subtotal	$1,600,000
		Construction Contingency 20%	320,000
		Subtotal	1,920,000
		Engineering and Administration Cost 20%	384,000
		Total Capital Improvement Cost	$2,304,000

CIP 14 serves 125 hectares, projected for development as commercial and light industrial, which drain to it by gravity. This area will require collectors and laterals smaller than 300 mm, not included in the scope of this report or the costs above.

To function properly, CIP 14 depends upon CIP 12 and CIP 13 being complete.

9.3.7 CIP 15 – WWTP Expansion

If the expansion noted in phase 1 is implemented no expansion is anticipated in phase 2.

9.4 Port Fouad Extensions and System

Port Fouad's developed area, located on the northwest corner of the island, is currently undergoing a wastewater development, with three wastewater lift stations, a dual force main, and wastewater treatment plant under construction. The available information indicates that most of Port Fouad is on a septic tank based system with supernatent discharged to the collection system. There was insufficient information available to assess the carrying capacity or adequacy for future expansion. An

important part of the Wastewater System Management Plan discussed in Section 1.5 would be to collect detailed collection system data on the Port Fouad collection system.

Based upon the information available, it appears that the lift stations, force main, and WWTP currently under construction are reasonably well balanced with the ultimate condition wastewater volumes predicted. For this reason, it is not advisable to unnecessarily add expansion areas to the existing wastewater collection system. The only area recommended for connection to the existing system is within 500 m radius south of the Southern Lift Station. This undeveloped area, on both sides of the cemetery, can be drained to the lift station by gravity.

The remainder of the island, projected for significant development due to commercial and industrial development underway in the area, is to be served by two independent systems: one serving the west side of the island and another serving the north and east sides. Initially, these systems can be connected to the existing WWTP (under construction); however, as development increases the flow will require expansion of the existing plant or conversion to a more 'land efficient' treatment process.

9.4.1 CIP 16 – Westside Development System.

CIP 16 is planned to collect wastewater in the area south of the Port Fouad developed area, beginning in the south docks area, around the ferry landing, south to the university site, then along the southwest coast to the treatment plant.

This system involves three feeder lift stations and a major inlet lift station feeding to the WWTP. The main trunk and lift stations need to be built at one time as part of Phase 2. The development can then proceed from north to south and be connected to the system.

Additionally at this time it may be necessary to expand the Port Fouad wastewater treatment plant. At the time of this Master Plan construction of the Port Fouad wastewater treatment plant was only in the initial stages.

The first construction phase is scheduled to include treatment facilities adequate for 22,000 m^3/day. The second construction phase is scheduled to bring total treatment capacity to over 37,000 m^3/day. Design and construction of these facilities are already scheduled and cost estimates for them are not included in this Master Plan.

The components and cost of CIP 16 are detailed on the following page.

CIP 16 – Southwest Development System			
Facility	**Size**	**Length**	**Estimated Cost**
CIP 16 – LS	125,200 m^3/d	NA	4,780,000
CIP 16/1 – LS	1,000 m^3/d	NA	220,000
CIP 16/2 – LS	25,600 m^3/d	NA	1,570,000
CIP 16/3 – LS	3,800 m^3/d	NA	270,000
CIP 16 - FM	1200 mm	800 m	990,000
CIP 16/1 - FM	100 mm	500 m	80,000
CIP 16/2 - FM	600 mm	1200 m	750,000
CIP 16/3 - FM	200 mm	200 m	40,000
Gravity Trunk	300 mm	3900	3,120,000
Gravity Trunk	400 mm	200	210,000
Gravity Trunk	500 mm	800	1,010,000
Gravity Trunk	900 mm	400	880,000
Gravity Trunk	1000 mm	200	490,000
Gravity Trunk	1200 mm	800	2,420,000
		Construction Cost Subtotal	$16,830,000
		Construction Contingency 20%	3,366,000
		Subtotal	20,196,000
		Engineering and Administration Cost 20%	4,039,000
		Total Capital Improvement Cost	$24,235,000

CIP 16 serves 400 hectares, projected for development as commercial, education, and residential, which drain to it by gravity. This area will require collectors and laterals smaller than 300 mm, not included in the scope of this report or the costs above.

To function properly, the WWTP under construction in 1999 must be completed and may need expansion under CIP 18.

9.4.2 CIP 17 – North and East Side Development System.

CIP 17 is planned to collect wastewater in the area east of the Port Fouad developed area, and following existing force main around the east coast. This trunk will collect wastewater from coastal developments that drain to it by gravity away from the coastline.

This system involves two feeder lift stations and a major inlet lift station feeding to the WWTP. The main trunk and lift stations need to be built at one time as part of Phase 2. The development can then proceed along the coastline and be connected to the system wherever it occurs.

The components and cost of CIP 17 are detailed on the following page.

CIP 17 – North and East Side Development System			
Facility	**Size**	**Length**	**Estimated Cost**
CIP 17 – LS	65,000 m^3/d	NA	3,350,000
CIP 17/1 – LS	39,400 m^3/d	NA	2,130,000
CIP 17/2 – LS	10,400 m^3/d	NA	895,000
CIP 17 – FM	1000 mm	400 m	410,000
CIP 17/1 – FM	600 mm	1050 m	650,000
CIP 17/2 – FM	300 mm	825 m	250,000
Gravity Trunk	500 mm	400	465,000
Gravity Trunk	600 mm	400	600,000
Gravity Trunk	700 mm	400	700,000
Gravity Trunk	800 mm	1700	3,370,000
Gravity Trunk	900 mm	1100	2,430,000
Gravity Trunk	1000 mm	350	850,000
		Construction Cost Subtotal	$16,100,000
		Construction Contingency 20%	3,220,000
		Subtotal	19,320,000
		Engineering and Administration Cost 20%	3,864,000
		Total Capital Improvement Cost	$23,184,000

CIP 17 serves 200 hectares, projected for development as commercial, tourist, and residential, which drain to it by gravity. This area will require collectors and laterals smaller than 300 mm, not included in the scope of this report or the costs above.

To function properly, the WWTP under construction in 1999 must be completed and may need expansion as noted in CIP 16P.

9.5 Wastewater System Management Plan

Surveys for wastewater system maintenance and control of infiltration are recommended at least every 5 years. Prior to this study, the City of Port Said conducted an Infiltration/Salinity study. The most urgent and cost-effective repairs are currently being implemented. The City should monitor the success of the infiltration reduction and rehabilitation projects in order to maintain the design life of the collection system facilities. If the expected degree of infiltration removal is not achieved, additional studies and rehabilitation projects may be required.

It is recommended that a wastewater system management plan be developed to improve the performance of the wastewater system, as indicated in Table V6-9.5. These activities are necessary in order to maintain the existing system and to prolong the life the facilities. Failure to implement a maintenance program will result in deterioration and premature failure of the facilities.

The recommended wastewater system management plan should include the following components:

- An annual program of cleaning and closed circuit television camera inspection of wastewater lines, and other inspections as needed.
- System inspections to identify areas in need of rehabilitation.
- Updating the hydraulic model at least every 5 years to ensure that it reflects the current land use, structural improvements, most recent system data, and demographic changes.

It is recommended that the model be updated with surveyed data on the manhole invert elevations. In order to obtain more accurate hydraulic evaluation of the system, it is necessary to survey the manholes included in the model and update the hydraulic model. It is estimated that the hydraulic analysis using the limited invert data could reduce the accuracy of the model for some pipe segments by as much as 40 percent. It is recommended that a complete inventory of the wastewater system be conducted to determine the pipe invert elevations and to identify negative pipe slopes which should be eliminated. The cost estimate in Table V6-9.5, Wastewater System Management Plan, does not include an allowance for in-country expatriate support.

Table V6-9.5 Port Said Wastewater System Management Plan

Work Tasks[1]	Purpose/Benefit	Probable Construction Cost ($)
Planning Activities		
Wastewater System Inventory	The wastewater system inventory will consist of surveying all 6,100 manholes in the study area and record manhole invert level, incoming and outgoing pipe inverts, and pipe diameters. The cost of surveying 6,100 manholes is estimated at $800,000, excluding mobilization fee. [2].	800,000
Flowmeters	Install flow-recording devices at the 13 major lift stations to record hourly flow data for future planning. The hourly data will provide information on diurnal patterns and any response of the system to rainfall or infiltration and changes in flow patterns over the years. [2].	250,000
Hydraulic Modeling Training	Provide up to six months training in hydraulic modeling. The purpose of the training will be to meet USAID's goal of producing a sustainable Master Plan that could be routinely and effectively updated by local utilities. This training will allow local staff to learn the model development process, to revise model input data, and to use the model to develop capital improvement programs. Long term training allows time for involvement of personnel at all levels, including management. [2]	300,000
Land Use Map Update (Year 2005)	Land use update will reflect current land use data and include any changes in demographic data since the completion of this Master Plan.	150,000
Model Update (Year 2005)	Model update will reflect accurate surveyed data from manhole inventory to be performed prior to updating the model. The updated model will produce more accurate results than current model. The updated model will also include current flow projections from the revised land use data.	500,000
Subtotal		$2,000,000
Inspection Activities		
Manhole Inspections	To identify infiltration sources and the structural condition of the manholes.[2]	1,000,000

Work Tasks[1]	Purpose/Benefit	Probable Construction Cost ($)
Television Inspections	To identify infiltration sources and sedimentation problems, which reduce the effective capacity of the system and to determine the condition of the wastewater lines. [2]	800,000
Subtotal		$1,800,000
Maintenance Activities		
Rehabilitation	To reduce infiltration and to extend life of the wastewater system.	3,500,000
Subtotal		$3,500,000
Total		$7,300,000
Individual projects will have to be prioritized prior to implementation. The cost estimate does not include an allowance for local expatriate administrative support.		

9.6 Summary of Costs

The total projected capital cost of the Phase 1 Implementation Plan is $58 million. The current value of the Phase 2 Implementation Plan is $45 million. The recommended capital improvement projects are summarized in Tables V6-9.6 and V6-9.7 and indicated on Figure V6-9.1, Port Said Wastewater System Recommended Improvements. Construction costs include allowances for mobilization/demobilization, shoring, dewatering, and surface restoration. Costs will vary depending on the actual surface and subsurface conditions. The projected capital costs listed for capital improvement projects include construction cost plus allowances of 20 percent for contingencies and 20 percent for engineering, legal, and administrative costs. No costs are included for land, rights-of-way, or rock excavation.

Table V6-9.6 Summary of Phase 1 Probable Capital Costs

CIP No.	Construction Cost US $ (1)	Total Capital Cost US (2)
CIP 1 – Existing System Critical Improvements	7,044,000	8,453,000
CIP 2 – A28 Lift Station	6,480,000	7,776,000
CIP 3 – El-Raswa Canal Eastern Interceptor	10,044,000	12,053,000
CIP 4 – Central Azmy St. Trunk System	3,720,000	4,464,000
CIP 5 – North Azmy St. Trunk System	1,152,000	1,382,000
CIP 6 – North Coast Trunk System	3,438,000	4,126,000
CIP 7 – Lake Manzala Shoreline Trunk Extension	6,000,000	7,200,000
CIP 8 – Phase 1 WWTP Expansion	33,228,000	39,874,000
Wastewater System Management Plan	NA	7,300,000
Phase 1 Totals	**$71,106,000**	**$92,627,998**
1) Construction cost includes 20 percent construction contingency. 2) Capital cost includes construction cost and 20 percent engineering and administration cost.		

Table V6-9.7 Summary of Phase 2 Probable Capital Costs

CIP No.	Construction Cost US $ (1)	Total Capital Cost US (2)
CIP 9 – Existing System Phase 2 Improvements	2,580,000	3,096,000
CIP 10 – Lake Manzala Interceptor/Force Main	17,442,000	20,930,000
CIP 11 – Western Trunk	3,288,000	3,946,000
CIP 12 – South Development Trunk	6,840,000	8,208,000
CIP 13 – Fish Farm Collection System	2,304,000	2,765,000
CIP 14 – South Commercial Zone System	1,920,000	2,304,000
CIP-16 Southwest Development System	20,196,000	24,235,000
CIP 17 – North and East Development	19,320,000	23,184,000
Phase 2 Totals	**$73,890,000**	**$88,667,998**

1) Construction cost includes 20 percent construction contingency.
2) Capital cost includes construction cost and 20 percent engineering and administration cost.

Recommendations for further studies or preliminary design include the following:

- ***Wastewater System Inventory.*** As noted in the Phase I summary, a complete wastewater system inventory should be prepared. Additionally, and of equal importance, this inventory must be continuously maintained and updated. This inventory should include pipes, manholes, lift stations and force mains. Inventory detail should be added to the GIS data prepared for the Master Plan. Inventory of smaller pipes should be added to the GIS database and used for system maintenance and replacement.
- ***Wastewater Treatment Plant Capacity Analysis.*** The original design of the wastewater treatment plant was based on limited knowledge of influent characteristics. Daily operation of the plant and daily testing of influent has shown the original design was somewhat conservative. A study should be initiated to test chemical and biological characteristics of plant flow at the influent, the effluent and at several intermediate points in the treatment train. This information should be used to re-rate plant capacity and to accurately target future plant additions and expansions.

Operation and Maintenance (O&M) Cost Evaluation. This Master Plan also included an evaluation of Institutional conditions within the wastewater utility. This brief review showed specific financial data was not available for system O&M. A detailed study should be initiated to determine O&M levels required to maintain the collection and treatment systems. Additionally this study should include a determination of the level of funding necessary to maintain the wastewater system.

End of Chapter 9: Implementation Plan

APPENDIX A

1998 PORT SAID WASTEWATER TREATMENT PLANT FLOW DATA

Port Said WWTP Influent Data

	Plant Influent Flow Data			Plant Influent TSS Data			mass	Plant Influent BOD Data			mass
	Min	Max	Avg	Min	Max	Avg	Avg*Avg	Min	Max	Avg	Avg*Avg
	m^3/day	m^3/day	m^3/day	mg/l	mg/l	mg/l	kg/day (1)	mg/l	mg/l	mg/l	kg/day (1)
Feb-98	94,000	136,000	106,700	108	256	178	18,993	106	354	156	16,645
Mar-98	78,000	119,000	104,100	92	256	166	17,281	84	285	148	15,407
Apr-98	93,000	112,000	103,000	76	228	174	17,922	110	202	154	15,862
May-98	89,000	107,000	99,600	128	284	181	18,028	108	229	147	14,641
Jun-98	93,000	171,000	104,500	120	272	185	19,333	94	180	142	14,839
Jul-98	98,000	204,000	110,300	124	244	182	20,075	122	252	183	20,185
Aug-98	98,000	197,000	110,000	112	332	173	19,030	91	250	173	19,030
Sep-98	97,000	120,000	107,800	116	252	178	19,188	111	244	177	19,081
Oct-98	95,000	115,000	107,200	132	300	190	20,368	34	264	177	18,974
Nov-98	95,000	116,000	105,700	164	248	194	20,506	136			0
Dec-98	92,000	113,000	102,300	132	232	192	19,642	162	291	244	24,961
Jan-99	93,000	110,000	101,600	152	260	200	20,320	160	314	250	25,400
min	78,000	107,000	99,600	76	228	166	17,281	34	180	142	0
max	98,000	204,000	110,300	164	332	200	20,506	162	354	250	25,400
avg	92,917	135,000	105,233	121	264	183	19,224	110	260	177	17,085

Design Inflow (1 train only)	*190,000*	*Design TSS*	*330*	*62,700*	*Design BOD*	*300*	*57,000*

Average WWTP Influent Flow (m^3/day)	105,233
Daily TSS Mass Loading (kg/day)	20,506
Daily BOD Mass Loading (kg/day)	25,400
TSS Concentration (mg/l) - based on Daily TSS/Average Influent Flow	195
BOD Concentration (mg/l) - based on Daily BOD/Average Influent Flow	241

(1) based on Average Daily Flow multiplied by Average Daily TSS or BOD

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APPENDIX B

LIST OF OVERLOADED PIPES

CIP - 1
Overloaded Pipes -- Existing Conditions

Pipes shown on Figure V6-9.2, Port Said Existing Wastewater System Improvements. Overloaded pipes in existing conditions shown as CIP 1.

Upstream Manhole ID	Downstream Manhole ID	Pipe Diameter (mm)	Pipe Run Length (m)
AOA168a	AIN024a	300	87
MIN026a	MIN031a	400	116
MIN031a	LS-8D	400	29
AST023a	AST029a	375	172
AST029a	AST033a	500	128
MT6021a	LS-R2	375	52
AST033a	MIN031a	500	41
MT3102b1	LS-R1	300	23

Notes:
1) Manhole IDs taken from I & S study.
2) Pipe runs indicated may include intermediate manholes.
3) Diameters shown taken from best available data, however not field verified.
4) Diameters shown indicate existing pipe.
5) To eliminate overloaded conditions, pipes should be replaced or paralleled. Decision to replace or parallel should be made during design and should be based on condition of existing pipe and field conditions.
6) Pipes shown on Figure V6-9.1, Port Said Existing System Improvements.
7) Lengths shown are approximate and should not be used for construction.

CIP - 9
Overloaded Pipes -- 2020 Conditions

Pipes shown on Figure V6-9.2, Port Said Existing Wastewater System Improvements.
Overloaded pipes in 2020 conditions shown as CIP 9

Upstream Manhole ID	Downstream Manhole ID	Pipe Diameter (mm)	Pipe Run Length (m)
MOK118a	MOK115a	300	88
AOA168a	AIN024a	300	87
MIN026a	MIN031a	400	116
MIN031a	LS-8D	400	29
AST023a	AST029a	375	172
MT6021a	LS-R2	375	52
AST033a	MIN031a	500	41
MT3102b1	LS-R1	300	23

Notes:
1) Manhole IDs taken from I & S study.
2) Pipe runs indicated may include intermediate manholes.
3) Diameters shown taken from best available data, however not field verified.
4) Diameters shown indicate existing pipe.
5) To eliminate overloaded conditions, pipes should be replaced or paralleled. Decision to replace or parallel should be made during design and should be based on condition of existing pipe and field conditions.
6) Pipes shown on Figure V6-9.1, Port Said Existing System Improvements.
7) Lengths shown are approximate and should not be used for construction.

CIP - 9
Overloaded Pipes -- Ultimate Conditions

Pipes shown on Figure V6-9.2, Port Said Existing Wastewater System Improvements.
Overloaded pipes in ultimate conditions shown as CIP 9

Upstream Manhole ID	Downstream Manhole ID	Pipe Diameter (mm)	Pipe Run Length (m)
MOK127a	MOK118a	300	280
DZZ014a	DIN043a	300	67
MOK118a	MOK115a	300	88
AOA168a	AIN024a	300	87
DSU017a	DSU011a	300	206
MIN026a	MIN031a	400	116
MIN031a	LS-8D	400	29
DSU011a	AST023a	375	254
AST023a	AST029a	375	172
AST029a	AST033a	500	128
MT6021a	LS-R2	375	52
AST033a	MIN031a	500	41

Notes:
1) Manhole IDs taken from I & S study.
2) Pipe runs indicated may include intermediate manholes.
3) Diameters shown taken from best available data, however not field verified.
4) Diameters shown indicate existing pipe.
5) To eliminate overloaded conditions, pipes should be replaced or paralleled. Decision to replace or parallel should be made during design and should be based on condition of existing pipe and field conditions.
6) Pipes shown on Figure V6-9.1, Port Said Existing System Improvements.
7) Lengths shown are approximate and should not be used for construction.