

PD-ABK-162

Evaluation

of the

Preventive Maintenance Project

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Final Report

Contract No.: 263-0132-C-00-2215-00

DATEX INC

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of the
Preventive Maintenance Project

FINAL REPORT

PRESENTED TO:

USAID/CAIRO

(Under Contract No.: 263-0132-C-00-2215-00)

Submitted by:

DATEX INC.

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PREVENTIVE MAINTENANCE PROJECT EVALUATION

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LIST OF ABBREVIATIONS

CMP	Channel Maintenance Program
EMS	Equipment Management System
GOE	Government of Egypt
IAS	Irrigation Advisory Service
IBRD	International Bank for Reconstruction and Develop
IMS	Irrigation Management Systems
MOMS	Management Operations for Maintenance Systems
MPWWR	Ministry for Public Works and Water Resources
O&M	Operation and Maintenance
PEC	Public Excavating Company(s)
PMP	Preventive Maintenance Program
ROM	Review of Operation and Maintenance
SPIC	Spare Parts Inventory Control
SR	Structure Replacement
USBR	U.S. Bureau of Reclamation
USAID	U.S. Agency for International Development

PREVENTIVE MAINTENANCE PROJECT EVALUATION

I. EXECUTIVE SUMMARY

The River Nile is Egypt's most important natural resource. The extensive irrigation system stemming from this great river covers an area of more than 7 million feddans (about 7.3 million acres).

The objective of the Preventive Maintenance Project (PMP) is to improve the capability of the Ministry for Public Works and Water Resources (MPWWR) for maintaining Egypt's irrigation and drainage system. The PMP is one component of the United States Agency for International Development (USAID) Irrigation Management Systems (IMS) Project, which has as its goal the improvement of control and utilization of Nile River water to help increase agricultural production and productivity. Funding of the PMP is a joint effort between the USAID and the Government of Egypt (GOE). USAID funding for the PMP is estimated to be about \$90 million over a period of 10 years, with the remainder from the GOE.

The purpose of this evaluation was to assess the extent to which project objectives have been achieved, identify major constraints that have impeded implementation, and make recommendations for further assistance. A team of four independent consultants from Datex, Inc. - two from the United States and two from Egypt - carried out the evaluation from November 3-26, 1992, in Cairo and the six PMP Governorates.

This report is divided into three sections:

- Section I - Provides an executive summary, including a listing of the main recommendations,
- Section II - Describes the PMP along with objectives, methodology, and scope of the evaluation, and
- Section III - Gives an assessment of the PMP, major constraints, additional assistance needed, future maintenance alternatives, and sub-goal accomplishment.

FINDINGS

Following is a summary of PMP accomplishments and progress to date.

The pilot program which has been established in Gharbia is fully operational and engaged in ongoing PMP activities. Joint funding by USAID and the GOE has been sufficient to develop the program at Gharbia and to initiate program development in the other five Governorates.

The initial inventory of the condition of all structures, canals, drains, and service roads has been completed, but the cost estimate for completing needed work has not. Estimates for maintenance work are now made in conjunction with the annual maintenance work plans.

Budgets are elaborated on the basis of the annual maintenance work plans and submitted for approval. This process will be further developed to include at least 3-year work plans; in some cases this is already being done.

Maintenance management planning procedures have been initiated but not fully implemented. Maintenance of the irrigation and drainage system is poor. Procedures must be established to develop and sustain a satisfactory maintenance program; manuals for maintenance and weed control are in various stages of completion and should be in use the Directorates soon.

Six Governorates' offices and repair shops and one central parts warehouse have been constructed with GOE funding. These facilities are generally well conceived but some shops are not yet fully operational. In most cases, only minor work is required to achieve operational status.

The weed problem is very serious on the irrigation and drainage systems. Due to the prohibition of the use of herbicides, the weeds must be controlled by biological and/or mechanical methods. There is on-going testing and research of methods and machines to determine best weed management practices and it is progressing adequately. The use of fish should be encouraged to provide weed control in the irrigation and drainage channels.

Commitment by upper management appears quite strong. Team discussions with officials, as well as progress in some Governorates, substantiates this. But progress in at least 2 Governorates could use improvement, perhaps indicating the need for stronger upper management commitment.

Funding appears to be adequate for reasonable development of the PMP. Future years' GOE budgets indicate increased and adequate funding for maintenance activity in conjunction with anticipated decreases from other sources.

An organization support unit has been established for the PMP headed by a PMP Director who reports to the Project Director, Cairo. This organization appears to be well conceived and is working well.

The projected staffing for the PMP is adequate. In several cases, projections have not been fully met; however, considering all conditions, this activity is progressing satisfactorily as development of the PMP proceeds.

In general, training has been satisfactory and is about 80 percent complete. More on-the-job training is required to fully utilize equipment and provide full capability.

Generally, the equipment which has been purchased is excellent and the procurement process is about 70 percent complete. Equipment utilization is beginning and needs improvement in most Governorates, but is nevertheless progressing satisfactorily.

The critical elements of a successful maintenance program are given below. These are based on the Team's review, discussions, data, and observations relative to the PMP; these critical elements have been evaluated and summarized as shown below.

<i>Critical Element</i>	<i>Deficient</i>	<i>Adequate</i>	<i>Excellent</i>
<i>Maint/Procedures</i>	X		
<i>Facilities</i>		X	
<i>Management Commitment</i>		X	
<i>Funding</i>		X	
<i>Organization</i>		X	
<i>Staffing</i>		X	
<i>Training (1)</i>			X
<i>Equipment (2)</i>			X

(1) Excellent for first generation, more training needed for irrigation system work

(2) Equipment procurement is excellent, full and proper utilization needs developing

The overall organization, facilities, staffing, training and equipment accomplishments have been commendable and are essentially complete or progressing on schedule.

Development of the process and procedures for irrigation and drainage system maintenance requires additional work in the areas of documented instructions, procedure and policy development, manual preparation, and training. Considerable additional technical assistance is needed in this area to achieve proper and full utilization of heavy equipment and maintenance of all equipment and facilities. The completion of this work will be a significant step in achieving PMP objectives and developing a satisfactory maintenance capability for Egypt's irrigation and drainage system.

Significant progress has been made in initiation and preliminary development of most of the PMP activities, and many of the project objectives have been accomplished. Due to the brief implementation period to date, however, additional time will be required to bring the PMP efforts in the initial six Governorates to fruition. The progress, major strengths and constraints of the PMP are identified and discussed in this report.

The development and progress of the PMP is commendable and demonstrates excellent potential to establish and sustain a satisfactory maintenance program for the irrigation system. This is critical to the future success of Egypt's agricultural economy. The success demonstrated in Gharbia, the pilot project, shows that the PMP can provide a satisfactory irrigation and drainage system maintenance capability in Egypt. Based on this success and the Team's evaluation, Datex believes that completion of the work recommended in this report will lead to fruition of the PMP objectives in the other five Governorates. The Team accordingly recommends that replication in the additional Governorates should also take place to accomplish the overall objectives of the PMP and the IMS Project. The program is badly needed in Egypt to improve the condition of the irrigation and drainage system.

RECOMMENDATIONS

Recommendation 1 *p. 11*

The "Irrigation and Drainage Systems Maintenance Manual" and "Irrigation and Drainage Maintenance Procedures Manual" should be completed in two volumes for use in the maintenance management process/procedures work by July 1993, in English and Arabic, and distributed for use.

Recommendation 2 *p. 11*

Arabize the "Weed Control Manual for the Irrigation and Drainage Channels of Egypt" by July 1993 and distribute for use.

Recommendation 3 *p. 12*

All PMP repair shops should be made fully operational by Jan 1993.

Recommendation 4 *p. 13*

A high priority should be placed upon the development and implementation of an integrated weed management program making maximum use of mechanical and biological practices.

Recommendation 5 *p. 14*

Assign a high priority and continue the existing PMP effort through May 1995 to complete priority on-going activities, to correct project deficiencies, and to fully develop the program.

Recommendation 6 *p. 14*

Based on the demonstrated success of the PMP in the Gharbia Governorate and the progress made in the other five Governorates, completion of the work recommended in this report will

lead to fruition of the PMP objectives, as long as proper maintenance procedures are fully developed and implemented. Datex therefore recommends that replication of PMP into five additional Governorates be initiated in June 1993 and in the remaining Governorates by July 1994, contingent upon demonstrated progress in maintenance.

Recommendation 7 *p. 16*
Technical assistance should be provided to complete the scheduled training and to provide on-the-job training in the development and implementation of the maintenance planning process/procedures and equipment repair and utilization work as described in III. C.

Recommendation 8 *p. 16*
Video equipment should be provided to the PMP Project Directors for training use and demonstrating the benefits of the PMP.

Recommendation 9 *p. 16*
Establish a technical library of O&M reference material in each Directorate, and Arabize as needed.

Recommendation 10 *p. 17*
Give a high priority to the on-going PMP effort to complete procurement of remaining equipment, to provide training for the equipment, and to further develop the MPWWR procurement capability.

Recommendation 11 *p. 20*
Develop a flexible reward/incentive program by March 1993 for operators, mechanics, and technicians based on quality of work and productivity to properly utilize their acquired skills.

Recommendation 12 *p. 25*
Evaluate all the IMS Project components in terms of their maintenance needs to determine the overall maintenance requirement.

Recommendation 13 *p. 26*
Develop and implement a Review of Operation and Maintenance (ROM) Program for the irrigation systems in Egypt beginning with the PMP Governorates in 1993.

II. INTRODUCTION

A. General

The River Nile is Egypt's most important natural resource. The extensive irrigation system stemming from this great river covers an area of 7.3 million acres (7 million feddans).

The objective of the Preventive Maintenance Project (PMP) is to improve the capability of the MPWWR for maintaining the irrigation and drainage system of Egypt. The PMP is one component of the USAID Irrigation Management Systems (IMS) Project which has the overall goal of improving the control and utilization of Nile River water as a means of increasing agricultural production and productivity in Egypt. Funding of the PMP is a joint effort between the USAID and the GOE. USAID funding for the PMP is estimated to be about \$90 million over a period of 10 years with other required project funding to be expended by the GOE.

The purpose of this evaluation was to assess the extent to which project objectives have been achieved, identify major constraints that have impeded project implementation, and make recommendations for further assistance. A team of four independent consultants from Datex, Inc., two from the United States and two from Egypt, carried out the evaluation from November 3-26, 1992, in Cairo and the six PMP Governorates.

In view of the current poor maintenance condition of the irrigation system and since the continued operation of the irrigation and drainage system is sorely dependent on effective maintenance, the Preventive Maintenance Project (PMP) should become a high priority component of the portfolio of USAID's Irrigation and Land Development Office. Within the logical framework, the operational improvements worthy of pursuit are those that can be sustained through a carefully developed and sustained maintenance program. **At this point in time, maintenance should be the immediate action program needed to "revive and sustain" the irrigation system which currently has enormous maintenance needs.** Maintenance is the first basic need of Egypt's irrigation system; other IMS components should build on strengthening the O&M program in conjunction with improving the basic maintenance program.

B. Preventive Maintenance Project Description

The MPWWR, with technical assistance from Morrison-Knudsen Engineers, Inc., of the U.S.A. has been working for three years on a component of the IMS Project, which is funded through a grant by USAID. The project is implementing a PMP on structures and on water distribution and drainage channels in six Governorates (Gharbia, Minya, Minufiya, Qalyubia, Beheira, and Dakahlia) to improve the flow of water to farmers. To implement this program, the existing equipment was evaluated in six Governorates. The needs to provide for proper maintenance

were determined, and recommendations were made for the procurement of about \$18.4 million of new equipment. In addition, the MPWWR and Technical Assistance team provided a design for repair shops to be constructed by the MPWWR in each of these Governorates. These shops are essentially completed and in various stages of operational status. A new PMP organization was also formed and training was accomplished for the various components of the project.

The Channel Maintenance Program (CMP) is a concurrent and related program. It involves development of an integrated maintenance program for channels. This program includes periodic or cyclic desilting and mechanical removal of ditch bank weeds. Submersed and floating aquatic weeds will be controlled by mechanical and biological means. The CMP makes extensive use of the Public Excavation Companies (PEC), and the program is being financed by a cooperative effort of the MPWWR, the International Bank for Reconstruction and Development (IBRD) and the USAID.

C. Objectives, Methodology, and Scope

1. Objectives

The objectives of this evaluation are to:

- **Assess the extent to which project objectives have been achieved.**
- **Identify major constraints that have impeded project implementation.**
- **Make recommendations for further assistance, if appropriate.**

2. Methodology--Indicators of Project Objective Achievement

The revised logical framework objectives for the project were used as a framework for the evaluation. This approach highlighted the progress toward achievement of project objectives, and the contribution of project initiatives toward those objectives.

a. Sub-goal---Improved Operating Efficiency

USAID has identified two indicators of sub-goal achievement; area served per unit of irrigation water delivered and value of production per unit of irrigation water delivered. The level of effort for this evaluation did not allow for the data collection and analysis required for measuring either of these two indicators. The following three elements of efficiency were judged to be valid indicators of progress toward sub-goal achievement and are discussed in III. E.

- (1) Improved Efficiency Along Sample Canals**
- (2) Water Delivered to Users at End of System**
- (3) Complaints from Water Users**

b. Purpose--Strengthened MPWWR Maintenance Capability

Indicators that are concrete and easily measurable relative to maintenance capability are difficult to select. Therefore, in order to address all key aspects of institutional maintenance capability; items (1) - (14) below were selected to give a more comprehensive listing than those in the revised logical framework for the project. Outputs for the project, from the revised project logical framework, are listed as items (1) - (6) below.

- (1) Inventories of facilities**
- (2) Annual maintenance plans being developed**
- (3) A maintenance management planning process and (procedures) established**
- (4) A set of manuals**
- (5) Facilities established**
- (6) Weed research reports and recommendations**

Whereas the first six outputs noted above constitute discrete indicators of project achievement, items (7) - (14) are more broad in scope and represent key elements of a maintenance program. Item (14) below, is very significant with regard to MPWWR maintenance capability, and is included on the project revised logical framework as a project objective.

- (7) On-going maintenance program in the six Governorates**
- (8) Management Commitment**
- (9) Funding**
- (10) Organization**
- (11) Staffing**
- (12) Training**
- (13) Equipment**
- (14) Elimination of maintenance practices that result in deterioration of the system**

Assessment of these items will constitute the core of this evaluation and will provide a measure of the level of maintenance capability achievement.

3. Scope

The Team visited each of the six governorates and collected information on the indicators of performance listed in II.C. The consultants collected additional information through extensive discussions with MPWWR and Morrison-Knudsen, Inc. (technical assistance contractor) personnel in Cairo and IMS Project personnel. The Team interviewed a broad range of personnel in the PMP/CMP and Governorate Offices including Under Secretaries, Project Directors, Chief Engineers, Maintenance Engineers (Mechanical and Civil), Technicians, and Operators. They found all of these personnel to be very cooperative and hospitable which helped immeasurably in obtaining the necessary information to effectively complete this evaluation.

Although there are some differences in current capability and progress among the Governorates, the major areas of strength and weakness are generally similar. Therefore, this assessment is presented as a composite of all six Governorates.

III. SUMMARY OF FINDINGS AND RECOMMENDATIONS

A. Assessment of PMP Progress and Capability

1. PMP Assessment and Progress

a. General

An evaluation of the PMP items (1) - (14), as discussed in II.C. is given below as a composite of all six PMP Governorates including Gharbia, the pilot Governorate, which has been operational about 2 years. The other five Governorates have received much of their equipment recently; therefore, their evaluation is based on a shorter operational period and perception of their projected progress and potential as applicable.

(1) Inventories

The requirements of this output are an inventory of all structures, canals, drains, and service roads by location, physical features, condition, and estimated cost of repair.

This inventory has been completed for all structures, canals, service roads, and drains. The estimated cost of repair is not completed. Cost estimates for needed maintenance work, however, are now done in conjunction with annual work plans. This inventory has been useful in determining the initial condition and as a basis for developing future work plans and environment.

(2) Preventive Maintenance Annual Work Plans

It is required that annual PMP implementation plans be developed and implemented along with a process for annual, or longer, updating.

All of the Governorates have a process established and implemented for inspection of their system facilities by field and other maintenance personnel to identify required annual work. This work is prioritized by maintenance and management officials and submitted to MPWWR for approval and funding. Most work plans are presently done on an annual basis; although this may be sufficient for the initial work planning, a more desirable procedure would be to develop at least a 3-year work plan which is then updated annually. The initial inventory could also be used for this purpose. Development of a 3-year work plan provides a good planning and budgeting tool that can be used with preventive maintenance activities.

Prior to the PMP, development of work plans was weak or non-existent. Implementation of PMP procedures has resulted in the development of work plans and related activities which have been very beneficial in the overall maintenance process.

(3) Maintenance Management Planning Process/Procedures

This output requires that a maintenance management planning process/procedures be developed and implemented. It would include appropriate policies and procedures for identifying and accomplishing maintenance needs and establishing maintenance standards, This requirement has not been fully met and still requires some work to accomplish its completion as discussed in III. C.

Significant work has been accomplished relative to this issue; however, due to the limited operational experience of five of the Governorates, much of it has not been completely finished. Completion of this work, as discussed and recommended in this report, will be a significant step in providing satisfactory maintenance capability to the Governorates . The potential to achieve this capability in Egypt has been demonstrated in Gharbia, the pilot Governorate. Based on their evaluation, the Team is confident that similar success can be achieved in the other five Governorates if the recommendations in this report are accomplished and given sufficient time for program development. The technical assistance and time requirement to fully implement the maintenance planning process/procedures is discussed in III. C.

(4) A Set of Manuals

As part of the PMP work, three documents have been partially completed which will contribute significantly to the development of the maintenance management planning process/procedures; however, none are in use presently. These documents are:

- a. Irrigation and Drainage Systems Maintenance Manual
- b. Irrigation and Drainage Maintenance Procedures Manual
- c. Weed Control Manual for the Irrigation and Drainage Channels of Egypt

Document a., with some modification, can provide the policies and procedures for planning the maintenance management process. Document b., also with some modification, can provide the specific maintenance procedures which are necessary to properly perform the field maintenance work. Document c. is an excellent publication which is completed in English but requires Arabization for field use.

Work should be initiated on a priority basis to complete these manuals into documents for use on the irrigation systems of Egypt. It will also be necessary to provide technical assistance to help in the development of the maintenance planning process/procedures as described in these manuals. Significant work has been done under the PMP on manual development, however, additional technical assistance is required for this activity as discussed in III. C.

It is important that the manuals be completed as soon as possible so that they can be used in all aspects of maintenance work on the PMP, including training of maintenance personnel in the Governorates.

The development of a "Review of Operation and Maintenance Program" should be discussed in the Maintenance Manuals because of its importance to the development and continuance of a successful maintenance program. Please see III. D. 5. for further discussion of this topic.

Recommendation 1

The "Irrigation and Drainage Systems Maintenance Manual" and "Irrigation and Drainage Maintenance Procedures Manual" should be completed in two volumes for use in the maintenance management process/procedures work by July 1993, in English and Arabic, and distributed for use.

Recommendation 2

Arabize the "Weed Control Manual for the Irrigation and Drainage Channels of Egypt" by July 1993 and distribute for use in Egypt.

(5) Physical Facilities

The requirement under this output was to construct six Governorate Offices, six repair shops, and one central warehouse.

These facilities, which were GOE funded, have been constructed or renovated in each of the six Governorates. The offices are good facilities and most are being used presently. The repair shops are in various stages of completion and operation. Only two had electrical service at the time of the consultants' visit; however, one was using a portable generator to perform maintenance. The facilities are generally well conceived and very well equipped and should be excellent facilities when fully operational. Progress relative to achieving full operational status of the repair shops is adequate in 4 Governorates and somewhat slow in 2 Governorates. It is important that the repair shops be made operational as soon as possible so that repairs can be made on the heavy and other equipment promptly and to avoid a large maintenance backlog.

Recommendation 3

All PMP repair shops should be made fully operational by January 1993.

The central parts warehouse is an excellent facility and is in the process of becoming fully operational. It is well conceived and developed and should provide excellent spare parts capability for the six Governorates and eventually to all of Egypt.

(6) Weed Reports and Recommendations

The weed problem in the irrigation system and drainage channels is serious and should be attacked with full vigor through an integrated weed control/management program. Neglecting

this problem further will seriously hinder the capability of the system to properly deliver and drain water to meet Egypt's water resources needs.

Since the use of herbicides is prohibited, the two available methods for weed control are biological and mechanical. Mechanical means commonly used/tested for the PMP include weed harvesters, flail mowers, brush cutters, side slopers, and drag lines. Most of these methods, or a combination thereof, are being used to determine the most effective and efficient methods under the conditions encountered in Egypt.

A research project is currently underway at the Weed Research Center to investigate the use of fish (grass carp) for managing vegetation in canals and drains. This method has had outstanding success on other irrigation systems of the world and should be actively pursued in Egypt to determine its feasibility. Potential management problems, such as handling of the fish during outages (the continuous flow concept could benefit this problem) and depletion of the fish population by fishing are being addressed. The key to the success/failure of the fish program may be in the establishment of a "season of fish taking" after the peak irrigation demand. The team is generally optimistic about the use of fish for managing the weed control problem in Egypt because of its success in other parts of the world, and other potential benefits. i.e. fishery, environmental and operational soundness.

Significant efforts have been expended to determine best methods of managing the weed problems in the canal and drainage systems, including research and field work, and this output is progressing satisfactory. Because of its severity, it should receive high priority.

Recommendation 4

A high priority should be given to the development and implementation of an integrated weed management program making maximum use of mechanical and biological practices.

(7) Ongoing maintenance programs in the six Governorates

The maintenance programs have shown significant improvement in all of the Governorates when compared to pre PMP conditions. Prior to PMP, most of the maintenance work was accomplished on an as needed or emergency basis and virtually no PM activities were performed.

During the visits to the six Governorates, the Team observed considerable maintenance work being done including PM type work such as cleaning and painting of gates, aqueduct repair and replacement, bridge repair, and O&M road maintenance. Maintenance work included the repair and/or replacement of badly deteriorated aqueducts and gates. Significant work was also being done on O&M road reconstruction and maintenance. Many of the canal roads had become impassable and their repair/reconstruction is a basic and important step in initiating the improvement of the O&M capability. In most cases where the consultants observed maintenance work being performed, the PMP purchased equipment was being utilized. Better utilization of

the equipment can be realized; however, the progress is commendable considering the limited experience of the operators.

In general, the ongoing maintenance program has improved significantly with the implementation of the PMP even though the operational time has been limited. Meaningful maintenance work is presently being done and will improve as operators become more experienced in proper procedures and practices. Although work remains to be done, maintenance programs and capability are presently being developed and work accomplished as a result of the PMP effort.

The above improvements in maintenance capability, and other factors discussed in this report, strongly demonstrate the on-going and potential benefits of the PMP. They also provide substantiation and credibility for its future continuance and implementation. Accordingly, replication should take place in five additional Governorates (Shargia, Kafe-Shiek, Beni Suef, Asyut, and Qena) beginning in June 1993. Replication in the remaining Governorates should begin as soon as possible, and no later than July 1994. Datex recommends replication in all Governorates because the on-going PMP program has successfully demonstrated the initiation and preliminary implementation of a strong maintenance program, something that is badly needed in Egypt. There is a strong belief that completion of the recommendations given in this report will lead to a strong maintenance program and capability in the six PMP Governorates. This further substantiates the need and benefits of replication in the remaining Governorates. Furthermore, it would be an inefficient use of time and funding if the replication process for the remaining Governorates is not developed to bring this program to its full fruition. The PMP process appears to be the best process to establish an effective maintenance program in Egypt.

Recommendation 5

Assign a high priority and continue the existing PMP effort through May 1995 to complete priority on-going activities, to correct project deficiencies and to fully develop the program.

Recommendation 6

Based on the demonstrated success of the PMP in the Gharbia Governorate and the progress made in the other five Governorates, completion of the work recommended in this report will lead to fruition of the PMP objectives. This is contingent upon the development and implementation of effective maintenance procedures. Therefore, PMP should be replicated in five additional Governorates starting in June 1993 and in the remaining Governorates by July 1994, as long as significant progress can be demonstrated in maintenance.

(8) Management Commitment

This is a somewhat subjective but key element in the success of an O&M program. Upper management must believe that a strong O&M program is critical to project success and provide strong support and commitment to all project activities and the employees, including sufficient

budget. It is evident, based on the condition of the irrigation system, that maintenance has not been a high priority of upper management. The perception and best judgment of the consultants is that commitment by management has improved significantly with the initiation and implementation of a satisfactory maintenance program.

Extensive meetings were held in each of the six Governorates at which information needed to assess the maintenance program commitment was obtained and discussed. The Under Secretaries and General Directors were in attendance at these meetings. Their comments were generally very positive and supportive of the PMP. The progress shown to date within the six Governorates is perhaps a better indicator of their commitment. On this basis, Gharbia (pilot project) has shown good progress along with Minufiya, Qalyubia, and Minya while Beheira and Dakahlia have demonstrated slower progress. For example, the lack of progress (little has been done in 3 years) on the repair shop in Dakahlia along with the lack of electrical service at some of the other repair shops demonstrates some lack of commitment by management.

On the positive side, significant work has been done in each Governorate which demonstrates a genuine commitment to the PMP.

Our perception is that management commitment is generally excellent relative to the PMP.

(9) Funding

Funding of the PMP development effort to date was not seen as a major constraint in the discussions. The attitude was generally positive on future funding of PMP even though the USAID contribution is programmed to decrease. The GOE five-year plan has budgeted PMP local operating funds in order to support the project until 1995. GOE funds are to increase annually in conjunction with reduced contributions from the projects' USAID grant funds to the point that in 1995, GOE funds are the sole funding entity. GOE budgets reflect this funding schedule.

(10) Organization

The irrigation sector in the MPWWR is divided into 19 Governorates. Each of these consists of one or more directorates, depending on the size of area served. The Irrigation Directorate is usually divided into a number of Irrigation Inspectorates which are in turn subdivided into Irrigation Districts, each headed by a District Engineer.

A new organizational unit has been established in each of the six Governorates with a PMP/CMP Director reporting to the General Director and to the PMP Project Director (Cairo). A typical organization chart for a Governorate is shown on Appendix 1. The PMP/CMP Unit is essentially a new support function within each Governorate. This Unit is generally organized on the basis of engineering disciplines with an administrative support unit. A typical PMP/CMP organizational chart is shown on Appendix 2.

The General Director has the overall responsibility of all irrigation activities including the PMP/CMP activities which is a Unit headed by a Chief Engineer (Director of PMP/CMP). He is assisted by a staff comprising civil, mechanical, and electrical engineers, technicians, operators, mechanics, drivers, and skilled and unskilled laborers.

The Cairo Project Director and his staff monitor and follow up on the irrigation maintenance activities in the six Governorates covering the PMP.

In general, the organizational arrangements are satisfactory.

(11) Staffing

The scheduled staffing of the organization to operate the PMP is generally adequate; however, additional personnel are needed in most of the Governorates to complete the staffing requirement. Additional staffing is an on-going activity and when this need is filled and there is further staff development and utilization, this activity should be satisfactory. To date, the staffing of the PMP units has been largely with younger personnel who are anxious to utilize their new skills.

(12) Training

A great deal of training has been accomplished within each of the six Governorates in accordance with an approved PMP training program (revised 1991). A total of 81 man weeks (78 percent of the approved program) of off-shore training has been completed. This program has focused upon management level personnel in the areas of observation programs and civil and mechanical technology. Consideration is currently being given for sending 10 General Directors on study tour training. A total of 1737 man months (81 percent of approved program) of on-shore training has also been completed to date. This program has focused on the staff (workforce) of the new PMP organization in each Governorate.

The training program has covered a very broad range of training from lubrication, maintenance and operation of equipment to secretarial, computers and engineering. This extensive and comprehensive training program will be virtually completed by May 1993.

The current training program lacks training in putting the established maintenance capability to work on the irrigation system. At this time the focus of the training program needs to be directed to on-the-job-training in full and proper utilization of the maintenance capability on the irrigation system and in proper maintenance of all equipment. This form of training can best be accomplished by the hands-on technical assistance expertise which is discussed in more detail in III. C. The use of video equipment would be very helpful in these training programs

The training provided under the PMP has been excellent and is a major improvement over pre-PMP conditions. Completions of the scheduled training, including on-the-job activities, and

related items as discussed in this report should result in a cadre of personnel capable of supporting a satisfactory maintenance program.

Recommendation 7

Technical assistance should be provided to complete the scheduled training and to provide on-the-job training in the development and implementation of the maintenance planning process/procedures and equipment repair and utilization work as described in III. C.

Recommendation 8

Video equipment should be provided to PMP Project Directors for training use and for demonstrating the benefits of the PMP.

Recommendation 9

Establish a technical library of O&M reference material in each Directorate, and Arabize as needed.

(13) Equipment

Each of the Governorates has been outfitted with an excellent configuration of heavy equipment, support equipment and vehicles. An appropriate assortment of shop equipment, tools, spare parts, and office equipment has also been (or is being) established. About 70 percent of the physical equipment capability in terms of funds is currently in place. A high priority needs to be given to (1) procurement and delivery of remaining equipment, (2) appropriate training on this equipment, and (3) further development of MPPWR procurement capability during the remaining time of the existing technical assistance contract and extended technical assistance proposal for this activity. The other immediate thrust of the on-going effort needs to be in proper and full utilization of the heavy equipment on the irrigation system and in proper maintenance of all equipment. This requires the addition of an Equipment Specialist/Utilization and an Equipment Specialist/Maintenance, as discussed in III. C.

Additional equipment which was purchased include computers (including software), copiers, fax machines, and related support equipment. The computer configuration includes software systems for the Equipment Management System (EMS), Spare Parts Inventory Control (SPIC), Management Operations for Maintenance Systems (MOMS), financial systems, word processing, and related programs. These software systems are being developed and are partially operational except for the MOMS package which is in the early stages of development.

The EMS package has progressed substantially and its use was ably demonstrated in several of the Governorates. It is well planned and will be a useful tool for equipment use analysis, equipment requirements, and tracking. The MOMS package will be developed as part of the technical assistance provided for development of the maintenance management planning process/procedures activity.

The equipment purchased under the PMP is a major step in the development of a satisfactory maintenance program. The equipment is high quality and appropriate for its intended purpose. Provisions made for equipment repair under the PMP is especially important and critical to PMP success. The pre-PMP equipment and associated activities were very minimal.

Recommendation 10

Give a high priority to the on-going PMP effort to complete procurement of remaining equipment, to provide training for the equipment, and to further develop the MPWWR procurement capability.

(14) Elimination of Maintenance Practices that Result in Deterioration of the System--The traditional method of clearing channels and weed control is by using a dragline excavator with attached digging bucket. However, this practice often widens and deepens the channel. The enlarged channel often tends to encroach on the embankment and in some instances has completely eliminated the O&M roads. Also, overexcavating of channels reduces water velocity and creates an environment for increased weed growth and maintenance.

The PMP/CMP introduced new methods of weed removal using a hydraulic excavator with special attachments such as flailmowers, brush cutters, and shallow draft buckets to control bank growth and water weeds without disturbing the canal cross-section. A side-sloper blade attachment to the motor grader, which has been provided, will also assist in weed control problems on the canal banks.

An experiment was carried out by providing flail mowers and shallow draft buckets using private excavating companies (PEC) hydraulic excavators. Accordingly, a procurement process is in process which will provide each irrigation Directorate with one hydraulic excavator with flail mower, brush cutter, and shallow draft bucket to be used according to the new system of weed control.

Another maintenance practice observed and discussed was the annual painting of gates. Procedures should be used which would provide a more lasting coating for the gates as this activity, as now practiced, is very labor intensive and expensive as it is now performed on an annual basis. Cathodic protection measures should also be considered as a protection for the metal gates.

The PMP has been instrumental in testing and implementing successfully proven maintenance practices and in identifying others which may require improvement. This aspect of the PMP is very important and its continuation is critical to the future success of maintaining the irrigation system in Egypt.

B. Major Constraints

1. Maintenance Process/Procedures (Manuals)

Technical assistance has been weak relative to the establishment of a satisfactory maintenance management planning process and procedures on the irrigation system. The absence of completed maintenance manuals and accompanying instructions has been counter productive to the initiation of a good PM program. The current maintenance manuals should be revised and completed, including Arabization. See Recommendations 1 and 2.

2. Employee Production

During the life of the PMP, many operators, mechanics, and technicians have had intensive training in operating and maintaining the heavy equipment. In many cases, the skills acquired in this training are not fully utilized due to excessive travel time to and from the job site which results in short "work" days and limited productivity. Many of these workers also work at second jobs which also contributes to reduction in time on the job and productivity.

Steps should be taken so that the acquired skills of these workers can be more efficiently utilized in maintaining the irrigation system. Perhaps a longer work day and flexible work program could be implemented along with an incentive system for productivity and work quality to develop a more efficient work process. If possible, these workers should earn a reasonable income from the maintenance job.

Recommendation 11

Develop a flexible reward/incentive program by March 1993 for operators, mechanics, and technicians based on quality of work and productivity to properly utilize their acquired skills.

3. Licensing of Equipment

There are long delays in licensing some of the equipment. For instance, equipment trailers have been in the country for one year and the Department of Transportation approval has not been obtained to complete registration of these trailers to allow their use. Other delays in licensing of equipment and operators have also resulted in delays in initiation operation of the equipment. The overall impact of this constraint on the PMP has been relatively minor; however, it is an issue which has interfered with initiation of certain PMP work programs.

4. Repair Shops

Delays in making the repair shops fully operational, especially relative to electrical power, has hampered all related activities and is causing a backlog in equipment repair. It has also hampered the training and development of mechanics and technicians. See Recommendation 3.

C. Technical Assistance

The following configuration of technical assistance is needed to complete important on-going PMP activities and to correct the current deficiencies of PMP (both as identified in this report).

1. Activities which need completion:

- a. Equipment procurement and delivery and further development of the MPWWR procurement capability**
- b. Defining, documenting, and implementing the maintenance management planning process and the maintenance procedures for the irrigation system. This would also include revision and development of the draft maintenance manuals into two completed maintenance manuals, one to include maintenance planning and one to include maintenance procedures, for use on the irrigation system facilities. This would include the development and implementation of the Management Operations for Maintenance Systems (MOMS).**
- c. Develop and provide a library of O&M reference material for use in the PMP Directorates, including Arabization as needed.**
- d. Develop full and proper utilization of heavy and support equipment for efficient system maintenance. This would consist of hands-on training by a technical expert in these activities.**
- e. Develop proper procedures and on-the-job training for mechanics in the Governorate repair shops. Most of the equipment for the repair shops is in place and the mechanics have received some formal training. On-the-job training, however, is required under the supervision of a mechanical repair specialist to complete this training process. This hands-on training is necessary for complete development and training of the mechanics.**

2. Positions Required and Duties

a. Chief Maintenance Engineer (January 1993 to about June 1994) Duties

- Development, documentation and implementation of an effective maintenance planning process and procedures for the irrigation system.**
- Revision and completion of existing draft Maintenance Manuals into a Maintenance Planning Manual and a Maintenance Procedures Manual in English and Arabic.**
- Completion and implementation of the Management Operations for Maintenance Systems (MOMS) program.**
- Completion of the existing on-going overall PMP training programs.**

b. Procurement Specialist (Jan 1993 - Feb 1994) Duties

- Complete procurement and delivery of equipment currently in progress
- Develop and implement training on the above equipment
- Implement Spare Parts Inventory Control (SPIC)
- Develop and implement an on-going maintenance program for all equipment and facilities.
- Development of the EMS
- Further development of MPWWR procurement capability

c. Equipment Specialist/Utilization (Jan 1993 - Jan 1995) Duties

- Develop full and proper utilization of all heavy and other equipment on the irrigation system.
- Develop and implement an on-going training program on all equipment utilization for the irrigation system
- Develop and implement an on-going irrigation system maintenance program including training of engineers/technicians on repair of structures, canal embankments and roads.

d. Equipment Specialist/Mechanical Repair and Maintenance (Jan 1993 - Jan 1995) Duties

- Develop a comprehensive maintenance management and training program for the repair/maintenance of all heavy, support, and shop equipment.
- Provide on-the-job training for mechanics and technicians in the Governorate equipment repair shops as well as utilization of mechanics trucks.

D. Future Maintenance Alternatives**1. Continue Current Maintenance Practices (pre-PMP)**

This alternative is generally not acceptable in view of the existing condition on much of the irrigation system. USAID's support in improving the deteriorated condition of the system is well founded. The Structural Replacement (SR) component of IMS, needed due to extensive deferred maintenance throughout the system, focused appropriately on renovating priority components of Egypt's irrigation infrastructure. The PMP component was a natural follow-up companion to the SR component, providing the capability to improve the condition of the system and avoid repetition of the serious deterioration that was addressed by SR. These efforts to improve maintenance practices must continue in order to maximize the benefits from irrigated agriculture that are of critical importance to Egypt's economy.

2. Privatize All or Part of the Maintenance Function

This alternative is currently in progress on two major fronts. First, privatization is underway for the PEC's, which continue to perform most weed removal from irrigation channels. As discussed elsewhere in this report, it is of critical importance that these PEC's be transformed into more versatile organizations that are capable of providing services with appropriate weed removal equipment. Making the PEC's qualified providers of equipment services should be given high priority.

Second, the Irrigation Improvement Project (IIP) component of IMS is laying the groundwork for privatization of maintenance at the mesqa level. In this case, the degree of privatization is not clear since government services are being expanded to the extent of creating an Irrigation Advisory Service (IAS) and financing mesqa infrastructure. The consultants agree with the initiation of privatization efforts at the farm level of the irrigation system, and it appears that the IIP component is an appropriate vehicle for exploring the most appropriate avenues in this regard.

There are certain areas where additional private sector services could improve the setting for maintenance of Egypt's irrigation system. For example, small contractors could undertake rehabilitation/replacement of structures, specific non-routine maintenance, performance of high-requirement work which must be done during down time, and contract for work at the mesqa level. To avoid dispersal of resources and help insure the success of current efforts, however, attention should continue to be paid to the two privatization initiatives discussed above over the next several years, with adequate flexibility in programming to allow expansion as future conditions dictate.

3. When other Maintenance Units are in Appropriate Operating Conditions the PMP Initiatives should be Replicated and Incorporated Into Other Initiatives.

Replication of PMP initiatives is recommended in accordance with the assessment, analysis, and progress, and recommendations contained in this report (see III. A.). The opinion of Datex is in agreement with that of MPWWR staff that were interviewed as well as that of officials on the technical assistance team. There is general agreement among Project personnel, and among the four members of the Team, that the issue of balancing private and public sector responsibility for maintenance has been appropriately addressed as the PMP was conceived, planned, and implemented. Considering the large on-going task of privatization mentioned above, it would be futile to improve irrigation system maintenance without strengthening the MPWWR organizations in the Governorates with basic equipment, facilities, funding, improved organization and procedures, and training. As privatization efforts mature, it may be possible to make the equipment package for the Governorates more modest than that provided under PMP; but for the present it is considered to be minimal.

The management tools provided in the form of computer equipment and management software packages, combined with the future completion of maintenance manuals, are key elements of an

improved sustainable maintenance package. Although implementation of these project elements remain in the developmental stage, there is good evidence that MPWWR staff can and will utilize these tools effectively. The consultants' observations and discussions of the use of the computerized management tools by trained staff was encouraging.

The recommendations for replication of PMP (see Recommendation 6). should be carried out along with continuing other improvements in the irrigation system sub-sector. As other components of the IMS Project were reviewed in conjunction with this evaluation, the number and extent of IMS activities, and their level of complexity and sophistication in terms of technology were overwhelming. Datex has also been concerned about the fragmentation of maintenance into a separate project. Accordingly, Datex wishes to **highlight the dire need for maintenance consideration with other components, and much better coordination among components.** See Recommendation 12.

During the course of this evaluation the activities of several other IMS Project components have been noted especially in regard to maintenance and PMP. The purpose of this section of the report is to highlight the need for maintenance consideration within IMS Project and the need for overall direction and coordination of the Project.

The need for maintenance consideration is especially critical for those components which physically affect the operation (or mode of operation) of the irrigation system, i.e. structures, gates, equipment, etc. The installation of each new facilities can seriously impact PMP by increasing the overall maintenance work load. For example, during the field visit to Minya a small road grader was observed on the system that was procured under IIP. This unit of heavy equipment has now appropriately become a part of PMP for that area. Unfortunately, it appears that the maintenance requirement of that unit was not properly considered as there is no dealer service for this off-brand unit in Egypt.

Another IIP initiative with great potential future impact on maintenance is the "continuous flow" mode of operation at the command area level. In order to change the mode of operation the installation of additional automated control gates is envisioned. Under this new mode of operation, the canals (and structures) which are now "rotated" would flow continuously. This change would greatly reduce the access to these canals for maintenance work and the automatic float control gates would also bring in a new maintenance requirement. These gate types create an additional potential operational problem of "gate tampering" by the water users.

In summary, any IMS Project initiative which affects or potentially affects the operation of the irrigation system should be carefully evaluated in terms of:

- What is the inherent maintenance requirement?
- How will the new device change/impact maintenance and the overall irrigation system?
- How will the required maintenance be accomplished?

Recommendation 12

Evaluate all IMS Project components in terms of their specific maintenance needs to determine the overall maintenance requirement.

4. Review of Operation and Maintenance (ROM) Program

In conjunction with the development of the preventive maintenance program in the Governorates as discussed throughout this report; a ROM Program should also be developed and implemented to improve and sustain the O&M program.

This periodic examination program (see Review of Operation and Maintenance Field Guidelines Manual) should be conducted each two or three years for the purpose of evaluating the overall O&M program, maintenance procedures, funding, and other pertinent aspects of the project operation. The examination should be done by an independent O&M expert who is not directly involved in project operations. A formal report is written describing the results of the examination along with recommendations to correct any identified deficiencies. The recommendations should be corrected by a definite established process, including a schedule for completion. The work items identified on this review should be included in the annual work plan of the project.

This is an excellent program to identify for correction, deficiencies in the project O&M activities, and therefore to sustain continued satisfactory service on a long term basis. The Team recommends that this program be developed and implemented as part of the PMP.

Recommendation 13

Develop and implement a Review of Operation and Maintenance Program for the irrigation systems in Egypt beginning with the PMP Governorates in 1993.

E. IMS Sub-Goal Accomplishment

1. Improved Operating Efficiency

A subgoal of the IMS Project is "to improve the operating efficiency of the water distribution system for agricultural irrigation and for other uses". The following are indicators of accomplishment related to this evaluation. It should be noted, with the exception of Gharbia, the Governorates have had operational PMP for less than six months; consequently, it is unlikely that obvious results relative to improved operating efficiency would be achieved during this relatively short period of time. Considering this, the results given below are encouraging, although not always conclusive.

a. Improved Efficiency Along Sample Canals

An example of more efficient water distribution is shown below for several canals in Gharbia where the total annual water requirement of the canal has decreased from 1991 to 1992 with a savings of water from 8 - 14 percent.

<i>Canal</i>	<i>Discharge (mill cubic meter/year)</i>		<i>Savings (%)</i>
	<i>1991</i>	<i>1992</i>	
<i>Bagouria</i>	<i>1026.6</i>	<i>949.4</i>	<i>8</i>
<i>Mehalia</i>	<i>1264.1</i>	<i>1064.3</i>	<i>14</i>
<i>Meet Yazid</i>	<i>1359.2</i>	<i>1359.2</i>	<i>11</i>
<i>Nelah</i>	<i>356.4</i>	<i>310.1</i>	<i>13</i>

b. Water Delivered to Users at End of System

A very common water distribution problem has been insufficient water at the tail end of the system. Discussions in the field indicate that this problem is decreasing since PMP work has been implemented. A letter of commendation was received by the Under Secretary of the Minya Governorate citing improved water service during 1992.

The following information from two canals in Minya show that the average water level in the canal tail has improved from 1991 to 1992 as a result of the PMP.

<i>Canal</i>	<i>Average Water Level (Tail) 1991</i>	<i>Average Water Level (Tail) 1992</i>
<i>Waslet Mantoof</i>	<i>37.65</i>	<i>37.80</i>
<i>Raheel</i>	<i>38.50</i>	<i>38.60</i>

c. Complaints from Water Users

This is perhaps one of the best measures of improved water deliveries as users are quick to complain if their water deliveries are inadequate. The following information from the Gharbia (pilot project) and the Minufia Governorates show a significant reduction in the number of complaints concurrent with the implementation of the PMP, along with a reduction in time to resolve the complaints. Discussions at most of the Governorates substantiated that the number of complaints received have decreased significantly since PMP activities have been implemented.

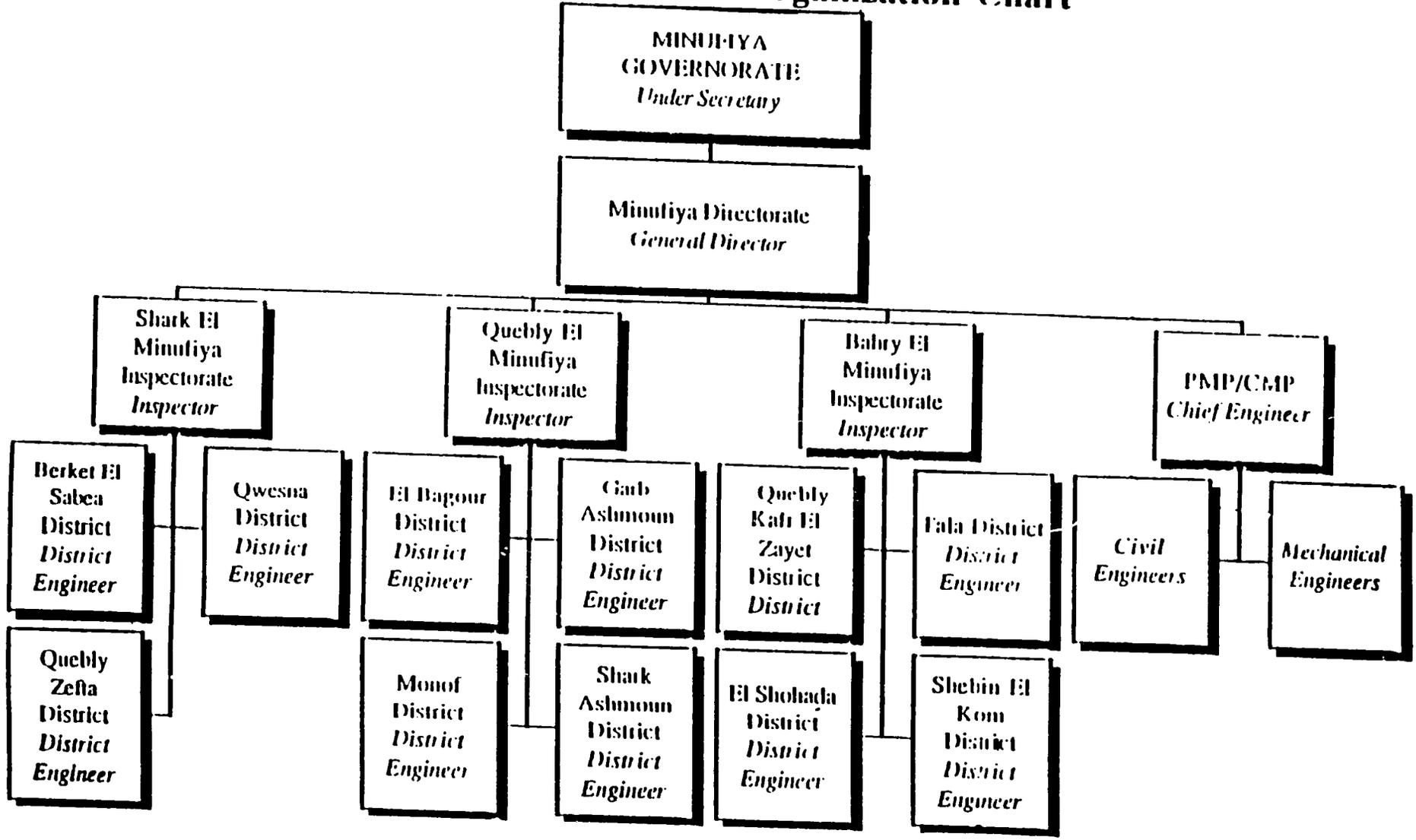
<i>Number of Complaints by Year and Time of Resolution</i>		
<i>Year</i>	<i>Number of Complaints</i>	<i>Days to Resolve</i>
<i>Gharbia</i>		
<i>1988</i>	<i>180</i>	<i>2-3</i>
<i>1989</i>	<i>130</i>	<i>1-2</i>
<i>1990</i>	<i>90</i>	<i>same day</i>
<i>1991</i>	<i>50</i>	<i>same day</i>
<i>1992</i>	<i>30</i>	<i>same day</i>
<i>Minufia Governorate</i>		
<i>1991</i>	<i>23</i>	<i>same day</i>
<i>1992</i>	<i>14</i>	<i>same day</i>

The above data was obtained from operational records of the respective Governorates and is representative of canals which have received major PMP Maintenance work. However, with the exception of Gharbia, the number of canals receiving major maintenance work is limited due to the limited operational time.

In summary, although the data is not conclusive; it appears that water service is improving concurrently with the implementation of PMP. This is based on above data and information and the Team's perception of discussions related to this issue. This data again points to the fact that the PMP is working and providing improved maintenance capability for the irrigation systems where it is being implemented, therefore, it should be continued.

APPENDIX 1

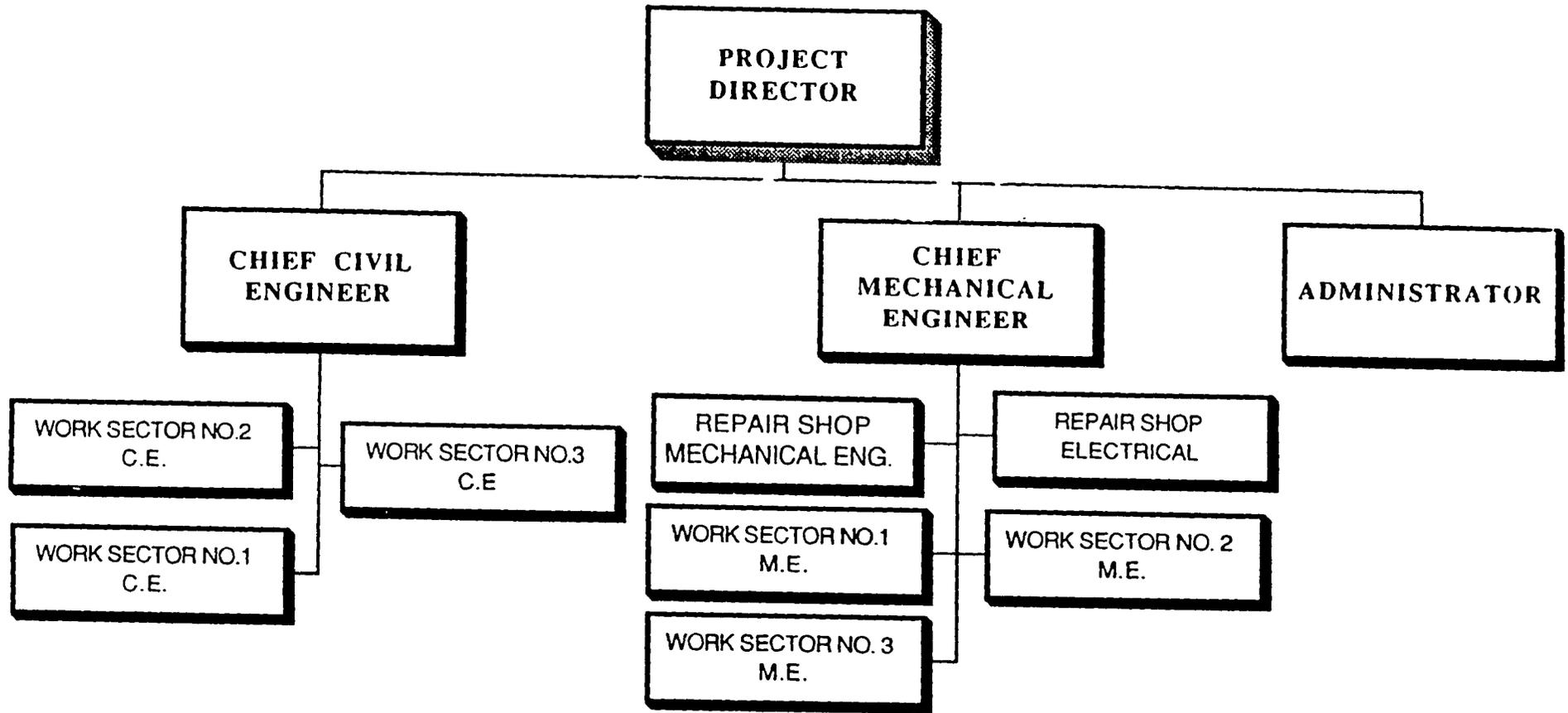
Preventive Maintenance/Channel Maintenance Project (PMP/CMP) Minufiya Governorate Organization Chart



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APPENDIX 2

**PREVENTIVE MAINTENANCE/CHANNEL MAINTENANCE PROJECT
ENGINEER STAFFING NEEDS**



	BEHAIRA	DAQAHLIA	GARBIA	MINUFIA	MINYA	QALIUBYA	
<u>GOV. WORK SECTOR</u>	3	3	2	2	3	2	
<u>CIVIL ENGINEERS</u>	4	4	3	3	4	3	ENGINEER NEEDED
<u>MECHANICAL ENGINEERS</u>	5	5	4	4	5	4	Project Directors 6
<u>ELECTRICAL ENGINEERS</u>	1	1	1	1	1	1	Civil Engineers 21
							Mechanical Engineers 27
							Electrical Engineers 6

APPENDIX 3

SCOPE OF WORK**A. ACTIVITY TO BE EVALUATED**

Project: Irrigation Management Systems Project
Number: 263-0132
Subactivity: Preventive Maintenance (263-0132.03)
Implementing Agency: Ministry of Public Works and Water Resources (MPWWR)
Grant Amount: \$340 Million (\$29.0 million for PM component)
Grant Period: September 1981 - September 1995

The purpose of the IMS project is to improve the operating efficiency of the total irrigation system and strengthen the Ministry's operation, maintenance and planning capabilities.

B. Purpose of the Evaluation

The purpose of the evaluation is to determine the effectiveness of assistance to date, determine where available resources can be best utilized, and what additional resources will be necessary to enhance MPWWR'S capability to replicate the preventive maintenance program in the remaining 13 Governorates.

Background: The Preventive Maintenance component will provide six Governorates with the management capability, equipment, and staff training necessary to perform routine first echelon maintenance. It is installing the procedures to plan for, manage and control higher levels of maintenance. MPWWR has committed itself to reorganize staff and provide funds needed to assure proper and reliable maintenance of the system. The product of this effort will be a preventive maintenance program that is tested, accepted, functional and fully staffed in six Governorates.

Under this component USAID will provide \$29 million technical assistance, commodities and training. Consultant services are provided by Morrison-Knudsen Engineers until May 1993. The Preventive Maintenance program began on 1982 and a portion of the component was evaluated in November, 1989 and an interim evaluation conducted in June 1990. The primary findings and recommendations were that the project was operating under some constraints: mainly inadequate staffing and training. The project funding level was reduced from \$38 million to the current \$29 million by dropping mesqa maintenance. Since the last evaluation, use of herbicides for weed control have been abolished in Egypt which resulted in certain elements dealing with herbicides (i.e. commodities, training) being dropped from the project and support of IBRD and Public Excavation Companies minimized in the channel maintenance part of the program which involved the remaining 13 Governorates.

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Outputs:

1. Assess progress of the 6 governorates towards meeting the objectives of the project to carry out the maintenance program and evaluate the effectiveness of U.S. and GOE funded activities in contributing to project objectives.
2. Assess the capability of the six governorates to effectively sustain and manage a preventive maintenance program after the MKE technical assistance contract is completed in May 1993.
3. Determine how available resources can be utilized after May 1993 to implement a preventive maintenance program in the remaining 13 Governorates.
4. Determine what kind and how many additional resources will be required after May 1993 to implement an effective preventive maintenance program in the remaining 13 Governorates and the resulting implications for project funding.
5. Describe alternative options/methods to carry out the preventive maintenance program. One alternative to include a mix of private sector, public sector companies, and ministry responsible for maintenance specific tasks. Develop selection criteria to measure cost-effectiveness, politically feasibility, and social acceptance in selection of the preferred alternative.

The evaluation will assist USAID and the Ministry of Public Works and Water Resources in assessing the results/impacts of the activities undertaken under this component, and in making decisions as to the extent the Preventive Maintenance program can be replicated in the remaining 13 Governorates, and the resources required (i.e., time, funding, personnel, equipment), for an effective program.

APPENDIX 4

LISTING OF PEOPLE INVOLVED IN DISCUSSIONS RELATIVE TO THE PMP EVALUATION

Bob Dixon, Team Leader, Morrison-Knudsen, Inc., Cairo
Bill McCarthy, Procurement, Morrison-Knudsen, Inc., Cairo
Richard Fitz, Administration, Morrison-Knudsen, Inc., Cairo

First Undersecretaries:
Lower Egypt (Tanta): Eng. Mahmoud Hassan
Upper Egypt (Minya): Eng. Mohktar Emara

Monitoring Office:
General Manager: Eng. Tharwat Fahmi
Deputy Manager: Eng. Mahmoud Abbas

PMP/CMP Project Offices, Cairo:
Project Director: Eng. Adel Abdel Khalek
Deputy Project Director: Eng. Youssef Mohamed Youssef

Beheria Governorate:
Undersecretary: Eng. Fawzi Barakat
Project Director: Eng. Fawzi Al-Lakany
Deputy Manager: Eng. Nabil Anies
Mechanical Engineer: Eng. Rageb Mohamed

Dakalia Governorate:
Undersecretary: Eng. Samir Youssef
Project Director: Eng. El-Said Abdel Moniem
Deputy Manager: Eng. Abdel-Said El-Sayed
Mechanical Engineer: Eng. Emem Mohamed

Gharbia Governorate:
Undersecretary: Eng. Abdel Wahab
Project Director: Eng. Fayez Hamouda
Deputy Manager: Eng. Ibrahim Hafez
Mechanical Engineer: Eng. Mousilv

Qalubia Governorate:
Undersecretary: Eng. Mohamed Fath El-Bab
Project Director: Eng. Said Mohamed Abdel-Hadi
Deputy Manager: Eng. Ayman El-Tokhy
Mechanical Engineer: Eng. Kamal Shamis

Minufiya Governorate:
Undersecretary: Eng. Mostafa Mohamed Selima
Project Director: Eng. Abdel Hamid El-Gayar
Deputy Manager: Eng. Mumdouh Batihiy
Mechanical Engineer: Eng. Gafar Zaghloul

Minya Governorate:

Undersecretary:

Project Director:

Deputy Manager:

Mechanical Engineer:

Eng. Mohamed Fathi

Eng. Salah Zaki

Eng. Amhed Shawki

Eng. Ahmed Abdel Maged