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ARAB REPUBLIC OF EGYPT

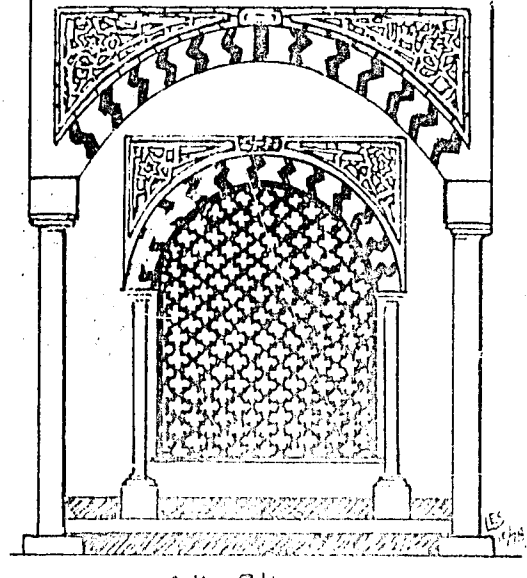
MINISTRY OF DEVELOPMENT
AND NEW COMMUNITIES

MANAGEMENT AND TARIFF STUDIES RELATIVE TO WATER/SEWERAGE SYSTEMS

MANAGEMENT SYSTEMS

PROCEDURES AND METHODS

FINAL REPORT



بسم الله الرحمن الرحيم

وجعلنا من الماء كل شيء حي

صدق الله العظيم

BVI-ATK ASSOCIATES WITH SABBOUR ASSOCIATES

BLACK & VEATCH
INTERNATIONAL
CONSULTING ENGINEERS

A.T. KEARNEY, INC.
MANAGEMENT CONSULTANTS

SABBOUR ASSOCIATES
CONSULTING ENGINEERS

OCTOBER 1979

U.S.A.I.D. GRANT NO. 263-0025

MANAGEMENT SYSTEMS

PROCEDURES AND METHODS

FINAL REPORT

The Story of Our Cover:-

On our cover is a sketch of a sybil, which is a fountain. During the Ottoman Empire these were a common source of drinking water. A well is located at ground level and a balcony on the second level where children were taught the Koran. Usually located near mosques, sybils were built and then donated to the public by various benefactors.

Beneath the sketch is a quote from the Koran, "We made from water all living things".

BLACK & VEATCH INTERNATIONAL
CONSULTING ENGINEERS

A. T. KEARNEY, INC.
MANAGEMENT CONSULTANTS

WITH SABBOUR ASSOCIATES
CONSULTING ENGINEERS

بـلاك أندفيتش العالميـة
استشارات هندسية
أ. ت. كارني
استشارات إدارية
المكتب الهندسي الاستشاري «صبور»
استشارات هندسية

OUR REF.: 79-250
YR REF.:
DATE: October 8, 1979

Engineer Soliman Abd El Hai, Chairman
Advisory Committee for Reconstruction
Ministry of Development and New Communities
1, Ismail Abaza Street
Cairo, A.R.E.

Dear Engineer Abd El Hai:

Pursuant to the provisions of Paragraph 6.7 of Appendix 1 to the Contract dated April 6, 1978 by and between the Ministry of Housing and Reconstruction and BVI-ATK Associates for Management and Tariff Studies Relative to Water and Sewerage Systems, we are pleased to submit the Final Report on Management Systems - Procedures and Methods. It is responsive to the provisions of Paragraph 5.3.6 of Appendix 1 to the Contract and incorporates, as appropriate, material related to the review comments on the Interim and Draft Final Reports.

Your attention is directed to Section 0.0 of this Report, Executive Summary, where a brief synopsis of the findings and recommendations may be found.

We wish to acknowledge the assistance and cooperation of the many individuals, agencies and organizations contacted during the course of the study.

We appreciate the opportunity to serve the Ministry on this important assignment.

Very truly yours
BVI-ATK ASSOCIATES

John R. Scott

John R. Scott
Project Director

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تليفون ٧٠٦٧٢٧ - تلكس ٩٣٨٤٥

TABLE OF CONTENTS

Section Reference		Page
0.0	EXECUTIVE SUMMARY	
	0.1 Findings and Conclusions	0-2
	0.2 Recommendations	0-3
1.0	INTRODUCTION	
	1.1 Background	1-2
	1.2 Scope and Objectives	1-2
	1.3 Approach	1-3
2.0	PROJECT PLANNING	
	2.1 Findings and Conclusions	2-1
	2.1.1 Functional Activities	2-2
	2.1.1.1 Project analysis	2-2
	2.1.1.2 Setting priorities	2-2
	2.1.1.3 Budgeting	2-3
	2.1.1.4 Programming	2-3
	2.1.1.5 Monitoring	2-4
	2.1.2 Effectiveness	2-4
	2.1.3 Procedures and Methods	2-5
	2.2 Recommendations	2-6
	2.2.1 Interim Period	2-6
	2.2.2 Long-Term	2-7

3.0 OPERATION AND MAINTENANCE OF THE WATERWORKS AND WASTEWATER SYSTEMS

3.1 Findings and Conclusions 3-1

3.1.1 General 3-1

3.1.2 Operations 3-2

3.1.3 Networks 3-3

3.1.4 Laboratories 3-4

3.1.5 Maintenance 3-5

3.1.6 Effectiveness 3-5

3.1.7 Procedures and Methods 3-6

3.2 Recommendations 3-6

3.2.1 Interim Period 3-7

3.2.1.1 General 3-7

3.2.1.2 Operations 3-8

3.2.1.3 Networks 3-9

3.2.1.4 Laboratories 3-10

3.2.1.5 Maintenance 3-11

3.2.2 Long-Term 3-11

3.2.2.1 General 3-12

3.2.2.2 Operations 3-12

3.2.2.3 Networks 3-13

3.2.2.4 Laboratories 3-13

3.2.2.5 Maintenance 3-13

4.0 BILLING AND COLLECTING

4.1 Findings and Conclusions 4-1

4.1.1 Meter Reading Practices 4-1

4.1.2 Meter Testing 4-2

4.1.3 Rotating or Replacing Meters 4-3

4.1.4 Meter Repair 4-3

4.1.5 Billing Procedures 4-3

4.1.6 Collections 4-4

4.1.7 Effectiveness of Collections 4-5

4.1.8 Account Policies 4-6

4.1.9 Effectiveness 4-7

4.1.10 Procedures and Methods 4-8

4.2 Recommendations 4-8

4.2.1 Interim Period 4-9

4.2.1.1 Meter reading 4-9

4.2.1.2 Meter testing 4-10

4.2.1.3 Rotating or replacing meters 4-10

4.2.1.4 Meter repairs 4-10

4.2.1.5 Billing procedures 4-11

4.2.2 Long-Term 4-12

4.2.2.1 Meter reading 4-12

4.2.2.2 Meter testing 4-12

4.2.2.3 Rotating or replacing meters 4-12

4.2.2.4 Meter repair 4-12

4.2.2.5 Billing procedures 4-12

5.0 PROCUREMENT AND INVENTORY CONTROL

5.1 Findings and Conclusions 5-1

5.1.1 Procurement 5-1

5.1.1.1 Laws governing procurement 5-1

5.1.1.2 Budgeting practices 5-2

5.1.1.3 Pre-purchasing procedure 5-2

5.1.1.4 Procurement cycle 5-3

5.1.1.5 Organizational structures 5-5

5.1.2 Inventory Control 5-5

5.1.2.1 Main and subsidary stores 5-6

5.1.2.2 Receiving practices 5-6

5.1.2.3 Receiving procedure 5-6

5.1.2.4 Stores practices 5-7

5.1.2.5 Inventory 5-9

5.1.2.6 Review 5-10

5.1.3 Stores Management 5-11

5.1.4 Effectiveness 5-12

5.1.5 Procedures and Methods 5-13

5.2 Recommendations 5-14

5.2.1 Interim Period 5-14

5.2.1.1 Procurement 5-14

5.2.1.2 Inventory control 5-15

5.2.1.3 Stores management 5-15

5.2.2 Long-Term 5-16

6.0 MAPPING AND RECORD-KEEPING

6.1 Findings and Conclusions 6-1

6.1.1 Role of Drafting Departments 6-1

6.1.2 Work Sequence 6-3

6.1.3 Control 6-4

6.1.4 Effectiveness 6-5

6.1.5 Procedures and Methods 6-5

6.2 Recommendations 6-5

6.2.1 Interim Period 6-6

6.2.2 Long-Term 6-6

EXHIBITS

1.1 Bibliography

1.2 List of Contacts

2.1 Standardization Program

2.2 Work Load Estimating for Projects Group

2.3 Project Planning

2.4 Professional Associations

2.5 Project Planning Using Critical Path Method

2.6 Project Priorities

2.7 Project Economic Analysis

3.1 GOGCWS Network- Branch Locations

3.2 Methods Study

3.3 Standard Operating Instructions

3.4 Facilities Engineering

3.5 Operational Procedures

3.6 Network Maintenance - Job Order System

3.7 Valve Rotation

3.8 Labor Standards for Maintenance

3.9 Maintenance Job Order System

3.10 Preventive Maintenance

3.11 Maintenance Department Organization

3.12 Equipment Files and Procedures

3.13 Operations Analysis

3.14 Centralized Overhaul

4.1 Meter Reading Process

4.2 Process for New or Renewed Service

4.3 Process for Discontinuing Service

4.4 Averages and Range-of-Time Techniques of Applied Work Measurement

4.5 Meter Test Procedure

5.1 GOGCWS - Main and Network Stores

5.2 Functions of the Purchasing Department

5.3 Standard Purchase Order

5.4 Materials Control

6.1 Drawing Control

6.2 Mapping/Drafting Request

6.3 Drawing Release Control

6.4 Change Order Control

Note: Exhibits are located at the end of the Section in which they are referenced. Appendices are located at the end of the Report.

0.0 EXECUTIVE SUMMARY

On April 6, 1978 the Ministry of Housing and Reconstruction and BVI-ATK Associates entered into a contract to perform management and tariff studies relative to water and wastewater utilities in Egypt. There are eight interrelated studies in the management section, each of which deals with particular areas of management concern. This report presents the findings, conclusions and recommendations developed concerning existing procedures and methods being used in the water and wastewater utilities.

Procedures and methods were reviewed in five functional areas:

- Project Planning
- Operation and Maintenance of the Waterworks and Wastewater Systems
- Billing and Collecting
- Procurement and Inventory Control
- Mapping and Record-Keeping

Each area was reviewed for the sequence established for various work elements and the manner in which the work is assigned and controlled. Particular emphasis was directed toward controls, utilization and efficiency with specific reference to:

- Control systems
- Skill utilization
- Work methods
- Work measurement
- Work standards
- Tools and equipment

Recommendations presented have been developed to emphasize the process by which methods and procedures are developed, implemented and controlled. The interim period was selected as the time during which improvements could be made to the existing organizations to establish control until the new organizational structure selected is implemented. The long-range recommendations were developed to support not only the new organizational structure but also to improve the functioning of systems, methods and procedures.

0.1 FINDINGS AND CONCLUSIONS

With the exception of the physical control of inventory, there is almost a complete lack of any procedures, methods or control over the various areas studied. The ability of the utilities to function as well as they have has only been because of the selfless dedication of a number of individuals throughout the organizations involved in this Study. In all utilities there are many improvements that can and should be made to provide control mechanisms which establish the foundation for labor management. A higher level of service will result not only in a more efficient and economical operation but provide an environment of motivation to the worker through economic and skill recognition.

0.2 RECOMMENDATIONS

Because there is an almost complete lack of procedures and methods, the recommendations of this Study are many. The principal, or key, recommendations in each functional area are:

- Project Planning
  - . Establish a formal project planning function.
  - . Implement a work measurement program.
  - . Establish formal long-range planning.
  - . Develop planning tools and techniques.
  - . Establish formal written procedures.
- Operation and Maintenance
  - . Develop effective organizational structures.
  - . Establish training programs.
  - . Develop methods improvements.
  - . Implement standard operating instructions.
  - . Establish preventive maintenance programs.
  - . Establish standards of performance.
- Billing and Collecting
  - . Establish training programs.
  - . Initiate meter testing, rotation and repair.
  - . Implement recommendations presented in the Data Processing Report.
  - . Resolve policy differences and eliminate current billings due from Government and public agencies.
  - . Review existing practices for new and renewed accounts.
  - . Implement standard operating instructions.

- Procurement

  - Define duties, responsibilities and authority; document and publish.
  - Develop a procedures manual.
  - Review the existing purchasing process for streamlining.

- Inventory Control

  - Eliminate current back-logs of equipment and material awaiting receiving inspections.
  - Evaluate existing main store locations to optimize service distribution services.
  - Conduct an extensive housekeeping program.
  - Eliminate obsolete and scrap material and equipment.
  - Develop standard operating instructions.

- Stores Management

  - Implement material control functions.
  - Implement recommendations made in the Data Processing Report.
  - Develop standard operating instructions.

- Mapping and Record-Keeping

  - Inventory existing maps, drawings and records.
  - Implement a mapping and records control system.
  - Implement a new mapping/drafting request system.
  - Develop a map release control system.
  - Develop a change order control system.
  - Establish a mapping and record-keeping organization.

The Report includes outline descriptions of several procedures and methods:

- Work measurement programs
- Work order system
- Long-range planning
- Material control function
- Standard operating instructions

The details and technical content of the procedures and methods presented have been developed to the extent of providing a framework for establishing control. The detailed elements can be developed by the personnel interviewed during the course of the Study. Simple guidelines and implementation assistance would initiate an effective program for all the utilities.

1.0 INTRODUCTION

This Report is submitted under a contract dated April 6, 1978 between BVI-ATK Associates and the Ministry of Housing and Reconstruction for Management and Tariff Studies Relative to Water and Sewerage Systems in six cities of Egypt. As a result of the recent reorganization of the Egyptian Government, the responsibility for administration of this contract now rests with the Ministry of Development and New Communities. For the Management Study portion, the contract requires that investigations, findings and recommendations be made in eight areas of concern being undertaken as a series of interdependent tasks:

- Management Procedures - Alexandria Water General Authority
- Organizational Environment and Structure
- Personnel System
- Procedures and Methods
- Management Information Systems
- Physical Assets
- Data Processing
- Organization Manual

The Management Study is to culminate in recommended programs for the development of the organizations or agencies needed to meet the current and future operational and management needs of water and wastewater systems through the year 2000.

This Report summarizes and presents findings and recommendations relative to the existing procedures and methods employed in the water and wastewater utilities in the conduct of their respective functional responsibilities. The Report is prepared in fulfillment of Task 5.3.6, Procedures and Methods as specified in the Scope of Work, Appendix 1 to the Contract. Separate reports have been submitted to cover other areas of management concern.

1.1 BACKGROUND

This study is in support of the Government of the Arab Republic of Egypt's program to evaluate management and cost of service studies of the water and wastewater utilities for the cities of Cairo/Helwan, Alexandria, Suez, Ismailia and Port Said. Although the study involves the six cities, the results are to be carried out within a national context with the recommendations expected, in general, to be applicable to other water and wastewater service areas throughout the country.

1.2 SCOPE AND OBJECTIVES

This Report examines the existing procedures and methods employed in the water and wastewater utilities in the following functional areas:

- Project Planning
- Operation and Maintenance
- Billing and Collecting
- Procurement and Inventory Control
- Mapping and Record-Keeping

For the existing utilities, recommendations are based on the analysis of present procedures and methods, and improvements are recommended for the interim period until the new organizational structure selected is implemented.

For the organizational structure selected recommendations for improvements will be relevant for all water and sewerage service areas throughout the country.

The Report deals with the sequence established for various elements of work and with the manner of assigning and controlling the work being performed. The intent has been to focus on the manner in which procedures and methods are selected, implemented and controlled, with the more detailed, technical content of the procedures and methods treated only to the extent that would generally impact the efficiency and effectiveness of the organizations, except as noted in the Scope of Work.

1.3 APPROACH

The analysis of Procedures and Methods has been based upon:

- A review of documents and reports prepared by consultants engaged in Master Plan Studies for the six cities.
- A review of reports and manuals prepared by EPA, U.S. water and wastewater utilities, and the BVI-ATK reference library. (See Exhibit 1.1.)
- Notes recorded during site visits and interviews by BVI-ATK team members with members of the ministries, organizations and utilities concerned. A list of agencies interviewed and facilities visited by the Study Team Leader is shown in Exhibit 1.2.
- The identification and collection of detailed information requirements during field visits and interviews with utilities' officials and members.

The approach followed in the conduct of this Study has been to:

- Develop a complete understanding of the utility operation and management practices.
- Review the existing procedures and methods of each utility for the purpose of identifying areas of need and improvement.
- Analyze potential areas of improvement to determine feasible and practical recommendations.
- Identify specific action improvements in sufficient detail to provide a clear understanding for interim period applications.
- Identify areas for further improvement in support of the organizational structure being selected.

The detailed findings, conclusions and recommendations concerning each functional area studied are to be found in the remaining Sections of the Report. Since clearly defined procedures and methods are virtually non-existent, the recommendations for improvements, both in the interim period and the long-term, are many. The principal, or key, recommendations are designated with an asterisk (*).

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- Installation of Asbestos - Cement Water Pipe
- Safety Practice for Water Utilities
- Backflow Prevention and Cross-Connection Control
- Fire Hydrants - Installation, Operation and Maintenance
- Cross-connections and Backflow Prevention
- Sizing Water Service Lines and Meters
- Water Meters - Selection, Installation, Testing and Maintenance

National Lime Association - Lime

New York State Department of Health - Manual of Instruction for Sewage Treatment Plant Operators

W.E. Nusbaum - Electricity and Electrical Equipment for Water and Wastewater Plant Operators

Stevens, Thompson and Runyan - Operator's Pocket Guide to Activated Sludge, Part I and Part II

United States Environmental Protection Agency Publications -

- A Primer on Wastewater Treatment
- Package Treatment Plants - Operations Manual
- Stabilization Ponds - Operations Manual
- Maintenance Management Systems for Municipal Wastewater Facilities
- Planned Maintenance Management System for Municipal Wastewater Treatment Plants
- Emergency Planning for Municipal Wastewater Treatment Facilities

BIBLIOGRAPHY

Performance Evaluation and Troubleshooting at Municipal Wastewater Treatment Facilities

Sludge Handling and Conditioning - Operations Manual

Aerobic Biological Wastewater Treatment Facilities - Process Control Manual

Water Pollution Control Federation - Manuals of Practice

Paints and Protective Coatings for Wastewater Treatment Facilities

Units of Expression for Wastewater Treatment

Sludge Dewatering

Chlorination of Wastewater

Treatment Plant Equipment and Facilities Maintenance Operation of Wastewater Treatment Facilities

Sewer Maintenance

Safety in Wastewater Works

LIST OF CONTACTS

WATER OPERATING AGENCIES

Alexandria Water General Authorit;

- Headquarters
- Rond Point Water Treatment Plant, Warehouses and Shops

General Organization for Greater Cairo Water Supply

- Headquarters
- Abbassia Warehouse/Storage Yards
- Ameria Warehouses/Storage Yards
- Cairo North Water Treatment Plant
- Giza Water Treatment Plant
- Giza South Water Treatment Plant
- Maadi Water Treatment Plant
- Mostorod Water Treatment Plant
- Roda Water Treatment Plant
- Rod El Farag Water Treatment Plant

Suez Canal Authority

- SCA Works Department Headquarters
- Ismailia Water Treatment Plant
- Ismailia Networks Stores
- Port Said Water Treatment Plant
- Port Said Warehouse and Meter Shop
- Suez Water Treatment Plant

LIST OF CONTACTS

WASTEWATER OPERATING AGENCIES

General Organization for Sewerage and Sanitary Drainage

- GOSSD Headquarters
- GOSSD Cairo Utility
  - Cairo Utility Office
  - Zenein Sewage Treatment Works
  - Ameria Pumping Station
- GOSSD Alexandria Utility
  - Alexandria GOSSD Office
  - East Sewage Treatment Works
  - Main Pumping Station No. 11

Suez Governorate

- Zarb Pumping Station No. 2
- Suez Wastewater Treatment Plant

2.0 PROJECT PLANNING

With the increasing emphasis on capital projects and long-range planning, project planning has an important role in shaping the future of the water and wastewater organizations.

2.1 FINDINGS AND CONCLUSIONS

The project planning function was found to be only part of the Projects Group within the water and wastewater treatment organizations. Little input is being supplied to future planning by the operating groups within these organizations. Personnel involved in the planning function have little formal or informal training in the use of planning techniques. Little guidance and few directives have been issued for the execution of the planning function.

Currently the Projects Group has responsibility for planning, design and construction involving:

- Expansion of existing facilities to meet the increased demand for services.
- Introduction of new equipment and technology.
- Major maintenance and renovation of existing facilities and equipment.

2.1.1 Functional Activities

Functional activities within project planning include:

- Project analysis.
- Setting priorities.
- Budgeting.
- Programming.
- Monitoring

2.1.1.1 Project analysis. The evaluation and determination of what projects to plan is the responsibility of the Projects Manager in conjunction with his staff and outside engineering consulting firms. The current work load and shortages of experienced personnel in both water and wastewater utilities has forced most project groups to rely on outside consulting support. There is a lack of procedures, guidelines and directives being issued for the Projects Group to follow in their planning process. The annual cycle of preparing the project plans for the coming year, which are submitted to the Chairman in August, appears to be the only known procedure.

2.1.1.2 Setting priorities. The lack of directives or procedures for project analysis has resulted in inadequate information for setting project priorities. Consequently, priorities appear to be established more by the opinions of a few top officials than by a formal procedure that directs resources to the most important activities. Priorities under the present system depend on the selfless dedication of a few top officials, which could easily be misdirected, and budgetary constraints. The fact that reasonable priorities have been established in the past is a tribute to the officials involved.

2.1.1.3 Budgeting. Projects groups in the utilities develop a budget for each project being considered. Steps taken in this development process are:

- Prepare the scope of the project.
- Determine requirements.
- Prepare draft specifications.
- Develop cost estimates, based upon historical data, similar equipment, or price lists and catalogues.

For each project proposed a similar exercise is undertaken with the cumulative cost of all projects forming the projects budget. The projects budget is then submitted to a Capital Projects Evaluation Committee, consisting usually of the Chairman and the Vice Chairmen for review and approval. The budgeting process is very informal with few directives, procedures or formal cost estimating tools being used. While the assistance of outside consultants has added credibility to the budgetary figures, the process is weak due to the failure to follow a formal process for the effective monitoring of results. (See Paragraph 2.1.1.5.)

2.1.1.4 Programming. Project scheduling has been more the result of budgetary considerations than direction by requirements. The annual projects budget is submitted in August and the approved budget is released in February of the following year. Historically both water and wastewater utilities have experienced 30% to 40% reductions in their budgets from that submitted. As a result the projects group must re-evaluate its priorities and establish a new program within the parameters of the approved

budget. The revised schedule of projects must then be reviewed by the Capital Projects Evaluation Committee and approved. After final approval, specifications are prepared for procurement, and the requests for proposal are released to Purchasing for review and procurement.

2.1.1.5 Monitoring. The practice of the utilities, in most cases, has been to designate an engineer from the Projects Group as the Project Engineer. With the shortage of experienced engineers, it has been necessary to use inexperienced staff. The ability to monitor effectively the progress on any project requires a dedication to the project. When more than one project is involved or for inexperienced personnel, the degree of effectiveness is diminished.

The status of each project is reported by the Project Engineer on a monthly basis in his Project Status Report. This monthly report presents expenditures compared with budget, shows percent complete, includes comments concerning problems or delays, and provides general statements about progress. Should there be any special problems, or if the project is particularly important, weekly reports may be issued.

2.1.2 Effectiveness

The Project Group's effectiveness is constrained by a number of factors:

- A lack of sophisticated forecasting or planning techniques
- A shortage of experienced personnel which has resulted in 50 to 60 projects at each utility being monitored by three or four people with much of their time being spent in transit to each project or writing reports
- Little detailed planning being performed to allow for effective monitoring
- Little planning beyond the five-year project plan, prior to current master plan programs
- A lack of close coordination between water and wastewater projects
- Limited project budgets while utility service requirements increase
- A lack of sophisticated cost-estimating techniques which reduces the credibility of budget requests
- Complex budgeting and procurement cycles which reduce functional responsiveness

2.1.3 Procedures and Methods

Interviews and investigations at the utilities revealed that there are no formal methods or procedures being used. Project planning is not a separate activity but part of the overall responsibilities of the Projects Group. While there are some procedures and methods being used in the preparation of the annual budget, the informality precludes an effective system. The dedication and efforts of the existing staff in all utilities to maintain the quality of treatment is a tribute to the Egyptian desire to do work as well as possible under the existing conditions.

2.2 RECOMMENDATIONS

The following recommendations are presented in two stages. The first step will be for an interim period, focusing on recommended improvements within the existing utilities which can provide the foundation for an effective organization. The second series of recommendations are for the long-term, covering further improvements, the new organization structure and the application of more advanced techniques of Project Management.

2.2.1 Interim Period

Recommendations for the interim period include:

*- Establish project planning as a distinct activity within the Projects Group of each utility.

- Establish a liaison function within the Projects Group of each utility to coordinate water and wastewater programs so as to maximize their benefits.

- Review current projects and develop detailed planning data to provide a basis for effective monitoring.

- Analyze current work methods for areas of improvement and need. Document, review, improve and revise the documented methods.

- Use existing consultants' reports to establish a basis for cost estimating. (See Standard Estimating Prices - Taylor & Binnie, Special Report No. 2 Volume 3, June 1977.)

- Develop a program for standardization of basic equipment, e.g., pumps. Standard connections and dimensions should be adopted so these items can be supplied by various international or local suppliers and units can be interchanged. (See Exhibit 2.1.)

*- Implement a work load estimating program to provide the basis for manpower planning. (See Exhibit 2.2.)

*- Establish a formal program for determining projects for one year and ten years. (See Exhibit 2.3.)

- Establish liaison with local and national agencies for the coordination of water, sewerage, housing, irrigation and other development projects.

- Actively pursue becoming members of various technical associations and subscribing to publications concerning water and wastewater treatment. (See Exhibit 2.4.)

*- Develop the use and apply such planning tools as Gantt charts, milestone charts and Critical Path Method (CPM) to execute performance against objectives. (See Exhibit 2.5.)

- Establish formal written procedures and documentation for:

  . Responsibilities of project planning.

  . Project justification.

  . Project analysis. (See Exhibit 2.6.)

  . Job descriptions of project planning.

  . Cost estimating.

  . Specifications preparation.

  . Procurement preparation.

  . Project control. (See Exhibit 2.5.)

  . Project planning. (See Exhibit 2.3.)

  . Project priorities. (See Exhibit 2.6.)

  . Project economic analysis. (See Exhibit 2.7.)

- Improve existing library capabilities and pursue the updating and expansion of technical area needs, equipment catalogues and literature. (See Physical Assets Report, Exhibit 4.1.)

2.2.2 Long-Term

The following recommendations have been developed for the long-term:

- Under the new organizational structure, a formal Project Planning Section should be created to coordinate all projects involving water and wastewater.

- Install a formal cost estimating system, using a mini-computer or micro-film which provides continuous revision capability.

- Install more formal, sophisticated planning techniques, such as line-of-balance (LOB), and input-output methods.

- Extend the standardization program to a central organization, country-wide program. Establish a central point for information, data and technical support. (See Organizational Environment and Structure Report.)

STANDARDIZATION PROGRAM

Standardization promotes interchangeability and flexibility by providing a broader range of supplies, reduced disruption of service and reduced emergency purchases.

Standardization provides efficiency and economy of design. It reduces routine detailing.

An initial step towards the development of standards would be in the area of the equipment form, fit and function. Equipment standards could be developed in such areas as:

- Flange dimensions and mounting hole patterns.
- Basic dimensions (envelope size).
- Shaft sizes and configurations.

For basic items that are used in large quantities, standards should be adopted and standard specifications prepared which can be used for international or local procurement. The task of developing and coordinating standards and specifications could be added to the engineering design contracts that are currently underway in Egypt. If this is done, one utility should be given the lead role and the others should be in a coordinating and review role.

Standard items could be procured centrally and furnished to contractors for incorporation into new projects. Stocks should be rotated to minimize deterioration during storage and proper cover or protected storage should be provided for stocks of these items.

An example of this approach is the standard module suggested in the Taylor & Binnie Wastewater Plan for Cairo. If adopted, it would be feasible to stock the equipment for one or more modules. If a component failed or spare parts could not be obtained promptly, spare units could be used from stock and replaced through procurement.

Equipment listed on the following page represent items that could be standardized as to form, fit and function.

STANDARDIZATION PROGRAM

Items to be Standardized

I Water Treatment and Pumpin

Centrifugal pumps
Chemical feeders
Chlorinators
Control components
Engine-generators
Flow tubes
Motors
Starters
Valves

II Water Networks

Hydrants
Meter bars
Meters
Pipe
Repair sleeves
Tapping cocks
Tapping machines
Tapping saddles
Valves

III Wastewater Treatment and Pumping

Blowers
Control components
Metering flumes
Motors
Screw pumps (return sludge)
Sewage pumps
Sludge pumps
Sludge valves
Starters
Surface aerators

IV Wastewater Networks

Manhole rings and covers
Manhole steps
Pipe

WORK LOAD ESTIMATING FOR PROJECTS GROUP

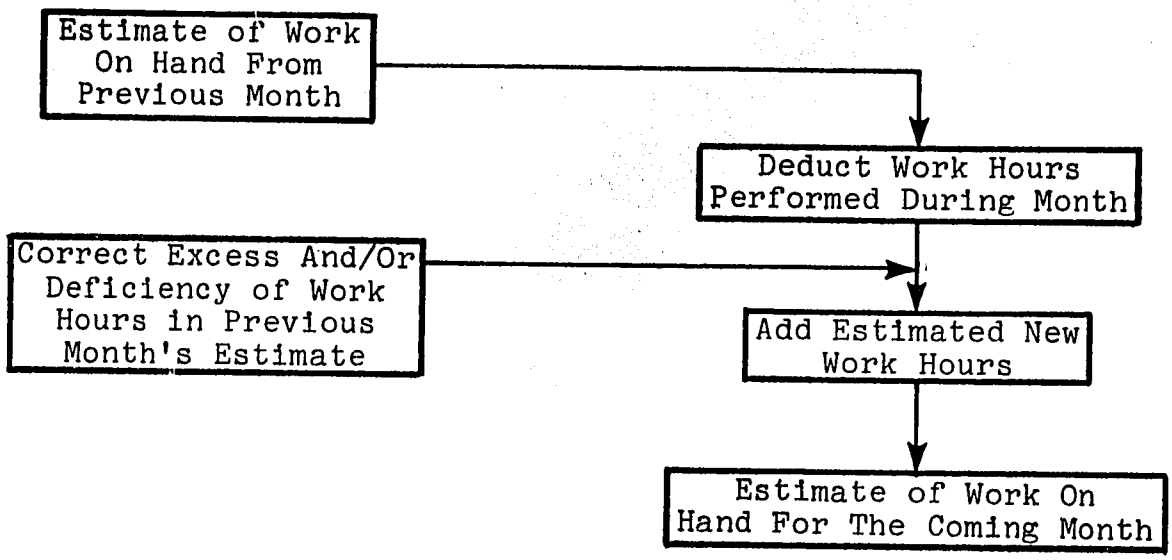
The following process can be used to develop work load estimates for the Projects Group personnel:

- Each staff member should define on a monthly or quarterly basis:
  - The scope of their work assignments.
  - How the work is to be performed.
  - The tasks not related to projects.
  - The work that is to be accomplished for the month, by task.
  - A monthly work load plan.
  - A quarterly work load forecast.
- An individual manager should consolidate these input reports and issue a work load schedule by month and by quarter.
- The schedule should be revised monthly and work load schedules adjusted accordingly.
- Monthly work load schedules should be submitted to the Projects Director.

The basic principles of the monthly cycle are shown in the diagram on the following page:

WORK LOAD ESTIMATING FOR PROJECTS GROUP

WORK LOAD ESTIMATING CYCLE



Input = Estimated new work + error correction

Output = Hours worked (actual)

$$\text{Excess of Input over Output} = \frac{\text{Estimated balance this month}}{\text{Estimated balance last month}}$$

This type of informal work load estimating has the he advantage of helping to determine reasonably accurate costs, manpower requirements and work schedules for the complete project.

This type of program can produce estimates that have accuracies greater than 90%. After experience is gained, considerations could be given to more sophisticated methods of work measurement and determination of standard performance rates.

PROJECT PLANNING

Since the planning of previous years has been less then successful due to budget constraints and manpower shortages, a new emphasis is being placed on project planning.

To provide a basis for planning, both current year and long-range strategies are developed as the prime focal point for the utility organizations. As a result of the Master Plans being developed by engineering consultants in conjunction with the utilities, specific planning and project management concepts are established to achieve these strategies and goals.

The first step toward making plans happen includes the identification of preliminary goals in support of basic strategies.

The key objectives of project planning are to:

- Provide guidance for moving toward desired goals.
- Prevent false starts and expedite results through effective planning.
- Establish project management techniques to realize benefits by 1980.
- Develop a means to monitor overall results and individual performance.

PROJECT PLANNING

The second major step involved in this process is the development of an action plan. The following are the specific tasks to be developed in this step:

- Identify the steps to be completed to meet the desired objective.
- Divide significant tasks into sub-tasks to provide clarity and understanding of how the plan is to be accomplished.
- Identify major tasks as milestones.
- Assign responsibilities for task completion.
- Estimate the man-days involved in each task.
- Develop a schedule including planned start and completion dates.
- Obtain approval for the project.

The result of this step will be a project work plan, part of which would be the Critical Path Method (CPM) (See Exhibit 2.5), which can be used for the review and analysis of the project by the Budget Committee in addition to providing a means of monitoring the performance of the project.

To be effective active projects must be monitored according to the milestone dates indicated on the project planning and control sheets. These:

- Assure that the planning effort achieves results for the time, cost and effort invested.
- Provide a foundation for future planning efforts.

To provide the mechanism for achieving this approach to planning, both immediate and future, the following suggestions are presented:

PROJECT PLANNING

Planning Development Cycle - Annual

The initial step in the development cycle is to define the individual projects to be undertaken. Specific tasks included in this step are:

- Define the need for a particular project. (Reason for undertaking)
- Specify the objectives of the project. (What is to be accomplished)
- Define the means or method of measuring the extent to which each project objective is attained. (Monitor Performance)

The output, or deliverable, from this procedure is the Project Proposal Form, shown on Pages 4 and 5. This Form is completed as a joint effort between the Projects Director and his staff or consultant. Upon completion, a final review session for clarification and approval is conducted with the individual responsible for the project. Reviews are critical to project planning and the success of the management system. They can provide a specific point in time where tangible evidence of accomplishment should be shown. As necessary, modifications in approval or accomplishment can take place at these reviews to reflect changes, problems or the unforeseen. In addition a post-audit review session should be conducted to determine the overall success of a project. This should occur within a few months after completion of the project. The project planning cycle should be revised following any changes in the organization's strategies and goals.

PROJECT PLANNING

PROJECT PROPOSAL

PROJECT ORIGIN

Project Title (1)

Proposed By (2) Date (3)

PROJECT DESCRIPTION

(4)

(5) New ☐ Addition ☐ Replacement ☐

PROJECT PURPOSE

(6)

PROJECT JUSTIFICATION

(7)

PROJECT PROPOSAL (Cont'd)

Project Title _____

PROJECT DEFINITION			
Task Analysis (8)	Date		Cost (LE)
	Start	Complete	
1			
2			
3			
4			
5			
6			
7			
8			

Brought forward from attached Schedule _____

Total _____

INPUT COST ANALYSIS		
(9)	Cost	
	Local	Foreign
Land		
Structures		
Equipment		
Raw Materials		
Labor		
Taxes, Tariffs and other		
Other		

Estimated Life _____ (10) _____ Total _____

Approved By _____	Disapproved By _____
Date _____	Date _____
Project No. _____	Reason for Disapproval _____
Asset Ledger No. _____	_____
Depreciation Account No. _____	_____
Asset No. _____	_____

PROJECT PLANNING

PROJECT PROPOSAL INSTRUCTIONS

1. Prepare a very brief descriptive title.

2. Enter the name of the person to whom all questions concerning this proposal should be addressed.

3. Enter the date the proposal is submitted to the Manager of Long-Range Planning.

4. Describe the project in general terms. The description should provide a clear indication of the scope of the project. For example:

   Build additional clarifiers at Roda. (poor)
   Build three additional clarifiers at Roda. (good)

5. Check New if the project by itself adds new capacity or capability to the utility.
   Check Addition if it extends existing capacity or capability.
   Check Replacement if it will replace existing capacity or capability.

6. Describe the objectives of project. Provide measures of how much it will expand the utility's capacity or capability. These measures should be specific enough to permit numerical analysis of the success of the project after it is in operation.

7. Provide a brief statement justifying the project. This statement should be supported by appendices containing a detailed analysis of the needs, costs and benefits. The following topics should be considered either in the statement or the appendices:

   Need for the project, for example:

   - Size and rate of growth of customer demand
   - Size and rate of growth of work load
   - Change in legal requirements
   - Change in labor force capabilities

   Cost of the project, including:

   - Initial cost
   - Operating costs

PROJECT PLANNING

PROJECT PROPOSAL INSTRUCTIONS (Cont'd.)

Alternatives, including:

- Doing nothing (This alternative must be discussed.)
- Other approaches to solving the needs (Where possible, compare costs.)

Benefits, for example:

- Quantified improvement in customer service
- Reduced costs
- Increased productivity

8. List the tasks against which the project can be controlled This analysis should be supported by a flow chart showing the timing and relationships among the tasks.

9. Estimate the costs of the project in terms of resources required. Attach additional details, if required.

10. Estimate the lifetime of the project. This value will be used to establish the depreciation rate for the completed asset.

PROJECT PLANNING

Long-Range Project Planning

For the long-range forecast the tasks outlined in the planning development cycle should be carried through the initial step with only minor modifications. The specific tasks include:

- Define the need for a particular project. (reason for undertaking, modified to reflect changes or problems resulting from reviews)
- Specify the objectives of the project. (what is to be accomplished)
- Define the anticipated means by which each project objective can be attained and measured.
- Outline the trends or factors to be considered, resulting from project reviews, government plans, population projections and others.

The output from this procedure is a completed long-range Project Proposal Form, shown on the following page. Preparation of this form is under the direction of the Projects Director. (General Manager Project Management). On completion a review is held for clarification, understanding and approval of the request.

At the conclusion of the Long-Range Project Planning preparations, the forms are placed in sequential order for a ten-year period. A tabulation of the titles, cost and anticipated start dates is prepared, accompanied by copies of the request forms as backup documents.

PROJECT PLANNING

LONG-RANGE PROJECT PROPOSAL

PROJECT ORIGIN

Project Title (1) _____

Proposed By (2) _____ Date (3) _____

PROJECT DESCRIPTION

(4) _____

(5) New ☐ Addition ☐ Replacement ☐

PROJECT PURPOSE

(6) _____

PROJECT JUSTIFICATION

(7) _____

ESTIMATES OF COST

(8)	Costs	
	Local	Foreign
Engineering		
Structures and Equipment		
Other		

Approved By _____

Date _____

Project No. _____

Fiscal Year _____

Disapproved By _____

Date _____

Reason for Disapproval _____

PROJECT PLANNING

LONG-RANGE PROJECT PROPOSAL INSTRUCTIONS

1. Prepare a very brief descriptive title.

2. Enter the name of the person to whom all questions concerning this proposal should be addressed.

3. Enter the date the proposal is submitted to the Projects Group Manager.

4. Describe the project in general terms. The description should provide a clear indication of the scope of the project.

5. Check New if the project by itself adds new capacity or capability to the utility.
   Check Addition if it extends existing capacity or capability.
   Check Replacement if it will replace existing capacity or capability.

6. Describe the objectives of project. Provide measures of how much it will expand the utility's capacity or capability. These measures should be specific enough to permit an evaluation of the success of the project after it is in operation.

7. Provide a brief statement justifying the project. This statement should be supported by appendices containing a detailed analysis of the needs, costs and benefits. The following topics should be considered either in the statement or the appendices:

   - Need for the project, for example:
     - Size and rate of growth of customer demand
     - Size and rate of growth of work load
     - Change in legal requirements
     - Change in labor force capabilities
   - Costs of the project, including:
     - Initial cost
     - Operating costs
   - Alternatives, including:
     - Doing nothing (This alternative must be discussed.)
     - Other approaches to solving the needs (Where possible, compare costs.)

PROJECT PLANNING

LONG-RANGE PROJECT PROPOSAL INSTRUCTIONS (Cont'd.)

- Benefits, for example:
  - Quantified improvement in customer service
  - Reduced costs
  - Increased productivity

8. Estimate the costs of the project in terms of resources required. Attach additional details, if required.

   - Priority:
     - When should project be implemented
     - Impact of not implementing
     - Utility need

PROJECT PLANNING

Review

An important phase in project planning is the annual review of the prior year's accomplishments, the revisions which reflect current conditions, and the projection of changes and impacts on future plans. Only through the annual review of all projects and the periodic reviews of completed projects will the foundation for future plans be provided.

Once the annual planning cycle is established with the current year's projects and the ten-year forecast, the following reviews should occur:

- Periodic reviews of each project completed, one to two months after completion.
- A semi-annual review of all projects to incorporate any changes of priorities and goals.
- An annual review, at some point which allows time for detailed preparation of the coming year's projects and preparation of a revised plan for the ten-year period.

Summary

This approach to project planning provides a mechanism for documenting future needs, outlining the immediate needs in the detail required for effective monitoring, and allows the opportunity to establish the foundations of good project planning and management concepts.

PROFESSIONAL ASSOCIATIONS

Professional journals and meetings are one of the best means of maintaining and expanding professional and technical knowledge. Ordinarily, journals are an adjunct of membership in professional organizations. Even though it is usually possible to subscribe to the journal without membership, in most cases the cost is nearly the same and other benefits accrue to the individual who becomes a member. For this reason the best way to obtain journals is often by designating an employee to become a member of the organization.

The latest technical developments are first reported at technical and professional meetings. The persons who attend those meetings receive first-hand reports on research and analytical developments and have an opportunity to discuss the subject with the authors.

Within a few months after the meeting the same type of information is usually published in the journals. Journals also contain other material that is not presented at meetings. The least costly way to keep current with new developments is to read regularly the appropriate journals. In order to encourage technical and professional employees to read the journals, it is recommended that the utility pay the membership fee for each technical and professional employee in one or more professional organizations.

PROFESSIONAL ASSOCIATIONS

There are a number of appropriate associations in Europe and other parts of the world. In the United States the organizations that could be considered are:

American Water Works Association (AWWA)
6666 West Quincy Avenue
Denver, Colorado 80235 USA

AWWA is an organization of water utility personnel. Its membership includes government and water utility officials, engineers, and other professional employees, equipment manufacturers and others who have an interest in water utilities. AWWA publications include a monthly journal, a monthly newsletter for operators, handbooks and manuals, and standards for materials, equipment and chemicals. Many of the AWWA publications for operating personnel should be considered for translation into Arabic.

Membership in AWWA would be beneficial for any technical or professional employee of a water utility, and who understands English well enough to read the publications.

Water Pollution Control Federation (WPCF)
3900 Wisconsin Avenue, NW
Washington, DC 20016 USA

WPCF is an organization of wastewater utility personnel. Its membership includes government officials, wastewater utility managers, wastewater utility operators, design engineers, equipment manufacturers and others who have an interest in wastewater utilities and water pollution control. WPCF publications include a monthly journal, a monthly newsletter for

PROFESSIONAL ASSOCIATIONS

operators and manuals of practice. Some of the WPCF publications for operating personnel should be considered for translation into Arabic.

Membership in WPCF would be beneficial for any technical or professional employee of a wastewater utility, and who understands English well enough to read the publications.

Construction Specifications Institute (CSI)
1150 Seventeenth Street, NW
Washington, DC 20036 USA

CSI is an organization of individuals who have an interest in construction. Its membership includes architects, engineers, designers, specifiers, material suppliers, contractors and others who have an interest in construction. CSI publications include a monthly journal, model specifications, data about construction materials and a handbook about specifications. CSI publications also include material that is helpful to personnel who are supervising construction. Some of the CSI publications about specifications and construction should be considered for translation into Arabic.

Membership in CSI would be beneficial for any technical or professional employee who is involved in preparing specifications or interpreting them during construction, and who understands English well enough to read the publications.

PROFESSIONAL ASSOCIATIONS

American Society of Civil Engineers (ASCE)
345 East 47th Street
New York, New York 10017 USA

ASCE is an organization of civil engineers. Since both water and wastewater utilities are considered civil engineering functions in the USA, many water and wastewater utility managers and design engineers are active members of ASCE. Water and wastewater utility activities fall under the Environmental Engineering Division of ASCE. ASCE publications include a monthly journal and a series of technical proceedings for the various divisions. The proceedings of the Environmental Engineering Division are published four to six times per year. The material published by ASCE is not directed to operating personnel, but rather to designers and research workers.

Membership in ASCE would be beneficial for engineers who are involved in design or research for water or wastewater utilities, and who can read and understand English.

Institute of Electrical and Electronic
Engineers (IEEE)
345 East 47th Street
New York, New York 10017 USA

IEEE is an organization of electrical and electronic engineers. Since water and wastewater utilities in the USA do not employ large members of electrical engineers, IEEE does not have a section specifically directed to water and wastewater utilities.

PROFESSIONAL ASSOCIATIONS

Power distribution and electrical controls are important activities of IEEE that are specifically applicable to water and wastewater utilities. IEEE publications include a monthly journal and standards for materials and equipment.

Membership in IEEE would be beneficial for electrical engineers who are involved in the design and operation of electrical facilities for water and wastewater utilities and who can read and understand English.

American Society of Mechanical Engineers (ASME)
345 East 47th Street
New York, New York 10017 USA

ASME is an organization of mechanical engineers. In the USA not many of the water and wastewater utility personnel are mechanical engineers. Consequently, ASME does not have a section specifically directed to water and wastewater utilities. ASME does have a large amount of activity in the operation of electric utilities and many similar problems are addressed. ASME publications include a monthly journal and standards for materials and equipment.

Membership in ASME would be beneficial for engineers who are involved in the operation of pumps and other heavy machinery and who can read and understand English.

PROJECT PLANNING USING CRITICAL PATH METHOD (CPM)

The Critical Path Method (CPM) is a basic technique for planning, scheduling and controlling projects of all types. A project is any set of activities or tasks which are necessary to achieve a single or complex goal.

In a typical project, some tasks can run concurrently while others must necessarily be performed in sequence. Even large and complex projects can be put together without difficulty by using a straightforward step-by-step procedure to establish the necessary sequence or ordering of the jobs. For each job or task that is added to the project diagram, the following questions are asked:

- What tasks immediately precede this task?
- What tasks immediately follow this task?
- What tasks can be performed concurrently with this task?

A simple example will make this clear. The following example lists the activities performed in preparing a building site and installing its utilities. The time estimates are assumed to be precise and determine the minimum time required to complete the project. The first step in the process is to identify the project tasks and develop estimated times to perform each task as shown on the following page:

PROJECT PLANNING USING CRITICAL PATH METHOD (CPM)

PROJECT TASKS

Symbol	Activity	Estimated Days
A	Site preparation	6
B	Survey and set elevation	3
C	Rough grade	4
D	Excavate for sewer	10
E	Excavate for electrical	3
F	Install sewer and backfill	5
G	Install electrical boxes	5
H	Install overhead pole line	6
I	Install electrical duct work	4
J	Pull power feeder line	4
K	Construct footings for water tank	3
L	Erect water tank	10
M	Install tank piping and valves	12
N	Drill well	14
O	Install well pump	2
P	Install underground water piping	10
Q	Connect all piping	2

PROJECT PLANNING USING CRITICAL PATH METHOD (CPM)

Calculation Procedure:

- Identify the predecessor(s) of each activity and tabulate the results.

CPM provides a systematic means of scheduling activities in a project and analyzing the consequences of departures from the schedule. The procedure consists of devising a logical connection of activities after ascertaining the relationships that exist among them. In the example, activities D and E are independent of one another and may therefore be performed concurrently. But activities D and F are sequentially related. F cannot start until D is finished. Thus D is the immediate predecessor of F. Using these principles, the related activities are listed as shown in the following table:

RELATED CPM ACTIVITIES

Activity	Predecessor	Activity	Predecessor
A	None		
B	A	J	H and I
C	B	K	C
D	C	L	K
E	C	M	L
F	D	N	C
G	E	O	N
H	C	P	O
I	F and G	Q	M and P

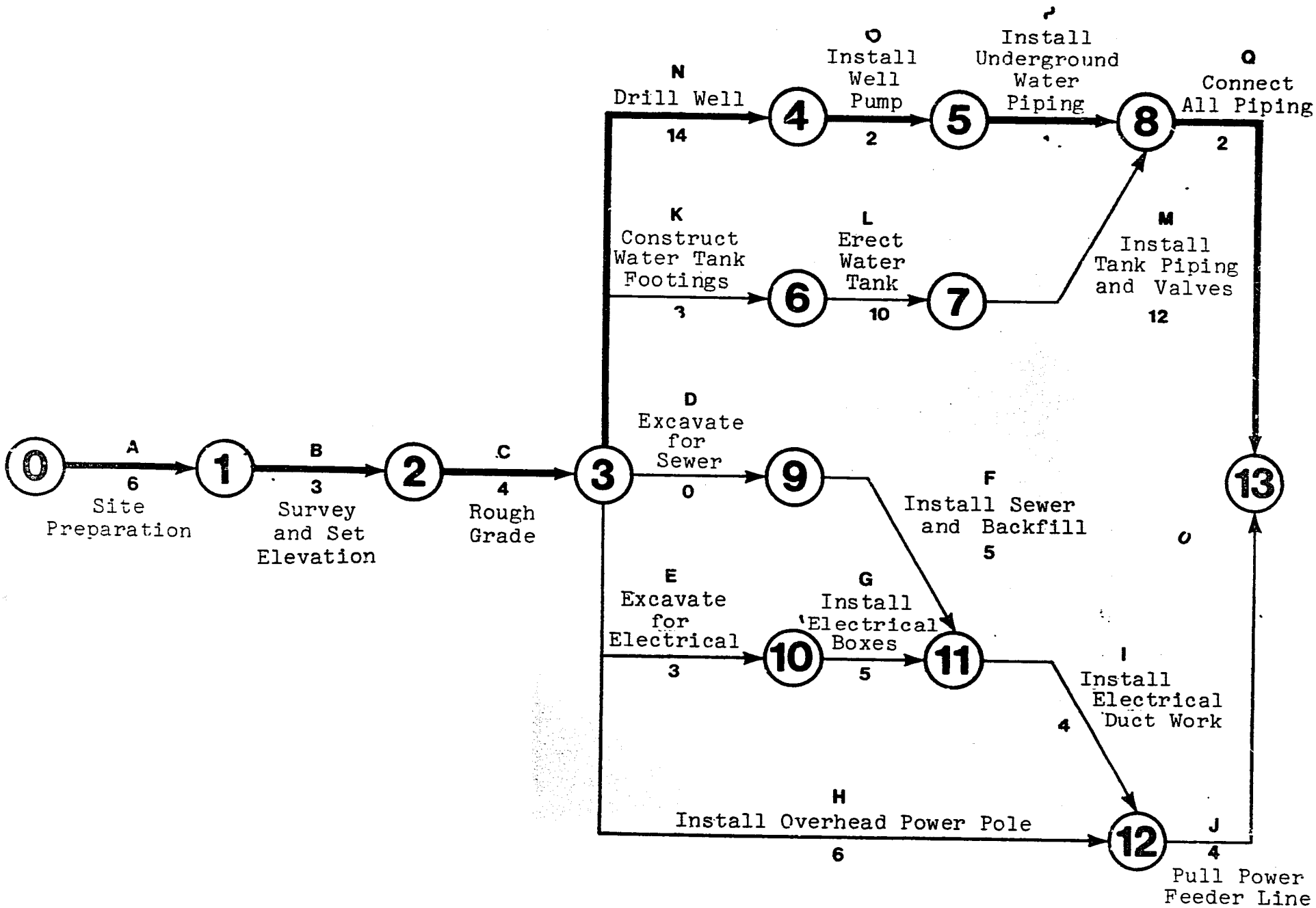
PROJECT PLANNING USING CRITICAL PATH METHOD (CPM)

- Construct the network for the project as shown on the following page.

The network is a delineation of the sequence in which the activities are to be performed. Each activity is represented by an arrow, which may or may not be to scale. The arrow for a given activity is placed to the right of its immediate predecessor activity. The estimate of time for each activity is recorded under its corresponding arrow. The network presents the sequential flow of the project and allows a quick analysis of the steps and their durations.

At a glance, the minimum time length of the project will be 41 days. During the project development period a CPM chart can be and should be prepared. Upon approval and initiation of the project, start and finish dates can be imposed on the activities and the CPM chart to establish a meaningful system of control and monitoring for the project. The CPM chart presents the project as a diagram which is very useful for analyzing the project, for pinpointing responsibilities and for communicating a clear picture of the project to everyone involved.

CPM NETWORK FOR SITE PREPARATION PROJECT



PROJECT PRIORITIES

Each utility, nationwide, should adopt a uniform procedure for project analysis to serve as the basis for establishing project priorities. A system for analyzing projects should have the following characteristics:

- Answer the question - When should a project be implemented?
- Provide a means for determining the cost impact of not implementing the project
- Serve as a source of data for budgeting equipment expenditures
- Make full allowance of future deterioration and obsolescence to be expected of new equipment
- Have a firm basis of theory spelled out in complete detail
- Have a method of analysis which is not difficult
- Be applicable to a single project or a combination of projects

Because of the types of funds being made available for water and wastewater projects and the restructuring of government priorities, the project priority analysis system would add an important element to establishing credibility for priorities.

In addition to the types of information developed in the Project Planning Section (See Exhibit 2.3) the following types of information are required:

- Initial cost, by year:
  - Egyptian funds
  - Foreign exchange

PROJECT PRIORITIES

- Interest cost on money invested
- Critical nature of the project
- Justification for the project
- Relation of the project to similar projects
- Cost benefits of the project
- Possibilities for phasing or completing the project in stages.

With a uniform system for establishing project values, the evaluation and ranking of each utility's projects could be combined and a nationwide priority listing generated. An overall, nationwide summary would assist the Ministry of Finance in preparing the capital budgets and the Ministry of Planning in assessing the impact of any budget changes, as well as provide a mechanism for control.

Three techniques for the economic analysis of projects are described in Exhibit 2.7, Project Economic Analysis.

PROJECT
ECONOMIC ANALYSIS

There are several methods for determining the most economical choice of a project. Each has its advantages and each industry has its favorites. Each must be selected on the basis of the specific projects at hand. The three methods presented are basic. They can be adapted to fit almost any project. These include:

- Differential yield
- Capitalized cost
- Minimum annual cost

Each method is based on the fact that an investment will definitely be made and the question is - Which project should be approved?

There are certain factors which must be considered in developing an economic analysis:

- Investment
- Expected economic life in years
- Estimated salvage value at end of life
- Annual cost of taxes
- Annual cost of insurance
- Annual cost of material
- Annual cost of direct labor
- Annual cost of indirect labor
- Annual cost of maintenance and repairs
- Annual cost of power
- Annual cost of supplies and lubricants
- Other annual indirect costs

PROJECT
ECONOMIC ANALYSIS

Whichever method is used, the type of depreciation does not influence the comparative results, provided that the same type of depreciation is used in each alternative.

Differential Yield. In this method the selection among several alternative projects is based on the financial return on the additional investment. Therefore the selection will start with the project requiring the minimum investment and only incremental increase in investment must be justified by an acceptable incremental increase in financial return.

As an example, assume there are three projects being proposed to increase the treatment capacity. Because of differences in equipment, process, operator skills, power requirements, and other, the initial costs and operating costs differ. The analysis requires the listing of alternatives in their increasing order of investment as shown in the following example:

	Project X	Project Y	Project Z
In-place Cost (Investment)	LE 16,000	LE 20,000	LE 26,000
Average Investment	8,800	11,000	14,300
Annual Operating Cost (Excluding Return on Investment)	6,900	6,450	6,200
Incremental Increase in Average Investment	2,200	3,300	
Increment Decrease in Operating Cost	450	250	
Differential Yield (Return on Additional Investment)	20%	8%	

PROJECT
ECONOMIC ANALYSIS

Normally, Project X would be selected as requiring the minimum investment. Nevertheless, with an increase of $ 4,000 investment a 20% return on investment could be realized. Note that if Project Y had been rejected because of lower production, Project Z would have been selected because, for a $ 10,000 investment increase over Project X, the decrease in costs would be $ 700 which yields 13%.

Capitalized Cost Method. This cost method is used most frequently for utility projects. An analysis of alternatives by this method compares the sums of the capitalized annual cost and the in-place cost. The capitalized cost is calculated by dividing the annual cost by the minimum acceptable financial return. Care must be taken in the use of this technique to avoid misinterpreting the figures used. The figures merely measure the magnitude of difference in alternatives and should not be construed as anything else.

As an example, assume there are three projects available for a given utility which have the same production rate and service life of 10 years. Because of differences in equipment, operator skills, power requirements, and other, the initial costs and operating costs differ.

In the following example, the annual operating costs, excluding return on investment, have been divided by the average interest, 6%, to get the capitalized annual cost:

PROJECT
ECONOMIC ANALYSIS

	Project X	Project Y	Project Z
Annual Operating Cost	LE 6,900	LE 6,450	LE 6,200
In-place Cost (Investment)	16,000	20,000	26,000
Capitalized Annual Cost	115,000	107,500	103,333
Total Capitalized Cost	LE 131,000	LE 127,500	LE 129,333

Project Y would be selected because its total capitalized cost is the least amount even though it is not the low investment cost.

Minimum Annual Cost - This technique is based on the premise that the least annual cost for a given treatment rate is the most advantageous. Therefore, the choice between alternatives is based strictly on the minimum annual operating cost which includes the required return on investment.

The same projects cited can be compared to show how this technique is applied:

	Project X	Project Y	Project Z
In-place Cost (Investment)	LE 16,000	LE 20,000	LE 26,000
Annual Operating Cost (Excluding Return on Investment)	6,900	6,450	6,200
Required Return on Investment (Average Interest - 10%)	880	1,100	1,430
Total Annual Cost	7,780	7,550	7,630

PROJECT
ECONOMIC ANALYSIS

In this case Project Y is the first choice, with Project Z being the second choice. Nevertheless, the monetary difference is very small. Therefore it would be well to examine the intangible factors more carefully, because Project Z may have advantages that cannot be measured but are worth more than the difference in annual cost.

3.0 OPERATION AND MAINTENANCE OF THE WATERWORKS AND WASTEWATER SYSTEMS

The purpose of this Section is to review the work elements of water and wastewater operations and maintenance activities and the manner in which this work is assigned and controlled. Where functional activities in water and wastewater systems differ by the nature of the work, they will be discussed separately.

3.1 FINDINGS AND CONCLUSIONS

The basic similarities of water and wastewater systems are the work elements and the manner in which the work is assigned and controlled. Differences among the systems and plants are their relative size, substance being treated, types of equipment and the age of the plant. The intent is not to present a description of the step-by-step activities being performed but to present impressions and facts as they relate to the functional responsibilities.

3.1.1 General

The following general observations apply to all the utilities visited:

- A lack of:
  - Consistency in organization structures between plants. Each organization appeared to be based on an organization of the existing manpower, not on the most effective organization.
  - Updated job descriptions for each position
  - Supervision and control over workers
  - Proper tools, equipment and spare parts
  - Safety programs or instructions

- Good and effective use of older, more experienced personnel, but little on-the-job training
- An excessive number of helpers and observers watching an experienced worker performing a skilled operation.
- An overall shortage of experienced operators and qualified maintenance personnel
- An excessive number of laborers employed, with the exception of SCA water plants
- A ratio of six or seven non-experienced workers to every experienced worker
- Work methods that reflect only an employee's habit or routine
- Little management control over employees

3.1.2 Operations (Treatment Plants and Pump/Booster Stations)

Those observations specifically related to the operations of treatment plants, both water and wastewater, are:

- A daily log of equipment operations is maintained by the shift supervisor.
- The Daily Employee Attendance Log is the only labor control report.
- There is little on-the-job training.
- Most automated equipment is inoperable.
- There is a lack of:
  - Operating manuals or instructions.
  - Performance standards to measure personnel effectiveness.
  - Attention to chlorination equipment and supplies.

Formal operating procedures for:

Pump start-up and shut down.

Filter washing (water treatment).

Operation and cleaning of screens (wastewater).

Grit removal (wastewater).

Chemical feeders adjustment and calibration (water).

Stoppage in sludge piping (wastewater).

Changing chlorine cylinders (water).

Inoperative clarifier mechanism.

Emergencies.

- Process flow schematics.
- Operational controls.

3.1.3 Networks (Distribution and Sewage Collection)

Network operations visited in the course of this Study resulted in the following observations:

- There is a lack of:
  - Scheduling systems for repair crews and personnel
  - Formal work-order systems for assigning and controlling work being performed.
  - Follow-up or inspection on work being performed.
  - Equipment utilization records.
  - Communication with network field crews.
  - Standard operating procedures.
  - Up-to-date system drawings. It is necessary to rely on the memories of experienced personnel.
  - A standard rotation system among valves and failure to identify proper direction of rotation.
  - Statistics to evaluate frequency and nature of repetitive problems and breakages.
  - Performance standards with which to measure personnel effectiveness.

- There is inadequate communication between network centers.

- Most job assignments are verbal with no following paperwork.

- The location of network centers fails to provide efficient logistics support. (See Exhibit 3.1 and Paragraph 5.1.2.1.)
- There are poor equipment maintenance practices and a lack of an effective maintenance program.

- There is a failure to operate and service valves periodically so they will function when required.

- Crews are reluctant to use equipment furnished for fear of loss and liability to worker.

3.1.4 Laboratories

Visits to laboratories resulted in the following observations:

- Each major water and wastewater treatment plant is equipped with a laboratory.

- With the exception of plants less than five years old, the laboratories are antiquated and poorly equipped.

- Some utilities have a central laboratory, others do not.

- Job descriptions are very specific for some positions, vague for others.

- There is a lack of written instructions and procedures.

- Basic laboratory tests and reports are consistent among plants and utilities.

- The line and staff relationships are vague between chemists and headquarters, plant managers and the Ministry of Health.

- Laboratories only recommend chemical treatment procedures and design.

3.1.5 Maintenance (Treatment Plants, Pump/Booster Stations, Networks)

Observations concerning maintenance functions and performance include:

- Maintenance is primarily corrective with very little preventive maintenance.
- There is a lack of:
  - An effective preventive maintenance program.
  - A work order system for scheduling maintenance crews and activities.
  - Any buildings and grounds maintenance.
  - Maintenance procedures.
  - Proper tools and equipment.
  - Emergency procedures.
  - Formal training programs.
  - Performance standards to measure personnel effectiveness.
  - Experienced personnel.
  - Follow-up and inspection of work.
  - Spare parts.
- There is an excessive number of unskilled laborers.

3.1.6 Effectiveness

The effectiveness of the operation and maintenance of the waterworks and wastewater systems in Egypt has been constrained by a number of social and economic considerations:

- A drain of skilled labor to higher income Arab countries
- The difficulty of changing traditional habits
- Insufficient funds to operate effectively and maintain existing facilities
- Lack of planning
- Lack of attention and direction

3.1.7 Procedures and Methods

Both site visits and interviews revealed a lack of any formal methods or procedures for operations and maintenance. There are unwritten procedures covering record-keeping (operations log) reports and employee attendance forms. From observations of work practices at various facilities it was determined that the methods of performing the job functions are the result of a worker's traditional habits rather than a developed or recommended method. For areas such as operations and maintenance the need for formal procedures and methods development must be accomplished prior to any considerations of performance operation standards.

3.2 RECOMMENDATIONS

The recommendations covering the operation and maintenance functions for water and wastewater utilities may appear monumental. In reviewing the existing circumstances there are two phases for which the recommendations have been proposed. For the interim period, those which can begin now and establish the groundwork for measured improvement are proposed to

establish control. The long-term recommendations involve not only an improvement in and refinement of the interim recommendations but also allow the integration of operations into the new organizational structure for water and wastewater utilities.

3.2.1 Interim Period

During the period of transition until the new organizational structure selected has been implemented, the following series of recommendations are presented:

3.2.1.1 General. The following recommendations are applicable to all functional areas related to the operation and maintenance of water and wastewater systems:

*- Establish a clear definitive organizational structure for each plant in each of the utilities. Designate responsibilities and staff accordingly.

- Prepare job descriptions with requirements, functions, responsibilities, duties and minimum qualifications for all positions. (See Personnel Systems Report, Section 4.0.)

*- Establish and implement formal training programs for:

  . Skills.

  . Operations.

  . Management techniques.

  . Safety.

  . New technology.

  (See Personnel Systems Report, Section 6.0.)

*- Establish a program for analyzing existing methods

*- Establish a program for analyzing existing methods and establish goals for improvement. (See Exhibit 3.2.)

- Consider the initiation of an awards program including:

  . Best appearance.

  . Housekeeping.

  . Best operation.

  . Best safety program.

  (See Physical Assets Report, Exhibit 2.5.)

- Consider developing a facilities engineering capability at each facility. (See Exhibit 3.4.)

3.2.1.2 Operations. The following recommendations have been developed for operations:

- Identify labor requirements, skills and needs, and staff accordingly. (See Personnel Systems Report, Section 5.0.)

- Assign personnel specific functions, responsibilities, establish informal performance standards, monitor and evaluate.

- Develop operating procedures for key steps and complex activities. (See Exhibit 3.5.)

- Initiate training of the next generation of supervisors while experienced workers are still available. (See Personnel Systems Report, Paragraph 6.2.1.1.)

- Develop detailed job descriptions for each task. Estimate standards of performance for each position.

- Assign job numbers to each position for labor accounting and measurement of performance against standards.

- Develop an equipment improvement capability.

- Set goals and standards of achievement for trainees.

- Establish clear lines of authority, responsibilities and supervision.

- Institute a program to repair all inoperable instruments, controls and equipment.

*- Prepare operating instructions for each work station. See Exhibit 3.3.)

- Develop a process flow layout. Identify work centers, staffing and organization.

- Improve housekeeping capabilities, trash removal and overall facility conditions. (See Physical Assets Report, Paragraph 2.2.1.1 and Exhibit 2.5.)

- Improve communications between work centers, maintenance and plant management. (See Physical Assets Report Paragraph 6.2.1.)

- Establish expediter position for spare parts, parts shortages and chemicals.

3.2.1.3 Networks. The following recommendations have been developed for networks:

- Establish an organizational structure for each networks branch. Define the areas of responsibility, supervision, quantity and mix of crews, support functions and capabilities.

- Establish a job order and scheduling system for assignment, control, and follow-up on work being performed. (See Exhibit 3.6.)

*- Develop standard operating procedures, e.g., valve rotation.(See Exhibit 3.7.)

*- Establish standards of performance for network crews, maintenance and administrative personnel. (See Exhibit 3.8.)

- Develop a follow-up and inspection function to monitor work performance, quality, equipment and man-power utilization.

- Improve the existing communications system between network branches, headquarters, stores and treatment plants. (See Physical Assets Report, Paragraph 6.2.1.)

- Provide a communications system for branch network crews to allow communication between branches and field crews for emergencies, equipment and material requirements, follow-up and coordination. (See Physical Assets Report, Section 6.0.)

- Install an equipment disbursement system to identify the location of all major equipment at all times.

- Install a quick reference drawings system with drawings being filed by area and location with a cross-index file by region and street. (See Section 6.0.)

- Provide up-to-date, record drawings to insure that both accurate and effective information is readily available to field crews. (See Section 6.0.)

- Provide a procedure to revise existing drawings to reflect existing conditions, changes and/or errors. (See Section 6.0.)
- Develop a records and analysis section which reviews all work being performed, by type of work, frequency, nature and corrective action as the basis for projecting seasonal demands for labor and equipment utilization, major renovation projects and budget requirements.

*- Initiate preventive maintenance programs for all network equipment and develop equipment records.

- Evaluate policies concerning the reluctance of personnel to use tools and equipment because of liability for loss or damage.

- Institute a program for the periodic cleaning of sewers especially problem areas.

- Develop a program for routine inspection of lines to provide an early detection of leaks.

- Provide appropriate equipment to facilitate cleaning and line repair. (See Physical Assets Report, Exhibit 5.1.)

3.2.1.4 Laboratories. The following recommendations are made for laboratories:

- Attention should be given to prior consultants' reports concerning laboratory practices, equipment and requirements. A policy decision should be made to evaluate the laboratory requirements, and to furnish and provide an effective laboratory for each operating facility.

- Procedures should be prepared identifying required tests to be performed on a daily, weekly, monthly and annual basis. (See Management Information Systems Report, Section 4.0.)

- Training programs should be developed for laboratory assistants to increase their skills. (See Personnel Systems Report, Paragraph 6.2.4.4.)

- Procedures and instructions should be prepared for each test performed with personnel being trained in their use and application.

- Standard forms should be prepared for test reports and used throughout the utilities for ease of comparison and evaluation.

- Standard job descriptions should be developed among the utilities to allow flexibility and rotation of chemists among plants and utilities.

3.2.1.5 Maintenance. (Treatment Plants, Pump/Booster Stations).

- Install a job order system for scheduling and controlling maintenance work for corrective maintenance operations. (See Exhibit 3.9.)

*- Develop, implement and schedule routine preventive maintenance for all equipment. (See Exhibit 3.10.

- Initiate a major overhaul program for all the operating equipment. As the work load diminishes, transfer emphasis to deferred maintenance and preventive maintenance.

- Review maintenance functions and organizations for each treatment plant. (See Exhibit 3.11.)

- A major maintenance program should be initiated for the buildings and grounds of all facilities to halt currently accelerated deterioration. (See Physical Assets Report, Paragraph 2.2.1.2.)

- Create and equipment file for each piece of equipment. (See Exhibit 3.12.)

- Evaluate current maintenance needs, tools, materials, equipment and spare parts.

*- Establish formal training programs at various levels of experience and shills to insure fulfilling maintenance needs. (See Personnel Sytems Report, Paragraphs 6.14 and 6.2.3.)

- Together with Operations and Networks prepare and implement emergency procedures and instructions.

- Establish the use of labor standards in maintenance work. (See Exhibit 3.8.)

3.2.2 Long-Term

The following recommendations are related not only to the new organizational structure selected but also represent improvements of the interim recommendations.

3.2.2.1 General. For the water and wastewater utilities the following recommendations are applicable for both the new organization and existing utilities:

- Within the new organizations for water and wastewater utilities, a coordinating group consisting of operations, networks, maintenance and laboratories should be formed to ensure a smooth development and introduction of procedures, methods and resources. (See Organizational Environment and Structure Report, Section 6.0.)

- Establish an operations analysis capability within the new organization for both water and wastewater application. (See Exhibit 3.13.)

- Integrate water and wastewater utility training programs into a central comprehensive training capability. (See Personnel Systems Report, Paragraph 6.1.1.)

- Expand safety programs to include incentives for work centers, plants and utilities.

- Evaluate the feasibility of providing a centralized overhaul capability. (See Exhibit 3.14.)

3.2.2.2 Operations. After the recommendations for the interim period are implemented, the following improvements should be considered:

- Establish through operations analysis techniques standards for all labor functions and install an incentive system.

- Expand training for operators to new, more sophisticated types of equipment and processes. (See Personnel Systems Report, Paragraphs 6.2.4 and 6.2.5.)

- Analyze existing methods and procedures. Improve, revise and implement.

- Review and analyze current methods and procedures used in water and wastewater operations for standardization and refinement.

3.2.2.3 Networks. Improvements in the actions taken during the interim period would include:

- Under the new organizational structure establish a combined water and wastewater central network district for major equipment utilization and disbursement within each zone, e.g., Cairo. For the Greater Cairo area, the city might be split into four zones with each zone containing three networks branches and one central branch for major equipment.

- For combined water and wastewater organizations centralize communications systems and emergency dispatching.

- Review existing network branches for optimum logistical coverage.

- Centralize network equipment maintenance functions for both utilities.

3.2.2.4 Laboratories. Recommendations for consideration after the interim period are:

- A central research laboratory should be established for the new organizations to perform research, establish health standards, monitor environmental conditions and serve as the source of new laboratory procedures and instructions for water and wastewater plants.

- Consideration should be given to establishing on-the-job training for students in the chemistry departments of the Egyptian Universities.

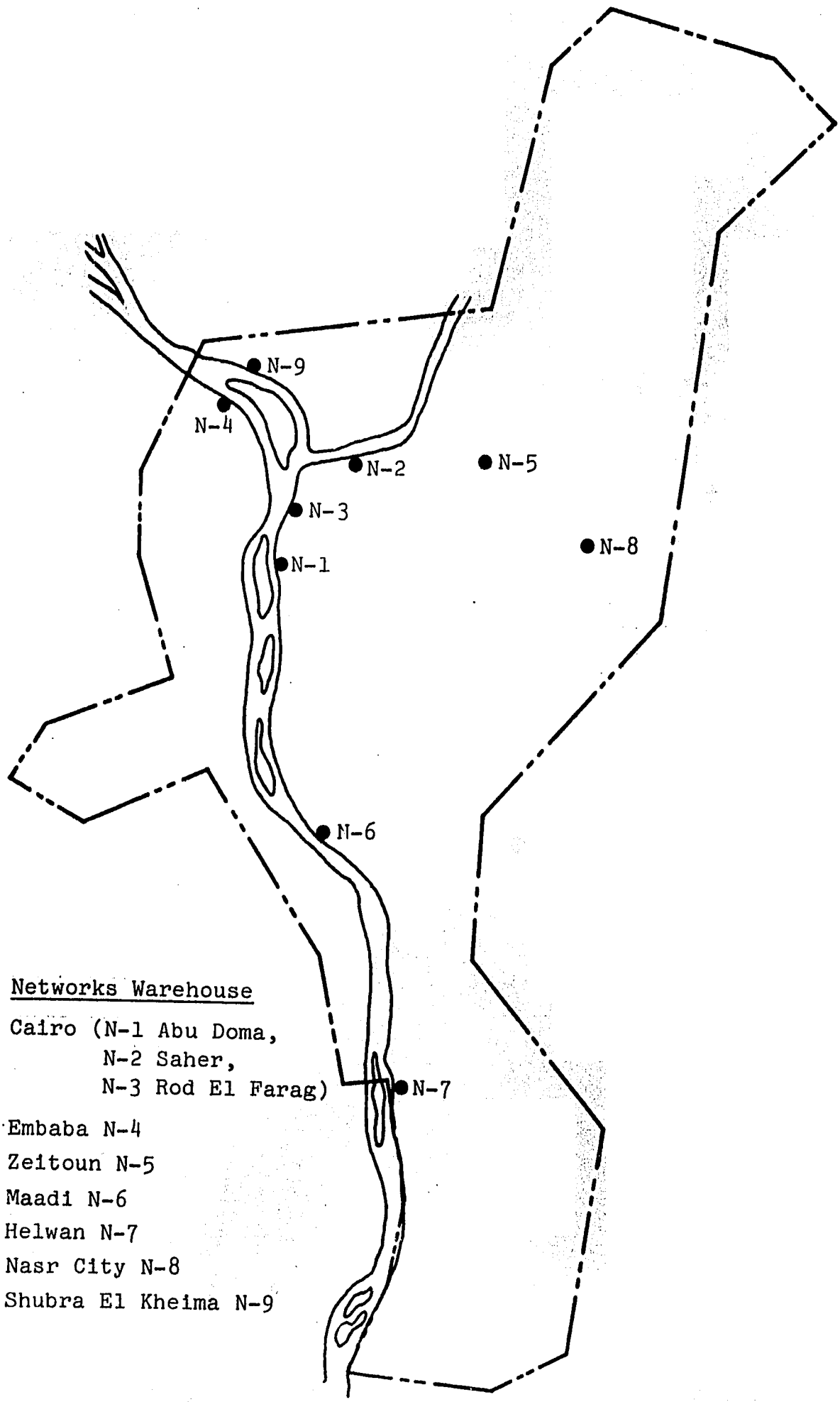
3.2.2.5 Maintenance. The recommendations for maintenance of treatment plants and pump/booster stations are:

- Under the umbrella of the new organization, maintenance practices and procedures should be reviewed for both water and wastewater utilities for optimum use of the most effective and efficient systems.

- Combine the physical assets inventory listing of parts, tools, and equipment for maintenance operations in water and wastewater utilities for optimum use.

EXHIBIT 3.1

GOGCWS NETWORK - BRANCH LOCATIONS



METHODS STUDY

The area of methods study has many names, such as methods analysis, methods engineering, methods research, work study and work analysis. It is defined as a systematic procedure for the analysis of work to:

- Eliminate unnecessary work.
- Arrange the remaining work in the best order possible.
- Standardize the usage of proper work methods.

As automation becomes more prevalent in the water and wastewater utilities the requirements for skilled operators increase. The objectives of eliminating unnecessary work and arranging the remaining work in the best order possible become important to utilize fully the skills of the available personnel.

Some basic steps inherent to a methods study of any operation are:

- Determination of goals. These could be general goals, such as cost reduction, increased productivity or the evaluation of a specific problem.
- Analysis of work. An effort should be made to gather as much information as possible about the work problem. Information is gathered through the breakdown of the work into common units and by obtaining data concerning other areas related to the problem.
- Selection of most feasible method. One method or group of methods which best fits the situation in which the work is performed should be selected.
- Formulation of methods design. The complete design of the method and the procedures needed to put the method into operation must be formulated.

METHODS STUDY

- Test of methods design. If it is possible to try out the proposed method, this should be done.
- Review of methods design. Assuming that all details and problems may not have been taken care of, it is advisable to re-examine all designs.
- Installation of the method. This step involves the training of those concerned with detailed procedures involved.
- Follow-up. There should be follow-up by the analyst to make certain the correct procedures and methods being used.

The solution of every methods study may vary slightly from one problem to another. If the review, test or even formulation shows that a design will not work, the analyst must return to the selection or the analysis step.

The analyst could be a supervisor, lead man, or some retired employee who has not only the experience but respect of his co-workers and the incentive to help.

STANDARD OPERATING INSTRUCTIONS

Each utility should form a group of experienced personnel, such as supervisors and engineers, that could prepare and implement standard operating instructions. These instructions consist of write-ups of established procedures for carrying out the various activities in the performance of certain kinds of work. Such write-ups constitute the system of the organization. The organization chart shows where a function is placed; an organization manual tells what the nature of the function is, and the standard operating instruction tells how a function is to be performed.

It is necessary to have such procedures written up not only for the guidance of employees performing the work and the training of new employees, but also to provide supervisors with a mechanism for reporting and control. For example, the procedures for employees' time sheet should cover not only recording employees' time on a job but should also be used for checking off completed work from an operations or maintenance schedule, the making up of the payroll, the correct distribution of charges of time to jobs to obtain current costs, the recording of data for future estimating and the posting of entries in the general accounts. The procedure for time sheets is only one of hundreds of items for which standard operating instructions are not only helpful but essential.

STANDARD OPERATING INSTRUCTIONS

After the organizations have established a process by which the standard operating instructions are being developed, the next step in the process would be the analysis of these instructions and procedures. Briefly, the analysis involves:

- Selecting the procedures to be improved.
- Obtaining and recording facts.
- Questioning each and every detail:
  - What is done? Why?
  - Where is it done? Why?
  - When is it done? Why?
  - Who does it? Why?
  - How is it done? Why?
- Developing new procedures. This requires the use of the four principal tools of methods improvement: elimination, combination, change in sequence and simplification.
- Applying the new procedure.

The analysis shown is identical to that used in a methods study (see Exhibit 3.2, Methods Study) and should be applied as a unified approach, not a duplication of effort.

Once the system for preparing standard operating instructions has been established, it must be reviewed periodically to ensure that the system is both effective and efficient.

FACILITIES ENGINEERING

The poor condition of utility buildings, grounds and support facilities appears to be the result of a lack of management attention and low priority rather than a shortage of resources. If the excess, low-skill workers that are observed at every facility were put to work cleaning up and repairing the buildings and support facilities and maintaining the grounds, their appearance and condition could be improved very quickly and economically.

Workers in a clean, orderly facility take more pride in their work and begin to recognize the importance of finishing each task. When someone has the responsibility for keeping the facility clean and orderly, he exerts pressure on the others to be more orderly about their work.

The majority of buildings and grounds work is such that unskilled workers can easily perform many of the required tasks with a minimum of instruction. Buildings and grounds work can be used as a form of on-the-job training for unskilled workers, but care must be exercised to prevent the buildings and grounds work force from being treated as a low status pool of common labor. Each worker should be assigned to a crew that has an on-going responsibility.

One of the inherent problems in the maintenance of buildings, grounds and support facilities is that mechanical and electrical engineers often have little interest in these support facilities. For this reason, a separate career called Facilities Engineering

FACILITIES ENGINEERING

has taken on increasing importance in recent years in industrialized countries. A Facilities Engineer should have a background in Civil Engineering or extensive experience in building construction. Advancement potential should be available to a Facilities Engineer either through increased responsibility for facilities or through movement into management positions within the utility.

A Facilities Engineer position should be established at each treatment plant and major pumping station, or groups of plants and stations, together with a similar position on the headquarters staff of each utility to provide technical coordination and guidance. The Facilities Engineer should report to the Plant Manager. Separate technical coordination should be established between the facilities engineering staff at each plant and the headquarters facilities engineering staff.

The Facilities Engineer should be assigned responsibility for maintenance of:

- Buildings.
- Housing.
- Grounds.
- Housekeeping.
- Roads and surfaced areas.
- Walls and fences.
- Site irrigation and drainage.

FACILITIES ENGINEERING

All personnel assigned to perform functions for which the Facilities Engineer has responsibility should be under his supervision and control.

A program of awards should be established by each utility's management to recognize the best maintained facility. An awards program would create a spirit of competition between the facilities engineering staffs and provide a worthwhile objective.

Several additional responsibilities could be assigned to the Facilities Engineer. They are not included in the previous list because they could dilute attention from the primary housekeeping and building repair activities.

- In-house utilities. These house-service or utilities are more like residential or commercial service and have little relationship to the plant process:

  - Water supply. Water for drinking, toilet flushing and similar uses is usually supplied from the potable water system which should be kept repaired.

  - Potable water is also used to seal pumps and is probably used for water-cooled motors. These are high-volume, process-related uses that should be separated from potable water use.

  - Water for filter washing should not be included in plant production.

  - Hoses used for basin wash-down are often connected to the potable supply because the water is at higher pressure. This is a poor practice that should be discouraged. Basin washing should be supplied from a separate system or from the same system that supplies seal water and motor cooling water

  - Sanitary sewage. The small sewers serving toilets and sometimes floor drains should be connected to the head end of the plant.

FACILITIES ENGINEERING

- Low-voltage electricity. Lighting and other low-voltage power can be assigned to the Facilities Engineer since a different class of electrician is used.

- Ventilation. Fans, particularly low-voltage, could be maintained by facilities engineering.

- Telephone. Telephone facilities could be placed under the jurisdiction of facilities engineering, particularly if low-voltage electricity is also included.

Placing in-house utilities under facilities engineering means that pipe fitters and electricians should be included on the facilities engineering staff as well as competent supervisors for those skill

- Security force. Each plant has assigned guards for security purposes. The guards could come under the supervision of the Facilities Engineer.

- Emergency power. The Facilities Engineer could be given responsibility for operating the emergency power facilities, but their operation and maintenance are mechanical and electrical and seem more closely related to process equipment.

- Machine shop. Since the primary purpose of the machine shops is to support maintenance, it appears most logical to have the machine shop assigned to maintenance.

- Sanitary landfill. Every plant probably should have a small sanitary landfill for disposal of trash. Since trash disposal should ordinarily come under facilities engineering, it would be logical to include operation of on or off-site sanitary landfills as a responsibility of the Facilities Engineer.

- Minor construction. Since the same type of skills are required for minor construction and facilities engineering, there is a strong rationale to combine the two activities. Nevertheless, since so much should be done, it would be unwise to dilute the efforts of the Facilities Engineer on minor construction.

(See the Physical Assets Report, Exhibit 2.4, for further discussion of Facilities Engineering.)

OPERATIONAL PROCEDURES

The best way to develop operational procedures is for the manager of the facility to develop and continuously review, revise and refine them. They should be in written form and reproduced for use by operating personnel. Office copying equipment is an appropriate method of reproduction since the number of copies required is small. Ring binder filing is suggested so that revised pages can be readily inserted.

The original designer can and should prepare a manual of how the facility should be operated, but the designer's concept must be modified on the basis of operating experience. Since both operational objectives and the method of operation may change with additional loads and changes in the system, operating procedures should be revised as needed. If the operating procedures are not kept up-to-date, they soon become virtually worthless.

Technical literature and periodicals in the USA and other countries provide considerable guidance for plant managers in developing better operational procedures. A translating service should be established to translate helpful materials into Arabic. A good method of distributing this material is a newsletter that could be published monthly with personal copies for all technical personnel. Similar translating and newsletter publishing would be desirable for training, maintenance and laboratory personnel. Perhaps a single service could support all of these activities.

OPERATIONAL PROCEDURES

Locating such translating and publishing activity near the library or near an engineering college can facilitate joint use of references, equipment and personnel.

Activities for which written procedures should be developed include:

- Water Treatment
  - Pump start-up and shut-down
  - Filter washing
  - Chemical feeder adjustment and calibration
  - Flow meter reading and calibration
  - Changing chlorine cylinders
  - Safety measures around chlorine supplies and equipment
  - Inoperative clarifier mechanism
- Wastewater Treatment
  - Pump start-up and shut-down
  - Operation and cleaning of screens
  - Grit removal
  - Flow meter reading and calibration
  - Stoppage in sludge piping
  - Inoperative clarifier mechanism

OPERATIONAL PROCEDURES

- Emergency Procedures: Water and Wastewater Treatment
  - Loss of electric power
  - Line break or stoppage in major sewer
  - Line break in major transmission line
  - Loss of cooling water
  - Major fire in the city
  - Fire in the plant or station
  - Explosion in the system
  - Gasoline or fuel oil in the sewers
  - Shortage of chlorine gas
  - Leak in a chlorine cylinder or piping

NETWORK MAINTENANCE - JOB ORDER SYSTEM

Effective network maintenance results from the effective assignment of work which is based to a large extent on records of past work done. The record of each job performed is the basis of maintenance control. Consequently, the cardinal rule is that no network maintenance work should be done without a written job order or work ticket. In case of an emergency, a man may be sent to the job by verbal instructions, but a covering order should be issued promptly.

Job orders may originate from each network branch for:

- Prescribed regular inspection and routine maintenance as well as the maintenance requirements uncovered by inspection.
- Operating plant requests for maintenance or repair work.
- Requests initiated by management, operations or engineering departments.
- Customer complaints.
- Emergency requests.

All work should be cleared and scheduled by a single authority, who may be the networks branch manager or his delegate.

Maintenance job orders may be either of a specific type involving a specific job or of a blanket type for emergency use and more routine network maintenance jobs. A typical network job order for either routine or emergency work is shown on Page 3. The form provides space for the type of work requested, location of the requested work, time of the request, space for a sketch or additional information, the crew assigned and the

NETWORK MAINTENANCE - JOB ORDER SYSTEM

time of their dispatch to the job. Upon completion of the job, the order is returned to the network branch listing the crew, hours worked, material used and a description of the work or corrective action performed.

Once the job order is assigned to a crew, the job order number should be entered on a schedule board showing the crew designated. The job order copy itself could be posted next to the schedule board which permits the scheduler, at a glance, to know if each crew is assigned and their location. On completion of the work, the completed job order is returned by the crew leader to the scheduler who checks it for completeness and notes on the schedule board the crew's availability.

Not only can the job order be used for scheduling of maintenance work but it also could serve as a form on which network maintenance costs can be collected, providing a running record of the status of network maintenance. When the job order is completed, the maintenance performed and inspected, it becomes the basic record from which network maintenance costs can be developed and supplies the financial data needed for formal accounting, planning and control reports.

NETWORK JOB ORDER

Order Number _____

Date Received _____ Requested By _____

Location _____

☐ Inspect ☐ Replace ☐ Service ☐ Repair ☐ Overhaul ☐ Emergency

Work Description _____

Sketch (Or Additional Information) _____

Work Performed/Comments _____

Shift Operator _____ Maintenance Superintendent _____

Crew Assigned _____ Time _____ Date _____

Personnel Assigned	Manhours	Date	Work Done	Parts and Materials
Total				

Work Completed By _____ Time _____ Date _____

Work Inspected By _____ Time _____ Date _____

EXHIBIT 3.7

VALVE ROTATION

In Egypt there is a variety of valves. Some rotate clockwise to open; others rotate counterclockwise. Each utility system should adopt a standard rotation (in the USA counterclockwise is used to open) and should retire from service as replacement is necessary, all valves that rotate in the wrong direction. In the interim all non-standard rotation valves should have operating nuts or wheels painted a distinctive color, e.g., orange, so that utility personnel will know rotation is non-standard.

LABOR STANDARDS FOR MAINTENANCE

To keep operating costs and expense at a minimum maintenance must be considered, both for networks and plant operations. It is important that pipelines, buildings, equipment and grounds be kept in good condition if treatment costs and interruptions to service are to be minimized.

Maintenance is one of the more difficult types of expense to control due to the varied nature of the work and the scattered locations where it is performed. It can be accomplished by establishing standards of work measurement, by careful planning before starting any job, by the increased use of preventive maintenance and by good control of all phases of the activity.

While there have been important developments in the applications of measured standards for maintenance work in the developed countries, the factors essential to its success are lacking in Egypt. These factors are:

- Proper organization of work.
- Properly developed work standards.
- A qualified standards applicator.
- Adequate training of the maintenance work force.

There are other successful methods which can be used by the utilities to establish the basis for workable maintenance work measurement programs. These require the following elements:

- Develop accurate time estimates for each type of work performed by the maintenance department.
- Establish standard work groups.
- Establish bench-mark jobs.

LABOR STANDARDS FOR MAINTENANCE

The foundation for any labor control system must start with a basic approach. The experienced Egyptian personnel at the treatment plants and network branches can initiate these necessary basic steps to implement labor control for measuring performance and effectiveness. These steps are:

- Detail the job or work to be performed.
- Estimate the labor and time required to perform the job.
- Review the estimate against actual time and develop a variance for future estimates.
- Continue to estimate and review until actual performance reaches 95%-105% of the standard.
- Review existing methods and procedures for improvements, measure performance and develop a justification for improvement.

This methodology can form the basis for estimating jobs, determining standards of performance, manpower planning, scheduling of maintenance and network work crews, forecasting manpower requirements and budgeting.

MAINTENANCE JOB ORDER SYSTEM

The maintenance job order system while similar to the network maintenance job order system, Exhibit 3.6, is different in its application and controls. An effective maintenance program requires the written assignment of work and is dependent to a large extent on records of past work done. The record of each job done is the basis of maintenance control. Hence, the cardinal rule is that no maintenance work should be done without a written job order or work ticket. In case of an emergency, a man may be sent to the job by verbal instructions, but a covering order should be issued promptly.

Job orders may originate from:

- Prescribed regular inspection and routine maintenance as well as maintenance requirements uncovered by inspection.
- Operating department requests for maintenance or repair work.
- Changes initiated by management, operations or engineering departments.

All work should be cleared and scheduled by a single authority, who may be the Plant manager or his delegate.

Maintenance job orders may be either of a specific type involving a specific project or of a blanket type for repeated use and more routine maintenance jobs. A typical maintenance job order for routine, general work is shown on Pages 3 and 4. The form provides space for a brief description of the work requested, the person requesting the work, the location and asset number of the

MAINTENANCE JOB ORDER SYSTEM

equipment to be worked on, whether planned or emergency maintenance, job order numbers for control purposes, accounting, and similar data which can be varied from utility to utility.

Not only does the job order initiate work requests but, after being given a priority rating, it is used for scheduling of maintenance work, serves as a form on which project costs can be collected, and provides a running record of the status of maintenance-in-process. When the work order is completed, the maintenance performed, it becomes the basic record from which maintenance costs on each item of equipment can be developed and supplies the financial data needed for formal accounting, planning and control reports.

MAINTENANCE JOB ORDER SYSTEM

Sample Job Order

Order Number _____

Planned ☐ Emergency ☐ | Date Received _____

Equipment Item _____ | Asset Number _____

Location _____

Work Required _____

Requested By _____ | Assigned To _____

Labor					Parts and Supplies		
Date	Name	Hours	Rate	Cost	Quan.	Description	Cost
Total Labor Cost					Total Parts Cost		

Total Cost _____

Work Completed _____ (Date) By _____ (Signature)

MAINTENANCE JOB ORDER SYSTEM

Sample Job Order

Order Number 25500

Planned ☐ Emergency ☒ Date Received 3/27/79

Equipment Item Raw Sewage Pump Asset Number 22511

Location North Fairfax Pumping Station

Work Required Repack Pump

Requested By S. Johnson Assigned To L. Stokes

Labor					Parts and Supplies		
Date	Name	Hours	Rate	Cost	Quan.	Description	Cost
3/28	L. Stokes	2	LE 2.50	LE 5	1 M.	15 mm. Asbestos Packing	LE1.25
Total Labor Cost				LE 5	Total Parts Cost		LE1.25
					Total Cost		LE6.25

Work Completed 3/28/79 (Date) By L. C. Stokes (Signature)

PREVENTIVE MAINTENANCE

Utilities cannot afford to ignore equipment until it breaks down, unless standby equipment is available. This is the most expensive type of maintenance because it sometimes shuts down equipment when most urgently required and it usually costs far more than planned repairs.

Preventive maintenance locates potential sources of trouble and corrects them before a breakdown occurs. Preventive maintenance can avoid trouble through proper oiling, cleaning, greasing and adjusting. The purpose is to maintain equipment in its optimum condition and effectiveness.

An effective preventive maintenance program should include:

- Systematic inspections. Key equipment should be inspected at established intervals. Potential problem areas must be checked so that necessary job orders may be initiated and repairs made. The aim of preventive maintenance inspections is to find something wrong, not something right.

- Systematic repair procedures. It is not enough to have the preventive maintenance inspection locate potential trouble, but there must also be a concerted and coordinated effort to schedule corrective action for the problems. This is not as simple as it seems. The tendency is to ignore whatever is not actually causing a problem. For this reason, there must be top-level understanding and support of the preventive maintenance program.

- Systematic servicing. Routine maintenance and service operations such as lubrication, and cleaning filters and traps must be scheduled and accomplished if preventive maintenance is to be effective. (See Pages 2-5 for a sample lubrication schedule and check list.)

- Systematic follow-up. An appraisal of inspection frequencies and methods should be made. In addition, a continuing evaluation of the costs of maintaining the system versus savings in breakdown repairs must be made.

PREVENTIVE MAINTENANCE

Lubrication Schedule

Date Prepared _____ Location _____

Item Number	Description	Frequency	Lubricant or Equivalent

Frequency Legend

D	Daily	S	Semiannually
W	Weekly	A	Annually
M	Monthly	OO	Hours of Operation
Q	Quarterly	V	Variable depending on use

PREVENTIVE MAINTENANCE

Sample
Lubrication Schedule

Date Prepared January 1975 | Location Giddings Avenue Plant Headworks Building

Item Number	Description	Frequency	Lubricant or Equivalent
1	Apply grease to teeth of spur gear on end	W	Texaco Crater
	of drive shaft with brush or paddle		Compound No. 1
2	Grease drive shaft bearings through	W	Texaco Nova
	pressure gun fittings		No. 1
3	Grease rake pivot hubs through pressure	W	Texaco Nova
	gun fittings		No. 1
4	Apply oil to roller shafts and limit	W	Machine Oil
	switch pivot pins		
5	Apply water proof grease to inside	Q	Dow Corning
	surface of channel guides		DC 44 Silicon
6	Wip wire ropes with waterproof grease	Q	Dow Corning
			DC 44 Silicon
7	Repack motor bearings per Westinghouse	A	Texaco H. Temp
	instructions		
8	Check oil level in worm gear speed	W	Texaco
	reducer and add oil if necessary		650 T Cyl. Oil
9	Change oil in worm gear speed reducer	2500	Texaco
			650 T Cyl. Oil
10	Grease speed reducer shaft bearings	Q	Texaco Nova
	through pressure gun fitting		No. 1
11	Grease Falk-coupling with pressure gun	A	Texaco Marfale
			H.D. No. 2

Frequency Legend

D	Daily	S	Semiannually
W	Weekly	A	Annually
M	Monthly	OO	Hours of operation
Q	Quarterly	V	Variable depending on use

PREVENTIVE MAINTENANCE

Lubrication Check List

Year _____ Location _____

Equip	No	Lubrication Item	Freq				

Frequency Legend

D	Daily	S	Semiannually
W	Weekly	A	Annually
M	Monthly	OC	Hours of operation
Q	Quarterly	V	Variable depending on use

Instructions

1. Place "X" mark opposite week lubrication is performed.
2. For additional information, see manufacturer's instructions.
3. See lubrication schedule for proper lubricant.

PREVENTIVE MAINTENANCE

Sample Lubrication Check List

Year _____ Location _____

Equip	No	Lubrication Item	Freq	JAN 3	JAN 10	JAN 17	JAN 24	JAN 31	FEB 7	FEB 14	FEB 21	FEB 28	MAR 7	MAR 14	MAR 21	MAR 28	APR 4	APR 11	APR 18	APR 25
Comminutor	1	Comminuter Proper	W	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	2	Extension Bearing	W	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	3	Gearbox Oil Level	W	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	4	Gearbox Oil Change	2500														X			
																	X			
	5	Motor Upper Bearing	A	X																
				X																
	6	Shaft Joints	A	X																
				X																
Sewage Pumps	1	Pump Bearing	Q	X													X			
				X													X			
	2	Motor Top Bearing	Q	X													X			
				X													X			
	3	Motor Lower Bearing	A														X			
																	X			
	4	Flexible Shaft Joints	A														X			
																	X			
	5	Shaft Steady Bearing	A														X			
																	X			
Scum Pumps	1	Motor Bearings	Q	X													X			
				X													X			
	2	Pump Thrust Bearing	M	X					X				X				X			
				X					X				X				X			
	3	Shaft Seal	M	X					X				X				X			
				X					X				X				X			
	4	Shaft Sleeve Bearing	W	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

X Planned ✗ Actual

Frequency Legend

D	Daily	S	Semiannually
W	Weekly	A	Annually
M	Monthly	OO	Hours of operation
Q	Quarterly	V	Variable depending on use

Instructions

1. Place "X" mark opposite week lubrication is performed.
2. For additional information, see manufacturer's instructions
3. See lubrication schedule for proper lubricant.

MAINTENANCE DEPARTMENT ORGANIZATION

The need for organizing maintenance work to prevent interruptions of operations is the result of several factors:

- Increased mechanization and automation. While decreasing direct labor costs per output unit, mechanization and automation have required an increase in the maintenance of equipment.
- Disruptions to service. Breakdowns in a utility service could cause serious consequences in terms of health and welfare.
- Cost of repairs. When major elements of an operation break down the cost of an emergency repair can be large when compared to routine maintenance.
- Operation costs. Basic costs of operating treatment plants can be reduced by maintaining the efficiency of equipment, the quantity and quality of treatment.
- Planning of maintenance. This can ensure that needed spare parts are available without excessive accumulation of obsolete material and that optimum manpower utilization can be realized.

With the kinds of maintenance tasks being highly variable from day to day, a maintenance organization must be kept flexible. No ready-made system can be imposed on an individual plant. Despite the variations in detail, certain general considerations are appropriate:

- Size and control of maintenance force. A primary requisite for adequate maintenance is sufficient men, but not an excessive number, of each craft to meet the demands under peak loads.
- Planning of work. A system must be established to provide an orderly and economic disposition of maintenance manpower to meet current requests and routine needs.
- Daily issuance of job orders. A job order system should be established and a control mechanism installed.

MAINTENANCE DEPARTMENT ORGANIZATION

- Standard operating instructions. Routine operating and maintenance procedures should be developed and used.
- Spare parts and tools should be provided for effective and economical maintenance operations.
- Inspection methods and schedules should be developed for an effective preventive maintenance program.
- Maintenance records should be developed for each asset for the purpose of entering all details of maintenance on equipment.

From the considerations for maintenance, a system must be adapted to each plant's needs and capabilities. The principal objective of maintenance is to anticipate and prevent interruptions and keep equipment in condition for high efficiency performance.

EQUIPMENT FILES AND PROCEDURES

Each piece of equipment should have a separate file by asset or control number which contains:

- Installation instructions.
- Lubrication instructions.
- Procedures for dismantling and reassembling.
- Parts lists and repair order instructions.
- Operating instructions.

Any maintenance procedures for a particular piece of equipment should be in accordance with the manufacturer's recommendations and a copy should be maintained in the file.

In order for a maintenance procedure to be effective, four basic points must be followed:

- Be thoroughly familiar with the equipment.
- Have available and be familiar with the proper tools needed.
- Use correct spare parts.
- Plan ahead.

OPERATIONS ANALYSIS

The procedure of operations analysis, including the design or improvement of an operation, work measurement and job standardization, is divided into the following steps:

- Preliminary analysis. Analysis and recording of existing conditions or proposed changes as to the process, equipment materials, workplace layout, methods and costs as well as limitations in the availability of resources such as capital, space and labor.

- Description of operation. Breaking the operation down into defined functional or motion elements to describe the existing or proposed method.

- Detailed analysis. Critical study of the elements of the operation to determine which ones may be eliminated or improved, including methods, tools, equipment, materials and layout.

- Work measurement. Analysis of the time consumed by productive and non-productive elements of an existing or proposed operation.

- Synthesis. Integration of improved elements into alternative operations design.

- Evaluation. Selection of the best alternative in terms of such specific criteria as unit time, costs and space required.

- Job standardization. Standardization of methods, job conditions and unit production times by reducing them to some form of written standard practice.

- Installation. Planning and executing the introduction and installation of new methods, including the training of the operator to perform the task in the manner and time specified.

- Control. Maintenance of standardized working conditions, equipment, methods, materials and standard times, including a method of detecting deviations.

OPERATIONS ANALYSIS

It is important to note the similarity in procedures between operations analysis and methods analysis, (See Exhibit 3.2). To differentiate between the two, operations analysis is applied to a specific job or operation whereas methods analysis looks at a specific part of the job or operation, and the types of data required by each analysis are different.

CENTRALIZED OVERHAUL

For standard items like pumps and motors a central overhaul facility should be developed in place of the dispersed, relatively inactive machine shops. A practice of changing an entire unit rather than overhauling in place should be adopted. This will minimize time out-of-service, facilitate removal of non-standard units from service and will make possible better repair versus replacement decisions. Another advantage is a reduction in the number of machinists required at plants and pumping stations and a more uniform work load for those assigned to central overhaul facility.

A central overhaul facility could also manufacture spare parts that are not obtainable and could improve components that have a poor performance record. Some engineering resources should be assigned to the central overhaul facility to assist in development of better components and in designing interface devices.

4.0 BILLING AND COLLECTING

This Section reviews existing practices, primarily of the water utilities, related to billing and collecting, including:

- Meter reading practices.
- Meter testing.
- Rotating or replacing meters.
- Meter repair.
- Billing procedures.
- Collections.
- Effectiveness of collections.
- Account policies.

4.1 FINDINGS AND CONCLUSIONS

The review of the water utilities visited resulted in the following observations: (For a more comprehensive discussion of metering practices, see the Water Utility Tariffs Report, Section 14.0.)

4.1.1 Meter Reading Practices (See Exhibit 4.1)

Observations at several utilities revealed the following practices:

- Meter readers receive on-the-job training.
- Meter books are permanently bound with hard covers.
- The sequence of pages does not necessarily reflect the sequence of route.
- Meter readers should report defective or damaged meters but it appears many do not.
- The quantity of accounts varies with each meter book. Some contain twice as many accounts as other books.

- The utilities generally alternate meter readers and their routes.
- Meter routes take from a few hours to over a week to cover.
- The meter reading assignment schedule is prepared monthly by some utilities.
- Consumption of water is reviewed by the Meter Reading Department prior to release of the books to the Revenue Department for billing.
- Meters are read every month by some utilities and every two months by others.
- There is no formal training program.
- There is a lack of written procedures or instructions.

4.1.2 Meter Testing

At the utilities where meter testing is performed, it was observed that:

- Only the meters being repaired are tested.
- The equipment for testing is old and its accuracy is questionable.
- Variable flow adjustment is not available on most test equipment.
- There are no field tests performed on meters.
- There is no established meter testing program.
- There are no established procedures or instructions for meter testing.
- There are no procedures for control and record-keeping.

4.1.3 Rotating or Replacing Meters

Discussions concerning the practices of rotating or replacing meters revealed that:

- There is no formal program for meter rotation or replacement.
- Meters are replaced only when defective or damaged.
- There are no plans for rotating or replacing meters.

4.1.4 Meter Repair

In reviewing the meter repair facilities the following observations were made:

- Most meter repair facilities are adequate in physical size for routine maintenance and repair work but lack efficient layout and work flow.
- Repair and test equipment is antiquated and in need of replacement.
- Record-keeping in most utilities is adequate and contains basic data and information.
- There is no meter repair performed in Ismailia, only replacement. A meter test capability exists but is not used.
- Only inoperative meters are repaired. There is no preventive maintenance or periodic testing.

4.1.5 Billing Procedures

The procedures followed by the utilities in their bill preparation include:

- Billing frequency may not be the same as the meter reading frequency as shown in Table 4.1:

TABLE 4.1

FREQUENCY OF BILLING AND METER READING

Utility	Frequency	
	Billing	Meter Reading(1)
GOGCWS	Two months	Two months
AWGA	Two months	Monthly or two months(2)
SCA	Quarterly or Semi-annually(2)	Monthly

Notes: (1) If done.
(2) Depending on type of customer.

- Bill preparation is initiated on receipt of meter books.
- Each account reading is checked and the consumption information is transferred, manually by some utilities and semi-automatically by others, to the billing ledger.
- Extensions are made by the Billing Department for the usage and the bill amount is computed (both manually and with automated equipment).
- Bills are then prepared. Some utilities use automatic equipment, others use semi-automatic equipment.
- Collection summary lists are then prepared and checked against the details in the meter billing books to ensure that the proper discount has been applied and is accurate.
- On completion of the summary list, statistical data is extracted for record purposes.
- Bills are checked against the collection list for price, legibility, format and errors.
- Bills are then stamped with a special stamp to prevent the possibility of unauthorized bills.
- Government accounts and special accounts are normally handled manually.
- There are no written instructions or procedures covering the bill preparation procedures.

4.1.6 Collections

The practices followed by the utilities in handling their collections are:

- Bills and summary lists are distributed to collection departments in various branches.
- Each branch has collectors and collection chiefs.
- The collection chiefs check bills against summary lists to insure receipt of all bills.
- Bills are issued to collectors with a summary list for collection.
- The collector may make up to two visits to collect.
- Should the collector fail to obtain monies due on the second visit a printed request is left notifying the customer to pay at the branch office within ten days.

- Some collectors operate on a bonus system for collections per day.
- Each day the collector completes a report on the details of his collections.
- There are no written instructions or procedures for collections.

4.1.7 Effectiveness of Collections

An analysis of collections versus billings was made for GOGCWS and indicated the information shown in Table 4.2:

TABLE 4.2

COLLECTIONS AS PERCENT OF BILLINGS - GOGCWS

	1975	1976	1977
Individual Accounts	94%	99%	95%
Government Accounts	72	59	56
Heliopolis	50	55	47

As the data indicate, the collection performance for GOGCWS is very good for their individual accounts. The Government accounts reflect the restraints of dealing with any government organization and the inability to exercise the same enforcement policies, i.e., cut-off and removal of meters. With Heliopolis the situation reflects a policy difference between GOGCWS and Heliopolis, not the inefficiency of collections.

For AWGA the overall collection effectiveness has declined in the last five years. A review of billings as a percent of collections revealed the information shown in Table 4.3:

TABLE 4.3

TOTAL COLLECTIONS AS PERCENT OF BILLING - AWGA

1973	1974	1975	1976	1977
65%	62%	62%	58%	51%

Data by individual account was not available for the entire period but the trend is a consistent decline in all accounts.

In general the policies and procedures used for collections, while not formally documented, are effective for individual GOGCWS accounts. For AWGA the overall collection system requires a detailed analysis to develop an effective system to correct the deficiencies.

For the Suez Canal cities, a war zone, a general exemption from collections had been in effect for a number of years. Although this exemption has been rescinded, insufficient data are available to assess the effectiveness of collections.

4.1.8 Account Policies

Policies for adding or discontinuing accounts were found to be generally uniform among the water utilities.

- Adding accounts. Added accounts may be either new or renewed. Exhibit 4.2 shows the typical process for new or renewed connections.

- Discontinuing accounts. An account may be discontinued by request of the customer or as the result of an unpaid water bill. The most frequent circumstance for discontinuing service is the unpaid bill. Exhibit 4.3 shows the current process for discontinuation of service.

- Evaluation. The procedures for connection and disconnection of service for all utilities are effective but the number of steps in the process consumes more time than necessary. The customer for a new connection may be required to visit the office three times to fulfill the requirements for contract preparation. Delays in new connections apparently range from a few days to as long as a year in some districts. Meter disconnection is being given priority and is occurring within a day or so of the notice being issued.

- The apparent emphasis on disconnections over new connections is favorable from the standpoint of revenues, but may be creating negative public relations as well as possible public health hazards.

4.1.9 Effectiveness

The operational effectiveness of billing and collecting, including meter reading and maintenance, is summarized in the following paragraphs:

- Meter reading. Field observations indicated that some meters have not been read for long periods of time. Many were found buried or in a condition that precludes them having been read for months or even years. With the number of inoperative or damaged meters not having been reported it would appear that the readers are not performing as effectively as they could or should be. As a result there is a lack of confidence in meter readings as a basis of determining water usage. There are two basic needs:

  - Locating each meter and obtaining precise information which will require an extensive program of improvement.

  - Metered service for every account.

- Testing, repair, rotating or replacement of meters appear to lack any emphasis or concern by management. Previous consultants' reports as well as this Study have shown more than half the meters installed are either damaged, under-registering or inoperative with no apparent program or effort to correct these faults.

- Billing procedures:

  - Bill preparation. The procedures followed appear to be labor intensive and slow. The number of checks performed in the process are required due to the number of manual operations and resulting errors.

  - Bill collections. Collections from the private sector are excellent by most standards for GOGCWS. The lack of detailed information for AWGA prevented an effective analysis. Governmental problems are more policy oriented, as is the case with large public accounts, and do not reflect on the collection mechanism. Nevertheless, action at the appropriate level must be initiated to reduce the current outstanding accounts.

    Bill collection should continue to be separate from meter reading because of the inherent conflict in the two functions.

  - Adding and discontinuing accounts. For new or renewed accounts the process is slow and involves many more steps than necessary. While the procedures take from a few days to a month, the actual installation may take up to a year in some districts. The discontinuing process is relatively quick and effective.

4.1.10 Procedures and Methods

Existing conditions reflect practices started when the utilities were established many years ago. Little attention has been focused on either the method of performing the job or on written instructions or procedures covering the functions and responsibilities.

4.2 RECOMMENDATIONS

Each functional area has been reviewed for the interim period, that is, those recommendations which should or could be accomplished in the near-term. Long-term recommendations concern the improvement of interim recommendations together with those brought about by the new organization to be selected.

4.2.1 Interim Period

Recommendations for the existing utilities include:

4.2.1.1 Meter reading. (For further discussion, see the Water Utility Tariffs Report, Paragraph 14.2.2.)

- Indoctrination training should be provided to meter readers on the types of meters being read, proper meter reading methods and responsibilities of meter reading. (See the Water Utility Tariffs Report, Paragraph 14.2.2.)

- Meter routes should be reviewed to establish routes that are consistently equal in the number of accounts and/or the time required to complete a route schedule. (See the Water Utility Tariffs Report, Paragraph 14.2.2.

- The current practice of printing permanently bound meter books should be replaced with the use of ring binder books for ease of maintenance, control and cost reduction. (See the Water Utility Tariffs Report, Paragraph 14.2.2.)

- Columns should be added to the account page form for notations on reporting damaged meters, non-registering meters and inability to gain access for reading. This allows ease of recording notes concerning any of these circumstances. During the check performed by the meter reading department appropriate action could be generated with job orders, letters and a follow-up file to ensure action being accomplished. The follow-up file can serve the dual function of checking on problem areas and providing a record of action taken.

- Estimates of water usage by accounts for which a reading was not available should be made by someone other than the meter reader.

- A special page should be included for special notes in the ring binder meter book. At the end of each day, it could be transmitted to the New Accounts Department to check for buildings where no meter is installed or for which no meter reading page is included in the route book. (See Water Utility Tariffs Report, Paragraph 14.2.2.)

- The practice of rotating the meter readers should be continued and a log maintained on the total time taken to accomplish each meter reading route. Statistics should be reviewed for the application of averages and range-of-time techniques of applied work measurement. (See Water Utility Tariffs Report, Paragraph 14.2.2 and Exhibit 4.4.)

random inspections should be performed by the audit and inspection teams from headquarters. (See Water Utility Tariffs Report, Paragraph 14.2.2.)

- Each month the meter reader supervisor should take the meter book of one of the readers on the day after the route is completed, and spot check the readings for accuracy, omissions and problems.

- Consideration should be given to establishing a bonus or incentive system for the meter readers in all utilities.

- In conjunction with the training program formal methods and procedures should be developed and issued to each meter reader in the form of a manual.

4.2.1.2 Meter testing. (For further discussions, see the Water Utility Tariffs Report, Paragraph 14.4.)

- The meter maintenance program should be initiated as recommended in the Report on Water Utility Tariffs.

- New meters should be tested prior to being placed in service.

- Existing record-keeping practices should be continued and procedures developed.

- Test procedures should be developed for each meter test facility for each range of meter sizes. (See Exhibit 4.5.)

4.2.1.3 Rotating or replacing meters. (For further discussion, see the Water Utility Tariffs Report, Paragraph 14.2.4.)

*- Recommendations presented in the Report on Water Utility Tariffs should be followed.

- The general guidelines for rotating or replacing meters, as presented in the Report on Water Utility Tariffs should be formalized in a procedure and implemented.

4.2.1.4 Meter repairs.

- Recommendations for the meter repair functions are covered in the Report on Water Utility Tariffs, Paragraph 14.4.)

4.2.1.5 Billing procedures.

*- Recommendations concerning the billing process as presented in the Data Processing Report should be implemented to improve the efficiency and effectiveness of the bill preparation systems.

- The existing collection process for private customers of GOGCWS should be continued and corrective action taken for AWGA. As data become available for the Suez Canal cities, the effectiveness of their collections should be reviewed.

*- Steps should be taken to reduce the accounts receivable balance currently outstanding with Government accounts and public agencies through vigorous collection efforts.

*- Action should be taken to correct any policy differences which affect current outstanding accounts with large public and private customers.

- The recommendations of the Water Utility Tariffs report, Paragraph 4.2.2 concerning billing frequency should be followed.

- Metering practices, as established in the Report on Water Utility Tariffs, Section 14.0 for a phased meter installation program for large industrial and commercial customers, should be followed.

- Where an existing building or other multiple unit is issued a single bill involving a number of users it should be the responsibility of the building or multiple-unit owner to allocate and collect for appropriate usage amounts and be responsible to the utility for payment. New units should follow the recommendations of the Water Utility Tariffs Report, Paragraph 14.2.3.

- The expense of installing single use meters in existing structures is prohibitive and recommendations presented in the Water Utility Tariffs Study concerning new structures, for single metering, should be followed.

*- Current practices for new and renewed accounts should be reviewed for streamlining:

. Establish a standard fixed cost for new meter installations.

. Require new and renewed service applicants to pay for the hook-up and make a deposit at time of application.

. Adjust the customer's account for any debit or credit balances on the customer's first bill. Adjust standard fixed costs annually to reflect economic and installation changes.

. Establish policies for service discontinuance which may impact the health and welfare of the customer affected.

*- Standard operating instructions should be prepared for all billing functions.

4.2.2 Long-Term

Recommendations developed for long-term consideration are:

4.2.2.1 Meter reading. (See Water Utility Tariffs Report, Paragraph 14.2.2.)

- Establish a standard meter reading program for all utilities.
- Standardize on the meter account forms for nationwide application and use.
- Review and implement the latest developments in meter reading practices and techniques.

4.2.2.2 Meter testing. (See Water Utility Tariffs Report, Paragraph 14.4.)

- Review the latest technological developments in meter reading practices and equipment.
- Establish a nationwide standard for meter test requirements.
- Include meter record details in computer files for storage and retrieval.

4.2.2.3 Rotating or replacing meters. (See Water Utility Tariffs Report, Paragraph 14.2.4.)

- Develop a rotation or replacement program for computer application.

4.2.2.4 Meter repair. (See Water Utility Tariffs Report, Paragraph 14.4.)

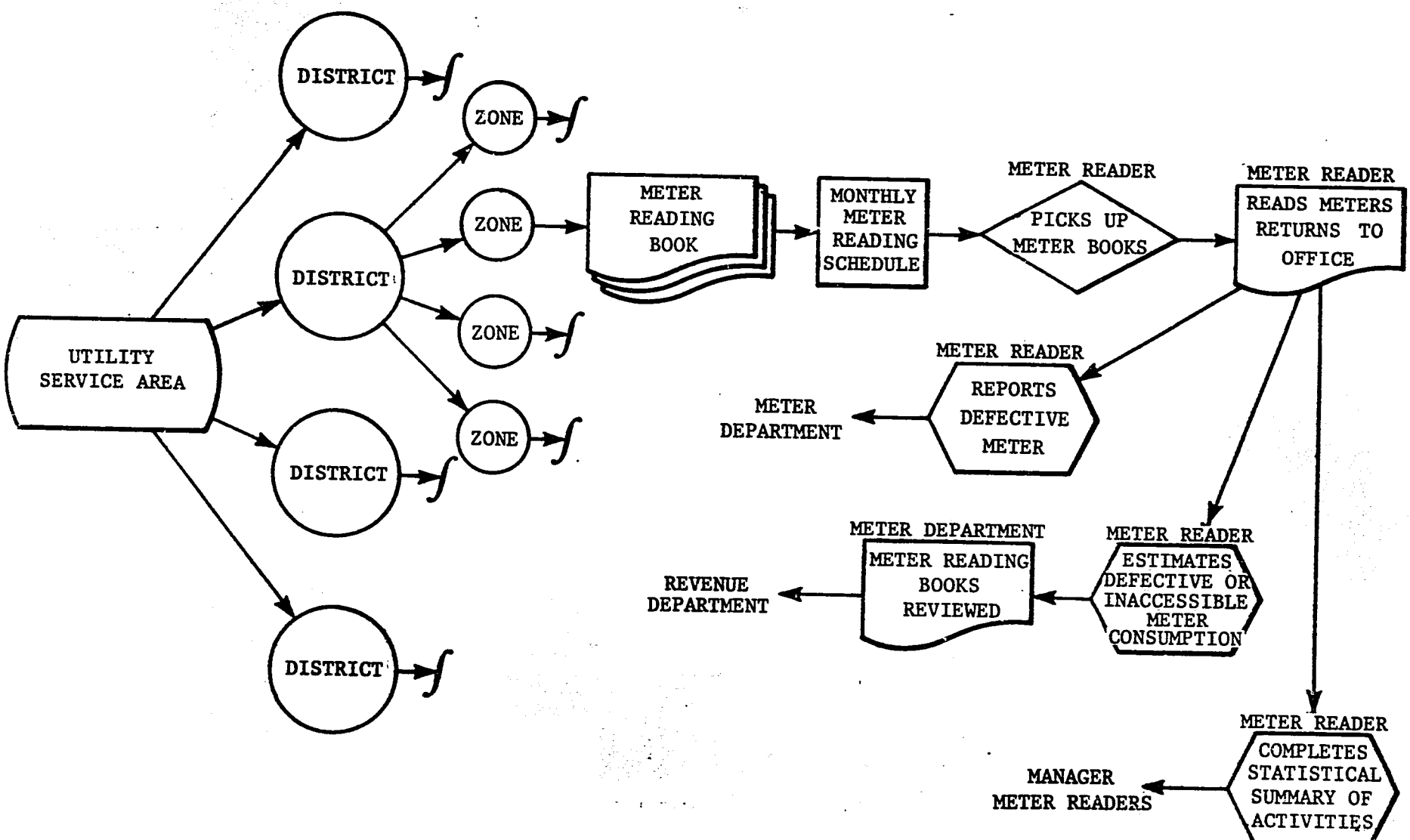
- Review latest technological changes in meter repairs.
- Include meter repair data in computer files for storage and retrieval to evaluate trends, costs, forecasts and other information.

4.2.2.5 Billing procedures.

- With the increased application of data processing, evaluate the use of data for projecting water usage, trends, financial requirements and other purposes such as presented in the Management Information Systems Report. (See Data Processing Report, Appendix 2.)

EXHIBIT 4.1

METER READING PROCESS



PROCESS FOR NEW OR RENEWED SERVICE

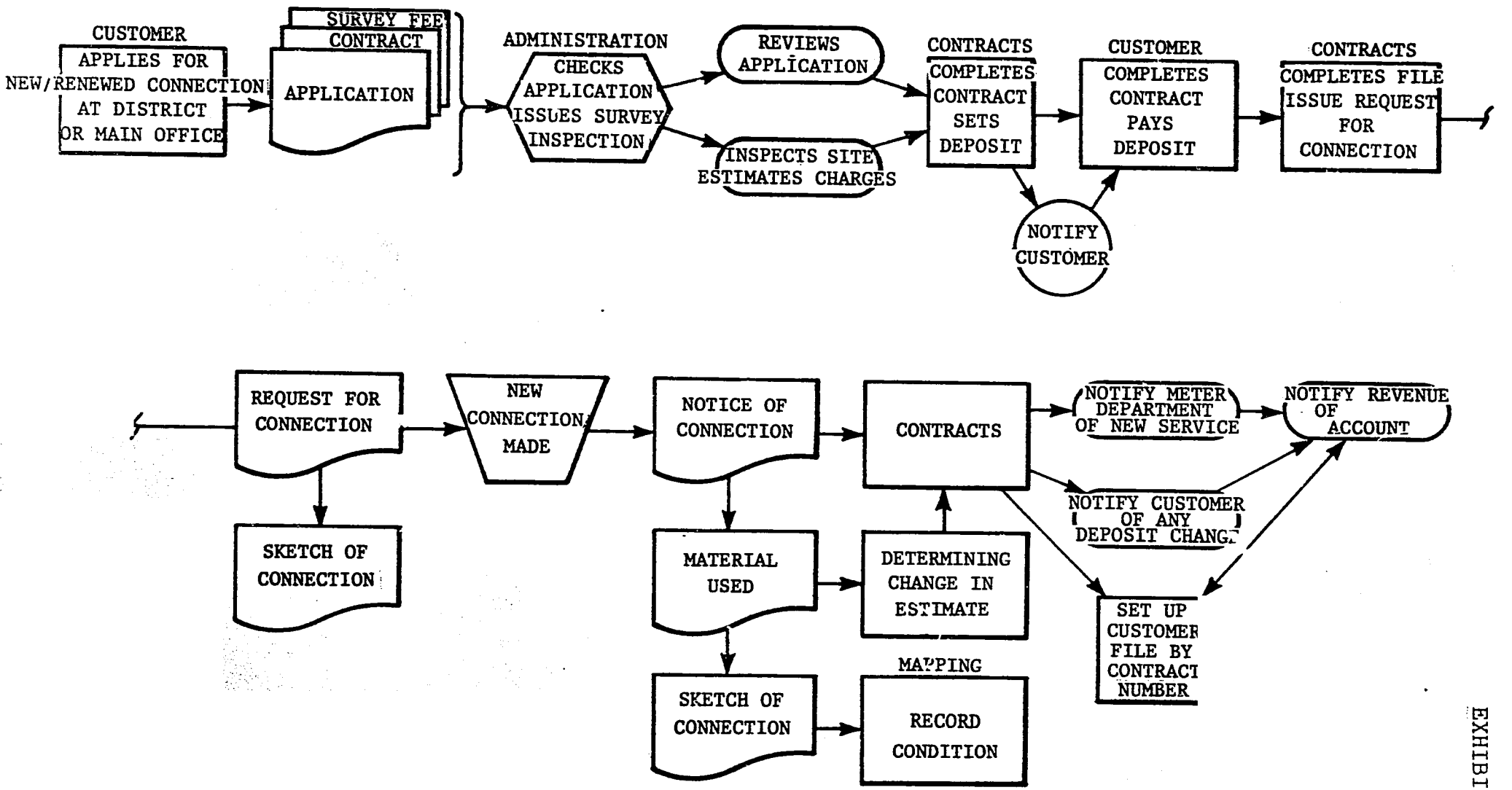


EXHIBIT 4.2

PROCESS FOR DISCONTINUING SERVICE

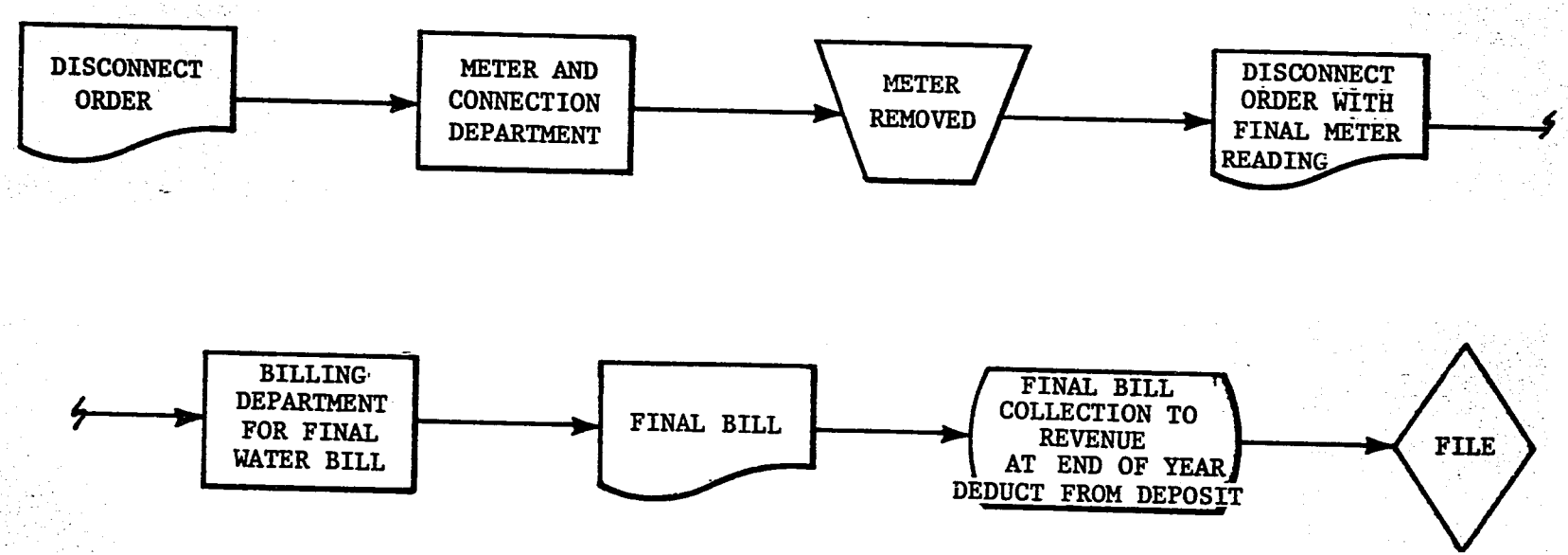


EXHIBIT 4.3

AVERAGES AND RANGE-OF-TIME TECHNIQUES OF APPLIED WORK MEASUREMENT

Successful measurement of low-quantity work, such as meter reading, is based on the fact that a given job may be accomplished in several ways due to the circumstances confronted, each of which is acceptable. Similarly conditions may change from time to time, and frequently the changes are not of sufficient magnitude or permanent enough to justify revision of the standard time for that portion of the work or meter route.

The principle used in most forms of standards application to low-quantity work is that an average time, based on good measured data, will be issued for the work. It is anticipated that the work will be completed within a given range of time, sometimes a given percentage above or below the average time allocated.

For instance, from the following example representing the time spent on three occasions to perform the meter reading function on four different routes, the standard for each route can be developed.

Route	Hours		
	January 4	March 5	June 3
A	5.4	4.6	6.2
B	8.1	7.5	9.3
C	6.5	7.1	7.4
D	10.5	10.8	9.3

AVERAGES AND RANGE-OF-TIME TECHNIQUES OF APPLIED WORK MEASUREMENT

The standard could be determined to be:

Route	Standard Hours	Time Range-Hour
A	5.4	4.5 - 6.2
B	8.3	7.5 - 9.3
C	7.0	6.5 - 7.4
C	10.2	9.3 -10.8

Statistical data for each route, standard against actual performance, could be measured each time a route is completed. This data would provide the following benefits:

- A basis for evaluating individual meter reader performance.
- The foundation for developing man-power projections for meter reading staff.
- Support of operations budget forecast for Meter Reading Department.
- The basis for installing an incentive or bonus program.

METER TEST PROCEDURE

Application: 16 - 19 - 25 millimeters

Equipment: One tank - 380 liter capacity, calibrated for volumetric testing

One tank - 38 liter capacity, similarly equipped

One test bench appropriately equipped

Procedure:

1. Clamp meter securely on test bench.
2. Remove the register box cover.
3. Open the discharge valve first; then open the inlet valve gradually and run water to drain until any entrapped air is cleared.
4. Shut off the discharge valve.
5. Check 380 liter tank discharge to ensure that the tank is empty and then close the tank drain valve.
6. Turn the meter register to set the test hand at the zero mark. In so doing, turn the register backward beyond the zero mark and then reverse its direction to bring the test dial hand forward to the zero mark. This procedure takes up any possible backlash in the gearing.
7. Open the test bench discharge valve as rapidly as prudently possible to the desired rate for the maximum-flow test (60 lpm) and continue the flow at this rate until the meter test hand has made ten complete revolutions; then stop the test at the starting mark. Read meter accuracy from the scale of the calibrated tank.
8. Post the results of this test on the meter record form for each meter.
9. If a repaired meter is being tested and its accuracy does not fail within prescribed limits, refer to the change gear chart and replace change gears with a set that should cause the meter to register within required limits. Repeat the test as outlined.

METER TEST PROCEDURE

10. If a repaired meter is being tested and found to register within limits on the maximum-flow test rate, repeat steps 3-7, for the intermediate (8 lpm) and minimum (1 lpm) tests, discharging the test water into the 38 liter tank. The test quantity for these rates is only 38 liters and the meter register test hand completes only one full revolution.

11. If the test is to determine the condition of a meter upon removal from service, it is desirable to reverse the order of test flows. The order would be minimum, intermediate and maximum flow.

12. After three separate test runs are made, the meter has been fully tested and may be removed from the test bench after the inlet valve of the test bench has been closed and pressure has been released by a partial opening of the discharge valve.

13. Upon conclusion of the final test, the meter should be drained, the register sealed, and dust caps placed on the meter spuds before being put in storage.

14. Post all information to the meter record card, such as repairs made and material used, and return the card and meter to the stores clerk.

5.0 PROCUREMENT AND INVENTORY CONTROL

The purpose of this Section is to review and analyze the procurement and inventory control practices of the utilities.

5.1 FINDINGS AND CONCLUSIONS

The water and wastewater utilities covered in this study followed the same basic approach and practices. Any differences were found only in the forms, certain procedures and organization which are the result of size rather than functional requirements.

5.1.1 Procurement.

The utilities all follow the same basic procedures in their procurement practices. Procurement and contracting are covered by the same regulations which include:

- Procurement of required articles at suitable prices.
- Protection of public funds of the organization from fraud.

Current procurement practices are reviewed in the following paragraphs:

5.1.1.1 Laws governing procurement. There are no laws specifically promulgated for procurement but the procedures involved are affected by public laws and regulations covering the organizations. Examples of this indirect effect are:

- Authorization of Budget Department of funding availability.
- Preparation of the annual planning budget of the organization.
- Control of the correct application of the expenditures.
- Control of the correct application of the foreign exchange allocation.
- Correct application of trade agreements with foreign business.

5.1.1.2 Budgeting practices. Annually each organization prepares estimates of the materials, spare parts and related items necessary for the coming year. This list is a summary of individual lists supplied by stores, treatment plants, networks and other functional areas within each utility.

The consolidated list is then submitted to the Chairman of the organization for review and, upon his approval, for inclusion in the annual budget submitted to the Ministry of Finance.

5.1.1.3 Pre-purchasing procedure. When the approved fiscal budget has been received the Purchasing Department then initiates the pre-purchasing procedure. The steps are:

- Request authorization for necessary funding allocation. To ensure that the budget will be maintained, the Budget Department maintains an allotment register in which each budget request is entered. The Budget Department then gives the department concerned a written declaration of fund allocation.
- Determine method of purchasing. There are a number of methods used in the purchasing process including any one of the following normal procedures:

- Public solicitation. Probably the most common method is an announcement in the appropriate newspapers or publications of the intent to purchase, setting forth general terms and conditions. Public solicitations may be limited to bidders residing in the country or international firms, open to all countries. There can also be limits set which permit only a few qualified suppliers (due to the type of product), such as government-owned companies or bidders invited to participate by formal invitation.

- Qualified bidders list. Purchases with costs that are within certain limits may be issued to firms listed as qualified suppliers.

- Direct order. In case of an emergency and within limit, a purchase may be made by direct order to a supplier.

- Negotiated procurement. When there is a need for specific technical requirements, a committee of technical experts is formed and authorized to conduct the procurement.

- Preparation of purchasing documents. The documents are drafted with both general and special conditions. The standard purchasing practices specify the general conditions for the order being prepared. Special conditions may be detailed specifications or requirements proposed by the department requesting the items or services to be purchased.

- Establish a suppliers register. The Purchasing Department creates a special register containing the name, address and specialization for those firms requesting the solicitation. As changes occur on the original solicitation, notification is then made to those firms of any modifications.

5.1.1.4 Procurement cycle. Upon the completion of the pre-purchasing requirements the procurement activity is initiated. Depending on the method of purchasing, one of the following is involved in the procurement cycle:

- For public solicitations the first step is a public announcement with the distribution of the conditions and a list or specification of requirements. The next step is the receipt of the bids. The time and date of the bids are noted, a review is made to ensure the bidder has complied with conditions set forth and a determination is made of the validity of the bid. If required the bid is also accompanied by a bid bond, normally 2% of the total value of the bid. On receipt of the bids, an evaluation committee is formed to review the bids. The bids are then evaluated, tabulated and a decision is made on the successful bidder. Upon the decision a notice is sent to the successful bidder for concluding the purchase contract and submittal of a performance bond.

- For qualified bidders, the request for purchase is sent to them with the normal procedures for review, award and conclusion being executed.

- A direct purchase involves notification of the type of purchase being executed with approval being requested of the responsible manager. A declaration is made by the responsible officer in the disbursement documents stating his agreement with the items being purchased and their prices. The last item required is a declaration that the purchase has not exceeded any financial limits.

- A negotiated procurement can be briefly described as the creation of a technical committee, development of the invitation for bids, documentation of committee meetings and submission of recommendations to the responsible manager for approval.

- After the purchase order has been issued, the delivery and payment procedures complete the procurement activity:

  - The delivery procedures are activated when the purchase order is compared to the shipping invoice. On receipt the Purchasing Department is notified to create a receiving inspection committee. This committee consists of individuals from the department for which the purchase was made, the Purchasing Department and the insurance company (bond). An inspection is made with a report being issued listing the percentage of articles received, examined, and comments of acceptance or refusal.

  - Once a satisfactory receiving inspection report has been issued, full or partial payment procedures are followed.

5.1.1.5 Organizational structures. The utilities included in this study have similar functional organizations. Titles may be somewhat different but the responsibilities are nearly identical. Only the size of the utility affects the nature and scope of the functional activities.

Procurement was found to be organized in the following functions:

- Solicitations. There are two groups responsible for solicitations, foreign and domestic. Each has responsibility for review, processing, analyses (as members of the review boards), awards and receipt (as members of the receiving inspection committee).

- Follow-up. This group expedites special orders, follows normal purchases, performs special studies and develops any statistical information that may be required.

- Contracts. This group is used for purchases or contracts with local companies, not released through the normal system.

For GOGCWS, financial review, evaluation of purchase requests and budget funding availability, and specifications review are distinct functions. In other utilities these activities are part of the procurement department's overall responsibility.

5.1.2 Inventory Control

The methods and procedures currently used for inventory control, receipts, disbursements and management were reviewed at each of the utilities. Stores, both main and subsidiary, networks, treatment plants, and supporting services (meters, transportation and machine shop) were included in the review.

5.1.2.1 Main and subsidiary stores. Each utility follows the practice of receiving all materials at a central or main store and then distributing them to the subsidiary stores. The number and locations of stores, both main and subsidiary, varies with the size of the utility. The largest utility, GOGCWS, has 31 different stores while SCA in Ismailia has four stores.

Locations of some stores (See Exhibit 5.1 for the store locations of GOGCWS.) appear to have been governed by space availability rather than optimum logistics support. The only exceptions are the stores located at each of the water treatment facilities.

Examples of poor stores locations include:

- Abbassia (GOGCWS) - The main store for pipe and valves is located at an abandoned pumping station. Access is difficult due to the remote location.
- Gabbary (AWGA) - A network station and store are located at the site of a reservoir with storage being provided by additions to reservoir walls. Carts are hand-carried up a flight of steps for storage. Its location is at the extreme end of its service area.
- SCA - The main warehouse is located at Port Fouad to serve Port Said, Ismailia and Suez.

5.1.2.2 Receiving practices. Raw materials, supplies and purchased parts are received at a designated main warehouse. The exception would be a large shipment of chemicals which may be sent directly to a specific water treatment plant. The material received at the warehouse is unloaded, inspected and then moved into stores. The Stores Manager identifies the material in accordance with the invoice, purchase order and stores classification, and then dispatches it to the appropriate storage area and location. Upon receipt of the inspection committee report the receipt of the materials is recorded into inventory in the master stores log.

5.1.2.3 Receiving procedure. The process presently used at GOGCWS was found to be typical of the practices at other utilities.

The receiving report process is initiated on receipt of any material. The Purchase Order file located in the storeskeeper's office is pulled and reviewed. The file contains the Purchase Order, Letter of Credit (if required), Insurance Certificate (Bond) and other pertinent information.

When a shipment received is incomplete, a receipt ticket is completed noting those items received and notifying the Purchasing Department to follow-up on the balance of the order.

The inspection function is initiated by the storekeeper notifying the Purchasing Manager for establishment of an inspection committee. The committee is normally composed of four individuals, the Storekeeper, a member of the Purchasing Department, a representative from the insurance company and a member of the end-user group, i.e., if for the waterworks operation someone from waterworks operations. The same occurs if for networks, projects and other.

Once the committee performs its inspection and agreement is reached, the inspection report is initiated.

When completed and signed by all committee members the material received can officially be moved to stores and recorded as inventory. Payment is authorized for the material by this report and the release of all related liabilities.

5.1.2.4 Stores practices. Material officially received, with an inspection report for new receipts duly completed, becomes the responsibility of the Stores Manager.

The material is then moved to its appropriate location within the stores area. The material is entered on the appropriate page for each item in the stock ledger books. The quantity is also entered in most cases on the bin card. The bin card is located in some warehouses at the store location of the item, while at other locations it is maintained at the stores clerk's desk with a bin card label at the location of the item.

Transactions concerning the disbursement of material are performed in two ways, one for normal transactions and the other for emergency needs. For the normal transaction a material requisition is completed, signed by a designated authority. In the case of waterworks it can be the Plant Manager or First Engineer. The requisition is then presented to stores for filling. For items leaving the stores area, i.e., networks or main stores, a Gate-Pass is also issued. When the material is received, the balance of copies of the requisition are signed and sent to accounting noting receipt. Accounting on receipt of the Requisition completes a Material Requisition for allocating costs to the designated account.

When there is material left over, a Material Return form is filled out for the material to be returned to the originating stores. Where equipment is involved a Material Return Form for Equipment (MRFE) is completed. In cases where the MRFE form is involved, a committee must be formed to inspect the condition of the equipment being returned. If the equipment is damaged or in need of repairs, an estimate is made of the amount required

to correct the deficiencies noted in the inspection report with the user being charged for repairs. For materials and equipment returned the accounts are adjusted, and debited or credited. If a customer's account is involved, extra material will be billed or a credit will be given for returned material.

When emergencies are involved a short, abbreviated version of the material requisition is used. This form is called a Temporary Issue Voucher which means the material is on loan until returned or a formal requisition is received. Transactions and paperwork are the same for any material and equipment returned to the originating store.

5.1.2.5 Inventory. A daily record of transactions is provided by the Daily Stores Record, which accounts for receipts and disbursements. At the end of each day the Daily Stores Record is summarized and recorded in the Daily Summary of Materials issued.

Stock levels are controlled on a day-by-day basis. While the stock card has a column for reorder points, it is not being used. When material is exhausted or has not experienced any movement a Statement of Shortage and Surplus is issued by the stores clerk citing the excess or deficiencies and the reason for this condition. This form notifies Purchasing of the problem and, if necessary, to order additional material or to take steps to reduce the excess material. Movement of material between stores is accomplished using a Material Transfer Ticket.

A physical inventory is taken once a year, normally during October of each year. Forms used include an Inventory-Taking Form, Materials Adjustment Sheet and Inventory-Taking Summary. During the inventory the stores are secured by locking and transactions are not allowed except for extreme emergencies. On completion of the inventory count the lock is tagged to ensure entry is not made until the extensions are verified. Based on the inventory results the stores clerk, in conjunction with the appropriate plant manager, will develop requirements for the coming year, using the Stores Requirements Estimates for projecting requirements. When excess inventory is determined, the Requirements Group will either redistribute the excess material or notify Purchasing to initiate a solicitation for the sale of excess materials.

5.1.2.6 Review. Three types of reviews of inventories are currently made by the utilities. Spot checks are initiated by the Storekeeper when material reaches a low level or is exhausted. Another review is when a complete inventory is performed during the year, at some point during the year when circumstances prompt the Requirements or Materials Manager to initiate such action. The third inventory is performed annually, in October, to establish a basis for forecasting needs for the ensuing fiscal year as noted in the preceding Paragraph. It is also during October that treatment plant managers must also develop forecasts of the inventory needs for their individual plants. After these requirements are determined, the physical inventory and forecasted plant needs are evaluated and the resulting budget needs for the next year are determined. The

budget request is then submitted to management for approval and inclusion in the utility's budget request for the next year. It has been common practice for budget requests to have been reduced to a point that requires an adjustment of inventory requirements. Typically the necessary day-to-day needs remain but maintenance supplies are so reduced that it impairs the operation of plant and equipment.

5.1.3 Stores Management

The decisions and basic practices involved in stores management are reviewed in the following paragraphs:

- Inventory turns. In reviewing the types and quantities of inventory, both by actual count and the review of stock cards, there does not appear to be a system or procedure available to develop effective inventory levels. It is estimated that 25% of the inventory has experienced no activity, or turns, during the year. Another 37% has experienced only two or three turns, with the remaining inventory having a steady turnover. There is no statistical data available to evaluate turnover rates for inventory comparison among the plants within a utility or among the utilities.

- Reorder points. Stock levels are controlled on a day-to-day basis. While stock cards observed in use have a column for reorder points, both maximum and minimum, in some cases the only entry found was the entry for the minimum stock level to be maintained. Apparently at some point the reorder point system was being implemented but was never completed and used. The current practice is for each store manager to use his own judgment for his stock. If he feels additional quantities of stock must be purchased, he must initiate a request to order accompanied by a justification for the request.

- Record-keeping. Of all administrative controls practised by the utilities, the system of records appears to be reasonably managed. The stock ledger book, bin cards and daily record of transactions are maintained daily with few exceptions.

- Inventory levels. From the review of records, physical survey of inventory, and discussions with stores managers and plant managers, there do not appear to be specific plans or policies regarding the total size and composition of inventory. Materials consumed in the daily operation of the treatment plant, e.g., chemicals, receive a priority over materials used in the maintenance of equipment. With the large quantity of foreign equipment in use and their individual part requirements, a system of establishing a sound inventory level practice is encumbered. Under existing conditions, standardization of current inventory may be unreasonable to consider.

- Transactions. The average number of transactions, or stock disbursements, was developed from surveys made at the various stores. On average, a stores manager reported five requisitions per day with the average requisition having four items. This represents, for each store, an average of 20 transactions per day or 120 per week.

- Staffing. The staffing of each store varies by its size and function. The average level of staffing is the stores manager, a records clerk and four or five laborers responsible for stock maintenance. For the number of transactions, the level of staffing seems high and should be reviewed.

5.1.4 Effectiveness

The effectiveness of procurement and inventory control practices is hampered by the following factors:

- While the procurement process is basically sound, it is encumbered by the number of steps and authorizations required. Another is the requirement to submit a detailed list of required material three months prior to the end of the fiscal year for budgeting, a budget review period of one to two months, a purchasing cycle of three to six months for solicitations and then awaiting receipt. Almost a year could be required before the material becomes available.

- Direct purchases may be made but are constrained by the LE limit on purchases imposed on plant managers. Extreme emergencies may exceed the LE limit but approval is required which slows the process.

- The requirements for the various review committees, i.e., inspection, solicitation analysis and such all require time to schedule, meet, agree and release findings.

- The location of main stores, in most instances does not provide for optimum support of their service area.

- There is a lack of procedures or instructions with which to measure manpower utilization or performance.

- There is no procedure to evaluate maximum and minimum levels of inventory, reorder points and lead times.

- An effective procedure is needed for disposing of obsolete inventory, material and equipment.

5.1.5 Procedures and Methods

Interviews, investigations and analysis of the procurement and inventory control practices revealed a lack of any written procedures or instructions. The practices used are developed on an as-needed basis and reflect the habits and routines which have developed as the utilities have grown.

In almost every department there is an excess of personnel many of whom lack the skills and training to be of any real assistance. The lack of management direction, control and techniques has resulted in excess staffing together with declining efficiency and performance.

5.2 RECOMMENDATIONS

For procurement and inventory control, recommendations are made for an interim period, which can be achieved in the short-range to provide for better utilization and control of resources. Long-term recommendations encompass an improvement in methods within the framework of the new organization.

5.2.1 Interim Period

Recommendations developed for the existing utilities are:

5.2.1.1 Procurement.

*- Prepare an organizational description of the purchasing department, detailing the principal objectives and functions. (See Exhibit 5.2 and Organization Manual.)

- Develop detailed job descriptions for each key position of the procurement function. (See Organization Manual.)

- Consideration should be given to reducing the number of purchase order forms to a single standard form for all utilities (See Exhibit 5.3.)

- A policy manual should be developed to include policies for:

  . Selection of and relations with vendors.

  . Making commitments and placing orders.

  . Reciprocity.

  . Commercial bribery.

  . Employee purchases.

  . Relations with other departments.

  . Policies for quality, quantity and price.

*- A procedures manual should be developed for all functional activities.

*- The existing purchasing process should be reviewed for reduction in the number of steps and the time involved.

- Consideration should be given to the formation of an association of utility procurement managers to exchange ideas on practices, current price trends, sources of supply and other.

5.2.1.2 Inventory control.

- The basic system for physical control of inventory is generally adequate and should be continued until such time as a full design study is made for the introduction of new data processing procedures. (See Data Processing Report.)

*- Definitive action should be taken to eliminate the current back-logs of equipment and material which have been received and still have not been inspected and recorded as inventory. (See Physical Assets Report, Section 3.0.)

*- A detailed analysis should be performed of stock transactions at each of the main stores to develop the basis for determining the optimum physical location for each. Existing locations reflect the use of available space without any consideration of cost, in terms of transportation and time to service the areas. (See Paragraph 5.1.2.1.)

*- Consideration should be given to an extensive housekeeping program at each of the stores to clean and arrange stock in an orderly manner, clear aisles and bins of trash, debris and obsolete material, and rearrange stock for optimum utilization and efficiency. (See Physical Assets Report, Section 3.0.)

*- Steps must be taken to eliminate the stocks of obsolete and scrap equipment, trucks, cars, and material presently located at treatment plants, stores yards, and other locations. These should be disposed of as scrap or some other purpose to free up valuable space and provide a source of cash for the utilities. (See Physical Assets Report, Section 3.0.)

*- Standard operating instructions should be prepared for each of the activities performed in inventory control. (See Exhibit 3.3.)

5.2.1.3 Stores management.

*- The material control function should be reviewed for application (See Exhibit 5.4) with stores management for:

. Developing average usage.

. Lead time analysis.

. Reorder points.

. Reserve stock.

. Economical order quantity (EOQ).

- With the introduction of new data processing procedures, as recommended in the Data Processing Report, the system for evaluating inventory turns will become available.

- Record-keeping practices currently employed should continue and be changed only as the new data processing requirements and procedures are introduced.

- Minimum stock quantities should be determined using the EOQ system in Exhibit 5.4, Material Control.

*- Recommendations as made in the Data Processing and Physical Assets Reports should be considered in developing an inventory of optimum size.

- Detailed procedures covering the functional responsibilities of stores management should be developed and implemented.

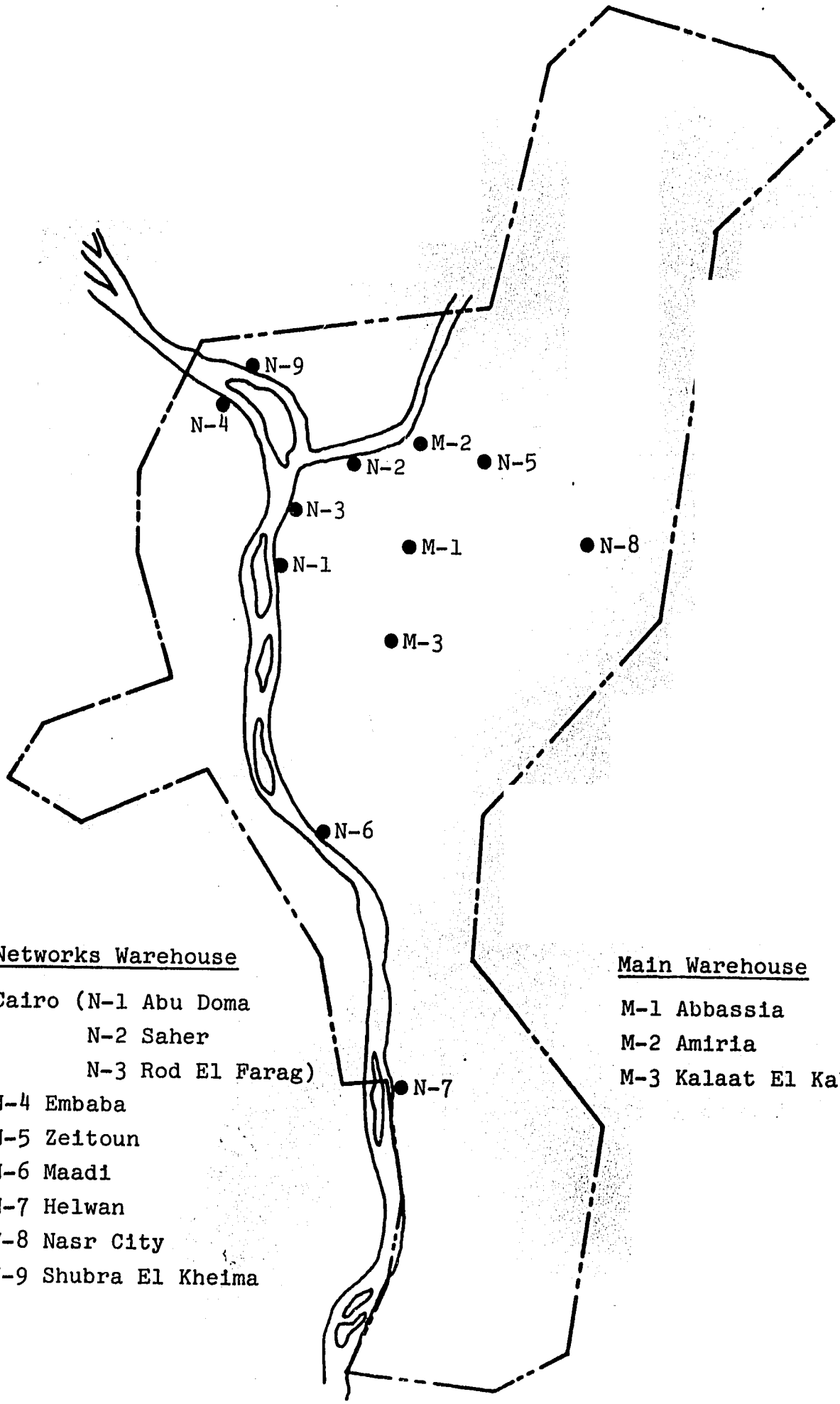
*- Standard operating instructions should be developed for all functions and duties.

5.2.2 Long-Term

For the long-term, improvements in methods can be made within the framework of the new organizational structure. As the new structure evolves consideration should be given to centralized purchasing of major bulk items as recommended in the Organizational Environment and Structure Report, Appendix 1, Item 17.

EXHIBIT 5.1

GOGCWS - MAIN AND NETWORK STORES



Networks Warehouse

Cairo (N-1 Abu Doma
N-2 Saher
N-3 Rod El Farag)
N-4 Embaba
N-5 Zeitoun
N-6 Maadi
N-7 Helwan
N-8 Nasr City
N-9 Shubra El Kheima

Main Warehouse

M-1 Abbassia
M-2 Amiria
M-3 Kalaat El Kabsh

EXHIBIT 5.2

FUNCTIONS OF THE PURCHASING DEPARTMENT

The functions of the purchasing department cover all dealings with vendors. No contacts involved in the purchase of any goods or services should be made without the cognizance of this department.

The principal functions, not necessarily listed in an order of importance are:

- Locating and selecting sources of supply for materials or services required.
- Interviewing suppliers' representatives and arranging conference and visitations.
- Requesting quotations, qualifying bidders and conducting negotiations.
- Procuring materials and services when required.
- Verifying the quality and quantity of material received.
- Approving invoices and handling rejections and adjustments.
- Maintaining records necessary for proper operation of the purchasing functions.
- Keeping informed on national trends, collecting and reviewing pertinent information on markets, supply, demand, price trends and other.
- Disposing of scrap and surplus.

STANDARD PURCHASE ORDER

A standard form of purchase order is advisable as long as it is readily understood, economically handled by the vendor and suited to the requirements of the utilities' accounting system. The advantages of a standard purchase order are:

- Fewer misunderstandings and clerical errors.
- Lower printing costs.
- Economical use of standard paper stock.
- Economy in filing and record-keeping because of standard size.
- Economy in typing and recording.

A standard purchase order can also meet the requirements of a number of departments. The use and distribution of such a purchase order could be for the typical setup calling for eight copies:

- Vendor's copy
- Acknowledgement form, to be completed by the vendor and returned
- File copy for purchasing department, used for record purposes and for checking of invoices
- Follow-up copy which goes to follow-up clerk and is used to assure delivery of the goods when needed
- Accounting department copy
- Receiving department copy
- Inspection committee copy
- Requisitioner copy

STANDARD PURCHASE ORDER

The standard purchase order, seven copies and the original can be completed at one time and in the case of some utilities replace the current use of nine different forms.

This approach would achieve the advantages noted and improve the efficiency of all departments affected.

MATERIALS CONTROL

Materials control is the process of providing the required quantity and quality of materials which are needed in the treatment process at the required time and place with the minimum feasible expenditure.

The advantages of materials control are many in properly providing for and controlling materials, including:

- Reducing the possibility of shutting down a treatment plant.
- Reducing waste of materials due to theft, breakage, deterioration, spoilage and obsolescence.
- Reducing the operating costs by having the parts on hand when needed so it is not necessary to substitute other parts or material.
- Reducing the possibility of effecting the health and welfare of customers due to inadequate water or wastewater treatment.

Physical Control

Materials control is generally divided into two areas, physical control and planned control. From the review of the practices of the utilities, it is evident that only physical control is being practiced. Physical control is the proper receipt, storage, protection and issuance of materials from inventory.

Planned Control

Planned control, which is the maintenance of an adequate but not excessive supply of each of the raw materials, spare parts and supplies required by the treatment facilities and operations, appears to be missing.

Planned control requires certain information which must be known or estimated for each part and raw material in inventory. Some of this information is available within the existing systems of the utilities, while other information must be developed. The types of information necessary to establish control are:

- Average usage. The expected use of a particular part or raw material in the future. Past use, of which most utilities have a record, is usually taken as the best indication of the future with any adjustments, increases or decreases, anticipated for changes in the levels of service.

- Lead time. The average elapsed time between the initiation of the purchase requisition and the receipt of the material. This element will be the most difficult for the utilities to determine because of:

  - Purchasing practice, solicitation, direct negotiation, qualified bidder and other. Each has a limitation and constraint of an unknown amount of time involved. For example, the solicitation method could take up to a year.

  - Fund allocations. Should funds not be available or if budget approval has not been received, time again constrains the lead time and the release of purchase orders.

- Reorder point. The quantity expected to be consumed during the replenishment lead time plus a reserve. It is computed by multiplying the lead time in periods by the average usage per period and adding a reserve quantity.

- Reserve stock. An extra amount kept on hand to take care of greater-than-normal usage during the replenishment lead time or an average usage during greater-than-normal lead time. For the utilities this period may be during the period of high seasonal use.

MATERIALS CONTROL

- Economical Order Qualtity (EOQ). This element concerns the quantity which is the most economical to order and to inventory, considering:
  - Balance on order.
  - Actual balance in stores.
  - Unfilled orders.
  - Demand coverage.
  - Lead time.
  - Discounts.
  - Funding availability.

Economical O

How much to order is a problem which must be carefully considered. If small quantities are ordered the average inventory level is lower but may also result in more frequent ordering. For items with highly erratic usage, the most economical balance will usually be achieved by ordering the quantity expected to be required in the near future. For items having sustained and regular usage, however, the most economical balance can usually be obtained by calculating the economic order quantity (EOQ) for the item.

There are many useful formulas for calculating EOQ and a number of techniques are available to simplify the actual calculations. These include:

- Hand computations, using a formula.
- EOQ slide rules.
- Nomographs.
- Charts.
- Tables.

MATERIALS CONTROL

Two widely used formulas are summarized for possible application by the utilities in determining their EOQ. The first is used for items not subject to price differentials for different quantity purchases; it is a total cost formula.

Total annual cost = inventory carrying cost + ordering and specific cost

or $$T = \frac{Q}{2} IC + \frac{S}{Q} A$$

Where T = Total annual cost, LE

Q = Order quantity, units

I = Inventory carrying cost as a decimal fraction

C = Unit cost of the item, LE

S = Expected annual usage, units

A = Purchasing cost for specific order

The inventory carrying cost (I) includes only variable costs as a fraction of the inventory investment. These variable costs may include the costs of capital invested in the item, insurance, inventory taxes, and obsolescence or spoilage. Purchasing cost (A) would be special costs applicable to the orders; it may be the cost of a public announcement in a number of foreign papers, a special agent fee and other such costs.

The economic order quantity is determined by trying different values of order quantity (Q) in the formula until the lowest total cost (T) is obtained. The order quantity corresponding to the lowest total cost is the economic order quantity.

MATERIALS CONTROL

The second formula is used when an item has differential prices for different order quantities. If purchasing cost (A) is negligible, the EOQ for an item can be calculated by using the following total cost formula:

$$T = \frac{Q}{2} IC + SC$$

The procedure consists of calculating the total cost separately for each price, using in each case the minimum quantity associated with the price. The EOQ is then the order quantity corresponding to the lowest total cost.

Certain principles should be followed in applying EOQ formulas. First, the formula should be specifically designed for the class of inventory to which it is applied. This means that it should take into account all the cost factors that are significant, avoid unnecessary complexity and should exclude those cost factors that are insignificant. Second, the cost figures used should represent savable costs, those which will not occur were the order not placed.

In summary, with the application of such techniques as reorder points, reserve stocks and economic order quantities, planning control can be initiated. The utilities have one basic element for controlling materials, physical control. To complete the system planning control is needed.

6.0 MAPPING AND RECORD-KEEPING

Existing procedures for mapping and record-keeping of the treatment plants and the distribution and collection systems (including system maps, record maps/drawings, location drawings and listings of valves and hydrants) were reviewed at each of the utilities with regard to work assignment, sequence and control.

6.1 FINDINGS AND CONCLUSIONS

The mapping and record-keeping practices and conditions were found to be consistent at all utilities. A more detailed review of the findings is presented in the following paragraphs:

6.1.1 Role of Drafting Departments

Each utility visited maintains masters and copies of maps and drawings in a central location, generally within the Drafting Department. The bulk of the utilities' maps and drawings continue to be prepared by outside contractors. The departments function as a repository for maps and drawings in addition to providing normal drafting support. The adequacy of facilities for drafting and map storage is discussed in the Physical Assets Report.

As a repository for drawings and maps the departments appear to be poorly organized because they have developed no satisfactory filing and control system even though most of the people interviewed recognized the need. There was a general impression that it was someone else's job and there was no particular incentive to make changes. Written procedures for preparation, handling, revising, filing or storage and release of this vital information about the utilities systems do not exist, resulting in a very loosely-run operation left largely to the discretion of the drafting department supervisor. Lack of clear management guidance and supervisory attention is evident. The only work assignment procedures which exist are those which are initiated locally by the supervisor or developed by the drafting room personnel themselves based on individual initiative.

The departments visited have normal drafting practices. A statement of the functional responsibilities of the drafting departments has not been published. With a few exceptions, they were found to be crowded, cluttered with maps and drawings, dirty, poorly-lighted and had a very inefficient layout for work flow. Most drawings reviewed do not have a drawing number or other means of identification, or a system of drawing release and control. Revisions are made to drawings without indicating the date of revision.

6.1.2 Work Sequence

Lack of prescribed procedures at all utilities prevented a detailed study of work flow. A review of the drafting department at AWGA illustrates the manner in which work is performed.

The AWGA Drafting Department has responsibility to provide maps for main pipelines, networks and distribution systems, and drawings for certain types of civil works projects. A drawing control record has been initiated for new drawings being prepared by the Department. The log contains the drawing number, description, date prepared and date of entry in the log. Very few entries were in the log. There appears to be no record or system of change control for the drawings themselves. Some drawings have a date of initiation while others had no dates. There is no indication of revisions, or date of change or revision.

Most of the drawings for AWGA are prepared by a sub-contractor. Consequently, a primary function of the Department is to maintain record files for the utility. Nevertheless, new drawings by the sub-contractor are not logged in when received and no control over the drawings is established. The letter of transmittal accompanying these drawings is kept by the Project Director's office and is not made available to the Department.

Drawing filing and storage involves drawers and racks of drawings being grouped by their area designation (for networks) or by projects (for civil works). There is no cross-reference file, or single reference file for locating a specific drawing.

A secondary function of the AWGA Drafting Department is the re-drafting of old, worn master drawings. This is necessary because many of the drawings are in very poor condition because of age, handling and inadequate storage.

6.1.3 Control

A system for maintaining and controlling mapping records does not exist in most of the utilities. The few available records are informal and incomplete, and appear to be the result of individual need rather than administrative directives.

There is no formal drawing release system. Many drawings do not have a drawing or control number. Many bear no dates, bills-of-material, indications of approvals, revisions or release, and whether the drawings are preliminary designs, construction drawings or record drawings. At nearly all locations, many important drawings are kept rolled up and stored without being catalogued, and in no particular order.

Revisions to drawings are sometimes made by the Drafting Department as a result of customer account changes and/or pipeline changes. These changes are submitted to the department in the form of sketches from which the information is transferred to the master. The sketches and other forms of information are not retained for future reference.

6.1.4 Effectiveness

The mapping and record-keeping functions can best be described as ineffective. Information on physical plant, distribution and collection systems, record location drawings and equipment listings are basically not controlled and extremely difficult to access for use or information. When the need exists for drawings and records, the dependence is on the memory of individuals in the networks, treatment plants or booster stations.

6.1.5 Procedures and Methods

Existing mapping and record-keeping practices lack any application or consideration of procedures and methods. The functions are custodial and have received little direction from management.

6.2 RECOMMENDATIONS

The following series of recommendations are presented in two parts. Unlike the previous sections, where there were systems to improve, these recommendations involve the development of a system and then its refinement and improvement. The interim period focuses on what should be done to install an effective mapping and record-keeping system. The long-term period addresses refinements, improvements and new methods.

6.2.1 Interim Period

For the interim period, the following recommendations are made:

*- An inventory of all existing drawings should be performed and a control established for them. (See Exhibit 6.1.)

- An extensive review of existing maps and the data recorded thereon should be made to ensure records are up-to-date and accurate.

- Bills of material should be included on all new, equipment related maps and drawings when appropriate and when not practical a bill of material listing should be compiled separately and released as part of the map or drawing.

*- A procedure for initiating new drawings should be developed and implemented. (See Exhibit 6.2.)

*- A system for drawing release control should be established. (See Exhibit 6.3.)

*- A system for making drawing changes should be established. (See Exhibit 6.4.)

- Recommendations presented in the Physical Assets Report, Paragraph 4.2.1.1, should be followed.

- Responsibilities and functions for mapping must be clearly established.

*- An organizational structure for Mapping must be established and its role in Engineering defined with appropriate controls established.

- Responsibilities for the Mapping Groups should be defined, job descriptions developed and the group staffed accordingly.

- Techniques for mapping reproduction should be reviewed for in-house requirements capability and control. Factors to be considered in the selection of a reproduction system include:

  . Current reproduction costs.

  . Anticipated demand.

  . Cost of in-house reproduction systems.

  . Vendor service responsiveness.

  . Availability of service and supplies.

  . Location of in-house reproduction and improvements required (electrical, vents, storage).

- The following drawings should be maintained:
  - Originals, if an in-house reproduction service is used (one copy)
  - Reproducibles, if outside reproduction services are used (one copy)
  - Copies depending on availability of reproduction service:

    In-house - one reference copy

    Outside - one reference copy plus two copies for back-up

    Excess copies should be destroyed

6.2.2 Long-Term

Recommendations for the long-term include:

- Under the new organization structure, the feasibility of integrating primary service lines of both water and wastewater utilities on single maps should be investigated.
- When the mapping system has been established and is under control, more sophisticated drawing storage and retrieval systems can be reviewed for application. The types of information needed to evaluate such systems are:
  - Number of maps in system
  - Types and sizes of maps
  - Number and frequencies of map revisions and changes
  - Number of copies being distributed and controlled
  - Size and type of map most frequently requested and used
  - Requirements for control

  Only until this type of information, data and control is available can a realistic assessment of the most effective drawing storage and retrieval system be pursued, such as a micro-film system.

DRAWING CONTROL

Field surveys and interviews revealed a lack of control over the mapping and record-keeping functions.

To establish control the following steps should be taken and as illustrated on Page 3:

Step 1 Gather all maps in one location; organize the maps for review and inventory.

Step 2 For each map complete an inventory card containing at least the following information

- Application or title
- Master or copy
- Date of last change
- Size of the drawing and scale
- Age and condition
- Number of pages

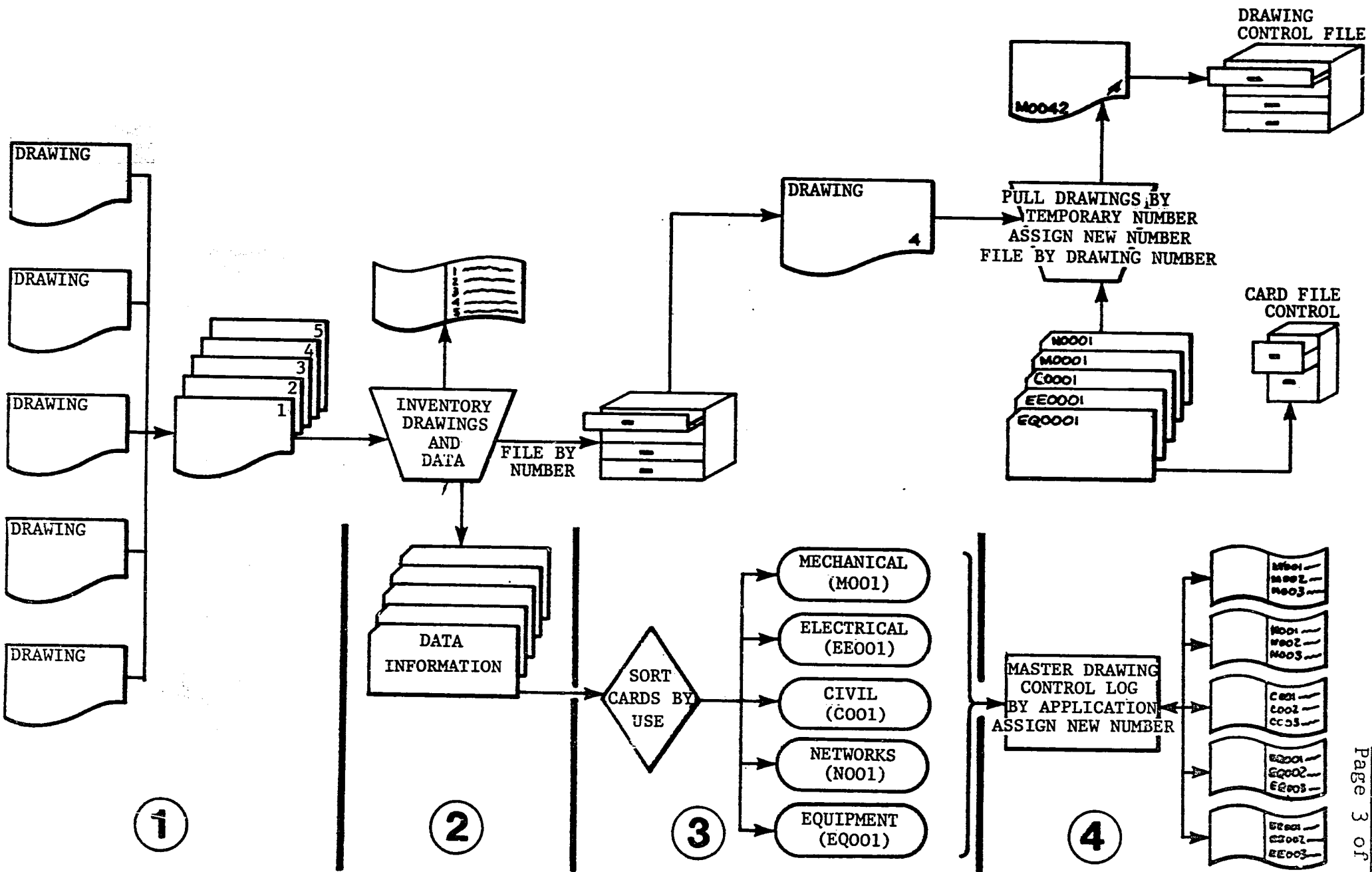
Establish a temporary drawing control log, issue a temporary number and apply the number to both the card and map. File the map under its temporary number sequence.

Step 3 Upon completion of the inventory, sort the cards by application or title. Segregate all networks drawings, as an example, by zone or region, by application (either distribution or collection), and determine if a key map exists.

DRAWING CONTROL

Step 4 Establish a permanent drawing control log for each distinct need, mechanical, electrical, civil, networks, equipment and other. For each map in a specific series, assign a permanent drawing control number to the inventory card. If a key map is required, assign a drawing control number and make an inventory card. Issue a request to the drafting section to make a key map for the zone involved. On completion of the permanent drawing number assignment pull the drawings from the file and insert the new number. Establish a filing system for the drawings and file by alpha-numeric sequence under the new number. On completion, file the inventory cards by their title or application sequence which can then form the basis for a cross-reference file.

This process will take time, but eventually there will be a basis for control.


DRAWING
DRAWING
DRAWING
DRAWING
DRAWING
1
2
3
4
5
INVENTORY DRAWINGS AND DATA
FILE BY NUMBER
DRAWING
4
PULL DRAWINGS BY TEMPORARY NUMBER
ASSIGN NEW NUMBER
FILE BY DRAWING NUMBER
M0042
DRAWING CONTROL FILE
CARD FILE CONTROL
M0001
M0001
C0001
EE0001
EQ0001
DATA INFORMATION
SORT CARDS BY USE
MECHANICAL (M001)
ELECTRICAL (EE001)
CIVIL (C001)
NETWORKS (N001)
EQUIPMENT (EQ001)
MASTER DRAWING CONTROL LOG BY APPLICATION
ASSIGN NEW NUMBER
1
2
3
4

MAPPING/DRAFTING REQUEST

Once the drawing control system is established, maintaining control becomes important. The figure on Page 2 shows the steps necessary to introduce new drawings into the system and establish control for their use and application.

The steps involved in a new drawing are:

Step 1 A drawing request (DR), three copies, is made and submitted to the Drafting Supervisor. Upon review and approval the DR is assigned a preliminary drawing number with a copy of the DR being returned to the originator documenting the approval and the preliminary drawing number assigned.

Step 2 The DR is received by drafting and a new drawing is made. Time and material for the preparation of the new drawing is charged to the preliminary drawing number. The DR serves as a work order.

Step 3 On completion of the drawing, the new drawing and the DR are submitted to the Drafting Checker for review and the responsible engineer for approval. On approval, a permanent drawing control number is assigned.

Step 4 The new drawing is transferred to the drawing control section where a control card is completed noting the date of issue, approval, title and number. The DR copy is transferred to the temporary drawing log where the new number is added in the log to serve as a reference to the preliminary number.

The system allows a means of controlling the introduction of new or revised drawings into the system in addition to a means of controlling the cost of labor and material using the preliminary drawing number and DR as a work order.

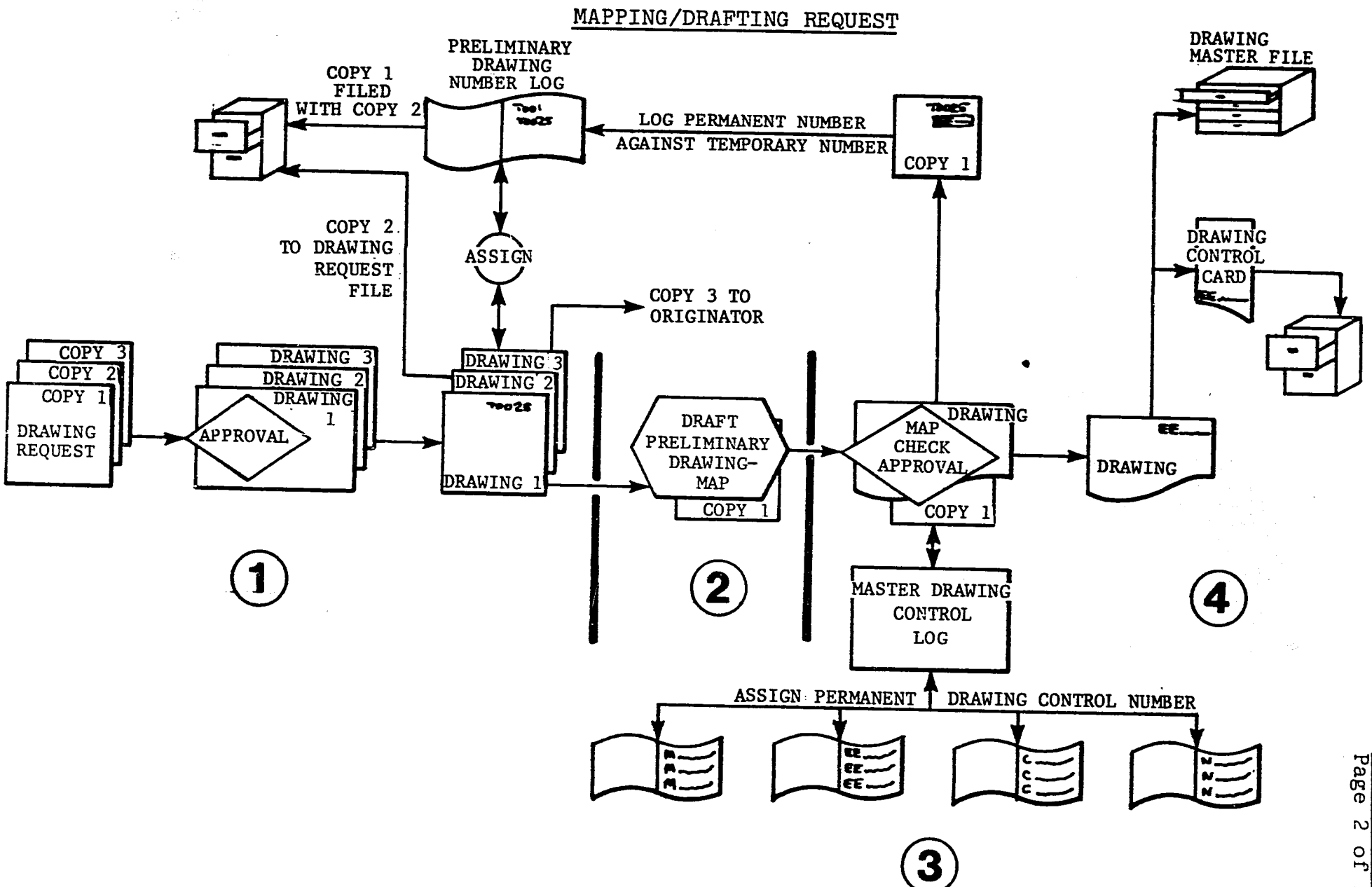


EXHIBIT 6.2
Page 2 of 2

DRAWING RELEASE CONTROL

One of the basic elements in controlling the use and application of up-to-date drawings is a controlled release program. This is not just releasing the drawings or records but also knowing where they are at all times to ensure the ability to insert the latest revisions, changes or corrections.

The system as shown on Page 2, is carried out in three steps:

Step 1 The master is removed from the file and copies made for distribution with the master being returned to the file.

Step 2 Copies are stamped individually, Copy 1, Copy 2 and so on. A drawing release card is made listing the copy numbers and the party to which the copy is assigned. The copy number also notes which revision or issue the drawing is, e.g., EE 00125 Rev. B.

Step 3 A two-part transmittal form is prepared for each recipient of a drawing or series of drawings with a note designating his receiving signature. The recipient signs and returns one copy of the transmittal letter to drawing control which is filed with the drawing release cards. The recipient must then bear the responsibility for controlling the drawing issued for his use and application.

This system puts the responsibility for the care and control of drawings on the user or recipient. Spot checks by drawing control must be performed to ensure that good control is being practiced by the user and reduce the chances of an incorrect or old drawing being used, resulting in costly delays or problems.

DRAWING RELEASE CONTROL

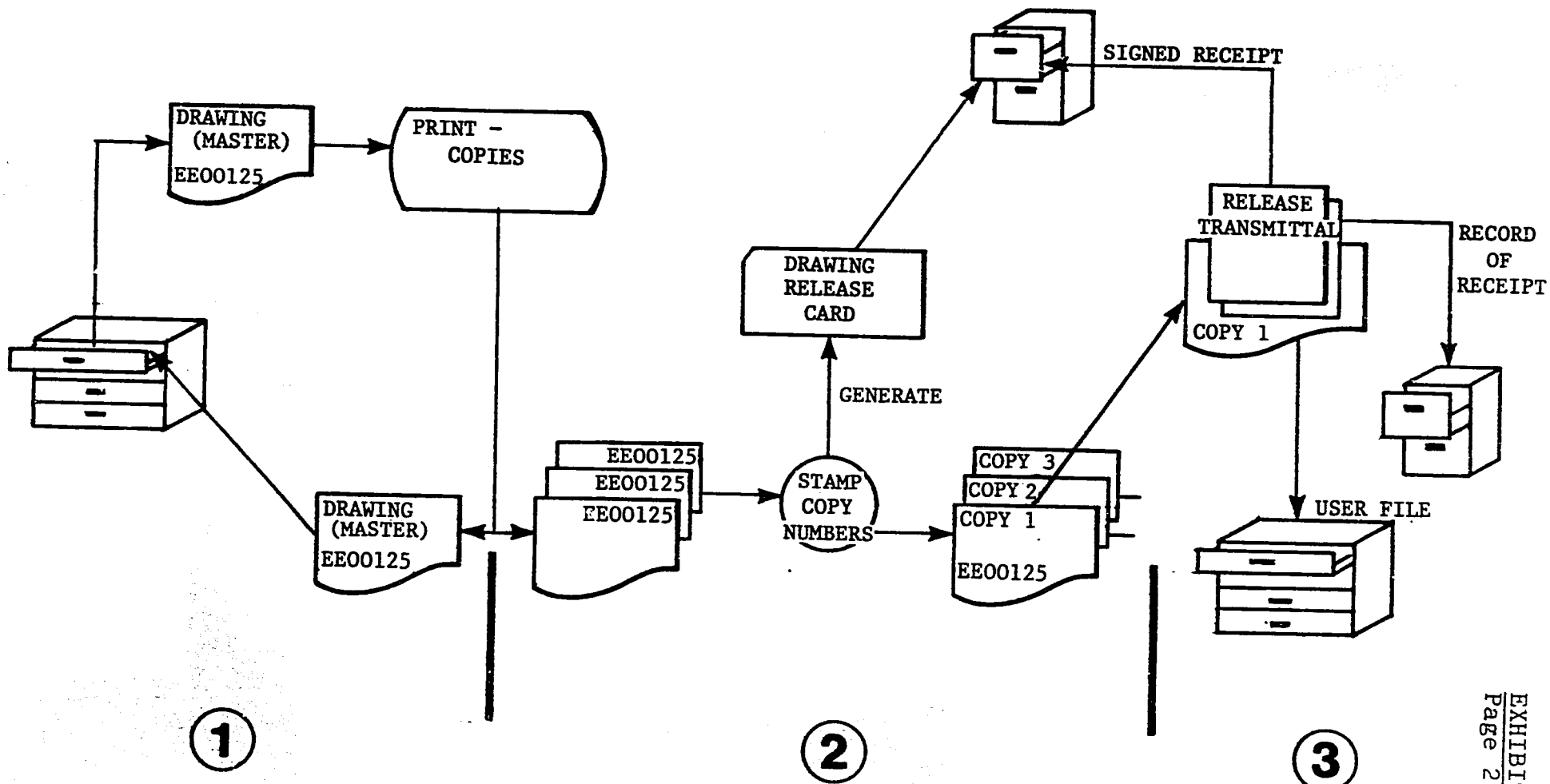


EXHIBIT 6.
Page 2 of

CHANGE ORDER CONTROL

Probably the simplest yet most important element in a control system is the need to incorporate changes. During construction projects conditions constantly arise reflecting situations which cannot comply with the drawing or specifications and results in what is known as the "as-built" condition.

To handle these "as-built" conditions, changes in equipment, and errors and omissions, a form can be generated known as an Engineering Change Order, ECO.

The ECO process is shown on Page 3 and includes the following steps:

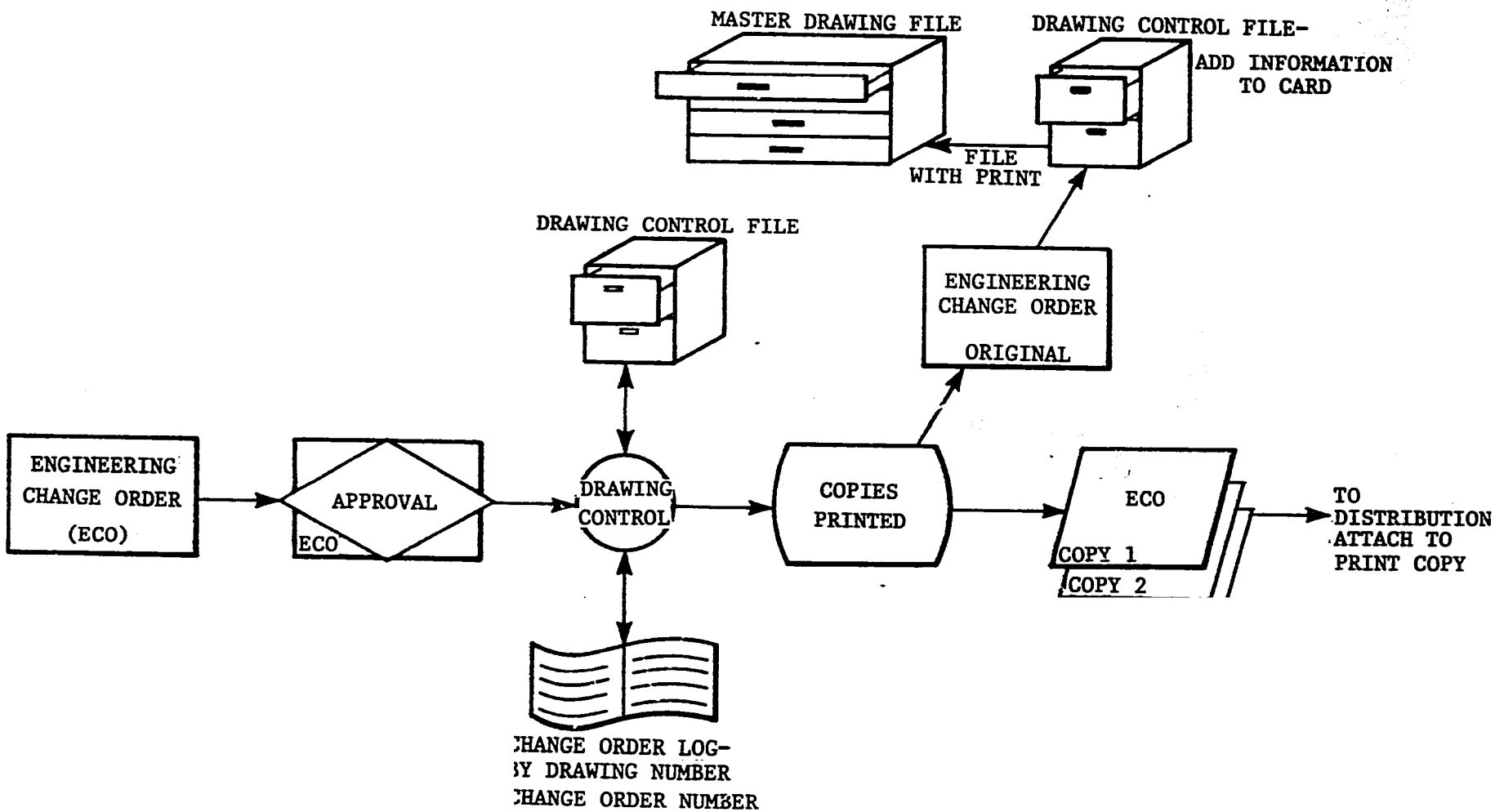
Step 1 An Engineering Change Order (ECO) request is initiated against a specific drawing or specification.

Step 2 The ECO is submitted to the Project Engineer or whoever is responsible for the drawing and upon approval submitted to the drawing control section.

Step 3 The drawing control section logs in the change order by the drawing number and assigns an ECO number. A copy of the ECO is placed in the Drawing Control file.

Step 4 Copies are printed, the number based upon the Drawing Release Card for the drawing, and transmittal forms are completed for issuance of the ECO. One copy of the ECO is sent to the Drawing Control Center for filing with the master drawing. The other copies are transmitted to the recipient where they are attached to a copy of each drawing

CHANGE ORDER CONTROL

This system provides a means of transmitting quickly approved and authorized changes. It is the practice to revise the master drawings after a set number of changes have been made, for example five. This prevents too many changes being outstanding or the opportunity of a change being lost, and reduces the expense of constantly making a new master. It also provides for the documentation of all changes with an increase in the reliability and validity of the drawings.

CHANGE ORDER CONTROL