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**Report No.** 5146

PROJECT PERFORMANCE AUDIT REPORT

ARAB REPUBLIC OF EGYPT: UPPER EGYPT DRAINAGE I PROJECT
(CREDIT 393-UAR)

June 27, 1984

Operations Evaluation Department

## CONVERSION FACTORS

1 Feddan = 1.04 acres/0.42 hectares

## ABBREVIATIONS

| | | |
|---|---|---|
| DRI | - | Drainage Research Institute |
| EGAD | - | Egyptian General Authority for Drainage Project |
| EPADP | - | Egyptian Public Authority for Drainage |
| FAO | - | Food and Agriculture Organization of the United Nations |
| GOE | - | Government of Egypt |
| GRI | - | Groundwater Research Institute |
| HAD | - | High Aswan Dam |
| MOA | - | Ministry of Agriculture |
| MOI | - | Ministry of Irrigation |
| NDDA | - | Nile Delta Authority for Drainage Projects |
| O&M | - | Operation and Maintenance |
| SWI | - | Soil and Water Research Institute |

# PROJECT PERFORMANCE AUDIT REPORT

## ARAB REPUBLIC OF EGYPT: UPPER EGYPT DRAINAGE I PROJECT (CREDIT 393-UAR)

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# PROJECT PERFORMANCE AUDIT REPORT

## ARAB REPUBLIC OF EGYPT: UPPER EGYPT DRAINAGE I PROJECT (CREDIT 393-UAR)

## PREFACE

This is a Performance Audit of the Upper Egypt Drainage I Project in the Arab Republic of Egypt for which a Credit 393-UAR was approved by IDA and which became effective on November 28, 1973. The amount of the Credit was US$36 million. The closing date was July 31, 1981. Disbursements amounted to US$34.9 million; US$1.1 million were cancelled.

The audit report consists of an Audit Memorandum (PPAM), prepared by the Operations Evaluation Department and a Project Completion Report (PCR), dated June 28, 1983 prepared by the Europe, Middle East and North Africa Regional Office. The Audit Memorandum is based on a review of the Appraisal Report (No. 80a-UAR), dated May 23, 1973, the President's Report (No. 1199a-UAR of May 23, 1973), the Development Credit Agreement (DCA) dated June 8, 1973 and the PCR. The Project Performance Audit Report for the first Nile Delta Drainage Project (Credit 181-UAR), dated June 21, 1982 was also reviewed. Internal Bank memoranda on project issues, as contained in Bank files, have been consulted and Bank staff associated with the project interviewed.

An OED mission visited Egypt in August 1983. The mission held extensive discussions with the staff of the project executing agency, the Egyptian Public Authority for Drainage Projects (EPADP), the Drainage Research Institute (DRI) and the Water Research Center (WRC). Field trips were made to project areas in the Beni Suef and Qena Governorates, during which the mission discussed construction and maintenance operations with field personnel. The mission observed on-going construction work in project areas of the follow-on Upper Egypt Drainage II Project, as well as routine maintenance work on areas where drainage systems were constructed under this project. The information obtained during the mission was used to test the validity of the conclusions of the PCR.

The audit mission did not review the Bilharzia control program which covered an area of 900,000 feddans and which was extensively reviewed in the PCR.

The audit finds that the PCR covers the salient features of the project. In addition to summarizing the objectives and results of the project, the audit memorandum examines the implications of the professional staff shortages in EPADP and with the contractors on the quality of project design and construction and on the maintenance of the drained areas. It also discusses the effects of inadequate performance feedback from the field to the design department and a controversial design issue which was under continuous review by the Bank during the implementation of the project.

The draft report was sent to the Borrower for comment on February 8, 1984. Comments received from EPADP have been taken into account in the final report and are attached as Annex 1.

The valuable assistance provided by the EPADP, the DRI and the WRC in the preparation of this report is gratefully acknowledged.

## PROJECT PERFORMANCE AUDIT BASIC DATA SHEET

### ARAB REPUBLIC OF EGYPT: UPPER EGYPT DRAINAGE I PROJECT (CREDIT 393-UAR)

**KEY PROJECT DATA**

| | Appraisal Estimate | Actual or Estimated Actual | Actual as % of Appraisal Estimate |
|---|---|---|---|
| Project Costs (US$ million) | 123.8 | 119.6 | 97 |
| Credit Amount | 36.0 | 34.9 | 97 |
| Date Board Approval | 06/08/73 | 06/08/73 | - |
| Date Effectiveness | 09/06/73 | 11/28/73 | |
| Date Physical Components Completed | 06/30/79 | 06/30/83 | |
| Proportion then completed (%) | | 91 | 166 |
| Closing Date | 12/31/79 | 07/31/81* | 112 |
| Economic rate of return (%) | 20 | NA | |
| Financial Rate of Return (%) | NA | NA | |
| Institutional Performance | Fair | | |
| Agronomic Performance | Good | | |
| Number of Direct Beneficiaries (year 15) | 88,000 farm families | | |

**CUMULATIVE DISBURSEMENTS**

| | FY74 | FY75 | FY76 | FY77 | FY78 | FY79 | FY80 | FY81 | FY82 |
|---|---|---|---|---|---|---|---|---|---|
| Appraisal estimate (US$ million) | 1.0 | 7.4 | 17.0 | 25.0 | 31.0 | 35.3 | 36.0 | - | - |
| Actual (US$ million) | - | 1.1 | 12.4 | 17.4 | 20.4 | 29.5 | 33.0 | 33.9 | 34.9 |
| Actual as % of estimate | 2 | 15 | 73 | 70 | 66 | 84 | 92 | 94 | 97 |

Date of Final Disbursement: May 21, 1982

**MISSION DATA**

| Mission | Month/ Year | No. of Persons | Mandays in Field | Specializations Represented /a | Performance Rating /b | Trend /c | Types of Problems /d |
|---|---|---|---|---|---|---|---|
| Identification | 12/70 | 3 | 14 | | | | |
| Preparation | 02-10/72 | 4 | 26 | | | | |
| Appraisal | 03/72 | 8 | na | | | | |
| Supervision I /e | 07/73 | 2 | 16 | a,c | 2 | 1 | M |
| Supervision II | 04/74 | 3 | 10 | a,c | 2 | 1 | M,P |
| Supervision III | 10/74 | 3 | 8 | a,c,b | 3 | 2 | M,T |
| Supervision IV | 03-04/75 | 3 | 10 | b,c,e | 2 | 1 | M,F |
| Supervision V | 12/75 | 2 | 12 | c,b | 2 | 2 | M |
| Supervision VI | 04/76 | 3 | 7 | b,c | 2 | 1 | M |
| Supervision VII | 11/76 | 3 | 7 | a,b,c | 2 | 1 | M,F |
| Supervision VIII | 03-04/77 | 1 | 7 | b | 2 | 1 | M,F |
| Supervision IX | 11/77 | 1 | 8 | b | 2 | 3 | M |
| Supervision X | 03/78 | 1 | 8 | a | 2 | 1 | T |
| Supervision XI | 10/78 | 2 | 8 | a,b,c | 2 | 1 | T |
| Supervision XII | 02-03/79 | 3 | 5 | a,c | 2 | 2 | M,O |
| Supervision XIII | 09/79 | 2 | 4 | a,c | 2 | 1 | M |
| Supervision XIV | 05/80 | 1 | 5 | c | 2 | 1 | M,O |
| Supervision XV | 09/80 | 3 | 4 | a,c,c | 2 | 2 | M,O |
| Supervision XVI | 04/81 | 1 | 3 | c | 2 | 2 | M,O |
| Supervision XVII | 11/81 | 1 | 4 | c | 2 | 2 | M,O |
| Supervision XVIII | 04/82 | 1 | 4 | c | 2 | 2 | O |

**OTHER PROJECT DATA**

| | |
|---|---|
| Borrower | Arab Republic of Egypt |
| Executing Agency | Egyptian Public Authority for Drainage Projects |
| Fiscal Year of Borrower | From July 1972-June 1979 Calendar Year<br>Since July 1979 July - June |
| Name of Currency (abbreviation) | £E (Egyptian pound) |
| Currency Exchange Rates: | |
| Appraisal Year Average | US$1.00 = £E 0.39 |
| Intervening Years Average | US$1.00 = £E 0.39 (1973-78); US$1.00 = £E 0.70 (1979-82) |
| Completion Year Average | US$1.00 = £E 0.70 |

Previous and Follow-on Projects:

| Name: | Nile Delta Drainage I | Upper Egypt Drainage II | Nile Delta Drainage II |
|---|---|---|---|
| Loan/Credit Number | Cr.181-UAR | Ln.1285/Cr.637-EGT | Ln.1439/Cr.719-EGT |
| Loan/Credit Amount (US$ million) | 26 | 10 40 | 39 27 |
| Date Board Approval | 03/24/70 | 06/11/76 | 07/15/77 |

* The Credit accounts were kept open for making disbursements against commitments made before this date.

/a a = agriculturalist; b = economist; c = engineer; d = Division Chief; e = financial advisor; f = procurement specialist.

/b 1 = problem-free or minor problems; 2 = moderate problems; and 3 = major problems.

/c 1 = improving; 2 = stationary; and 3 = deteriorating.

/d F = financial; M = managerial; T = technical; P = political; and O = other.

/e Time spent supervising previous and follow-on projects is recorded separately.

# PROJECT PERFORMANCE AUDIT REPORT

## ARAB REPUBLIC OF EGYPT: UPPER EGYPT DRAINAGE I PROJECT (CREDIT 393-UAR)

## HIGHLIGHTS

The need to provide drainage in the irrigated areas of Upper Egypt, to control waterlogging and soil salinity, has been recognized since controlled perennial irrigation started in the 19th century. The problem became urgent when the decision was taken to construct the High Aswan Dam, which would enable doublecropping and consequently much higher yearly water applications. The way selected to drain the irrigated areas was by buried pipes, an expensive and demanding operation. Drainage would eventually be needed on some 5 million feddans (2.0 m ha) in the Delta and in Upper Egypt. The Government of Egypt approached the Bank Group in 1968 to assist with the first tranche of their draining program in the Delta, extending to 950,000 feddans (400,000 ha). Subsequently a second phase program was started in Upper Egypt on an area of some 300,000 feddans.

The primary objective of this project was to improve drainage in Upper Egypt at a total cost of US$123.8 million equivalent. The project included buried drainage, remodeling of existing and excavation of new open drains, and construction of pumping stations. A Bilharzia control program, covering an area of 900,000 feddans, was also included as was the provision of technical assistance for training the staff of the Egyptian Public Authority for Drainage Projects (EPADP). The IDA financing was to be used primarily for the import of construction machinery and pumping equipment including its installation and spare parts.

Due to implementation problems, it took 3-1/2 years longer to complete the principal objectives of the project than the originally agreed period of about 6 years. Of the three main components, viz pumping stations, open drains and buried drains, it was the third which delayed completion of the project. In general, the delays were due to weaknesses in EPADP's construction planning and management organization as well as the poor implementation capacity of the public sector contractors. While EPADP was unable to manage the program rigorously enough, the delays related largely to the management weakness of the contracting organizations. They lacked, and still lack, normal commercial incentives to meet construction schedules and EPADP has no effective means of enforcing the conditions of contracts.

During the course of the project, no changes were made in the project scope, its objectives or basic design. However, the original selection of the areas had to be amended from time to time, excluding or reducing some areas and substituting equivalent new areas. It seems clear that these changes were beneficial by allowing areas where more serious drainage problems were emerging to be given priority. On the other hand the lack of systematic water table depth recording raises doubts whether drainage was

necessary in all the areas that have been drained, as supervision missions have commented on the relative dryness of some formations in which tiles were being laid.

While the Bank was undoubtedly right to support drainage, once the priority in the Egyptian agricultural sector, the project success remains uncertain and depends on whether the drains are properly maintained and continue to operate. No analysis of the project's ERR has been carried out because of insufficient data on yield increases in the areas drained, the wide variability of the results recorded and the relatively few years through which data have been collected. The Drainage Authority is continuing to monitor the results of drainage and a more comprehensive picture should emerge during the next few years.

The audit notes that while continuing such a large drainage program in the country, the Government must organize, in parallel, an adequate maintenance operation which would safeguard the investments made on such large areas in the Nile Delta and Upper Egypt.

The need for systematic collection of groundwater and soil salinity data has been highlighted in the PCR. Also the monitoring of groundwater and soil salinity conditions outside the presently drained areas should be incorporated in any future loan agreement, as a means of identifying future areas to be drained. The Borrower's new drainage evaluation program (agreed in 1983) is a major step in the right direction.

Effective monitoring of maintenance has to be addressed by future supervision missions of the other two ongoing drainage projects. It is crucial to the success of the program.

Other points of interest and lessons learned are:

- The effectiveness of project consultants to advise on technical issues is questionable, where the Borrower is resisting their employment. This is particularly true in this case, in view of the existence of the Dutch Bi-Lateral Assistance Program and Panel, which is accepted by the Borrower as the highest technical authority in drainage matters (PCR, paras. 4.07, 9.02, 9.09);

- EPADP is short of technical personnel in relation to the scope of its operations. This is true also for the Public Sector Contracting Organizations. It is the view of the audit that without a solution to this staff shortage the two Bank-assisted follow-on drainage projects in the Delta and in Upper Egypt are likely to be delayed and their technical standards cannot be assured (PPAM, paras. 23-25; PCR, para. 6.02);

- The flexibility shown by the Government and the Bank in accommodating drainage needs, as they were identified during implementation, and not rigidly keeping to the areas defined in the project documents is highly commendable (PCR, para. 4.13); and

- The maintenance of farm drainage works needs the cooperation of the farmer beneficiaries. More efforts should be made by the field staff of EPADP to educate and motivate the farmers to cooperate (PPAM, para. 21).

# PROJECT PERFORMANCE AUDIT MEMORANDUM

## ARAB REPUBLIC OF EGYPT: UPPER EGYPT DRAINAGE I PROJECT (CREDIT 393-UAR)

## I. SUMMARY

1. The Upper Egypt Drainage Project was the second large-scale tile drainage project undertaken in Egypt. It covered an area of about 300,000 feddans south of Beni Suef in Upper Egypt. The need for drainage in the project areas became obvious soon after perennial irrigation had replaced free flooding in parts of the project area. A system of open main and branch drains was constructed first in many places with pumping stations that lifted the effluent into the main irrigation canals or back into the Nile. This trunk drainage network was never expected to solve the problem of water-logging once full perennial irrigation had started. In the late 1930s investigations started into field drainage, using buried tiles. In anticipation of the perennial irrigation and near 200% cropping intensities of all cultivable lands, that the High Aswan Dam would make possible, a program was launched in 1956 to provide the whole Nile valley with tile drains within 30 years. Progress, however, was exceedingly slow. To speed up implementation, a UNDP pilot project was launched in 1963 to establish the criteria and feasibility of mechanized tile laying. Machine operation was not only expected to speed up execution, but also to allow pipes to be laid where the watertable was less than 1 m below the surface and manual excavation of the trenches would cause sloughing before the pipes are laid. Based on the UNDP study, the first Bank supported drainage project was identified and appraised in December 1968.

2. The present project is the second drainage project supported by the Bank and the first in Upper Egypt. The project supports the Government of Egypt's (GOE) policy of providing improved drainage throughout most of the nearly 5 million feddans (2.0 million ha) of the historically irrigated area ("the old lands") in the Nile Valley below the dam at Aswan. The project aimed to provide field drainage to some 6% of this area. Following the pattern set by the previous project, the Bank extended its participation in the drainage program by financing this and two further projects involving three credits and three loans totalling US$153 million. The four projects together cover improvements of surface drains in about 2.56 million feddans and installation of tile drains on 2.16 million feddans (about 40% of the old lands). The project and its successors have attracted significant amounts of aid from other donors including USAID, KfW, the Netherlands Government and the World Food Program.

3. Credit 393-UAR, the second in the agriculture sector, represented a continuation of Bank Group lending operations in Egypt. The Credit for US$36.0 million was approved by the Bank Board on May 17, 1973, signed on June 8, 1973 and became effective on November 28, 1973. The project was to improve drainage on 300,000 feddans and included remodeling of 775 km of

existing open drains and the excavation of about 865 km of new open drains, the construction of four pumping stations and the expansion of an existing station, provision of transmission lines and power substations for the pumping stations, the reclamation of about 22,400 feddans of saline land, a Bilharzia control program covering an area of 900,000 feddans in the Governorates of Beni Suef, El Minya and Assiut, provision of necessary vehicles and equipment for the Authority and extension services and the provision of technical assistance for training the staff of the Authority. The IDA financing was to be used primarily for the import of construction machinery and pumping equipment including its installation and spare parts as well as for consulting services.

4. The agreed implementation schedule projected completion of the project by June 1979. The credit closing date was set for December 31, 1979. While the project objectives remained unchanged, many events conspired to cause delay. The closing date was revised once, to accommodate slippages in implementation. The credit was closed on July 31, 1981, but its accounts were kept open for making disbursements against commitments made before this date.

5. In general, progress in implementing the project was slow since it took almost 3-1/2 years longer to complete the principal objectives than the originally agreed period of about 6 years. The project was the first large-scale drainage effort in Upper Egypt and the time needed for contractors to train manpower in manufacturing and installing cement tiles was longer than anticipated. Non-cooperation by farmers in the first few years due to sugar cane occupying more than 50% of the project area was another reason for project start-up delay. Of the three main components viz pumping stations, open drains and buried drains, it was the third which delayed full completion of the project.

6. In general, implementation delays were due to weaknesses in EPADP's construction planning and management organization as well as the low implementation capacity of the public sector contractors. While EPADP failed to manage the program rigorously enough, the delays largely related to the management weakness of the contracting organizations. They lacked, and still lack, normal commercial incentives to meet construction schedules and EPADP has no effective means of enforcing the conditions of contracts.[1/]

7. The final disbursement from the credit was made on May 21, 1982, bringing the total amount disbursed to US$ 34.9 million. On this date, the installation of field drainage, an activity critical to full completion of the project, was accomplished in 255,000 feddans out of the 300,000 feddans originally planned. The remaining area was completed by March 1983.

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1/ The Drainage Authority adds the following reasons for implementation delays: (i) abnormal conditions prevailing in the area; (ii) time taken by contractors to train manpower for manufacturing and installing cement tiles; and (iii) lack of cooperation by farmers in the first few years.

8. During execution of the Project, yields of the main crops--namely wheat, cotton and maize--have been assessed on some sample areas before and after drainage and in similar undrained areas outside the project area. The results indicate that yields have increased due to field drainage in almost all tile drained areas, but the magnitude of the increase varied greatly with the crop, location, yield levels before drainage and other factors affecting crop production. Using the available data, the results show the average increases over 4 years (1977-1980) after drainage to be 9% for wheat, 9% for cotton and 15% for maize. Although these results indicate that tile drainage has a positive effect on crop yields, the values given can only be considered indicative.

9. Some of the completed drainage areas are not maintained adequately, and it is difficult to estimate the size of such "inadequately-performing" areas. Any quantitative estimate of overall project benefits is difficult to make at this time. Data available on yield increases from the areas monitored by DRI in the Delta cannot be extrapolated to the whole project area without allowing for differences in production factors and in the performance of the drainage systems. This is particularly true for the large sugar cane areas south of Nag Hammadi, where maintenance of the systems appears inadequate and drainage performance seems to be poor.

10. The PCR did not directly estimate the rate of return of the project because of insufficient data on yield increases in the areas drained. It states, however, that an increase in yields as low as 5% over the whole area of the project would provide a rate of return in excess of 12%. The audit is reluctant to accept these conclusions, for the reasons stated above. At the same time the Audit contends that drainage is absolutely essential in most of the irrigated areas in Egypt; the main issue is how to make the projects perform adequately.2/

11. There can be no doubt that the Bank made the right choice in selecting drainage for its priority lending activity in the agricultural sector. Investment in drainage in the Egyptian context is a sound long-term investment and a necessary condition for attaining high levels of agricultural production. Over the long term, the success or failure of the drainage projects will, however, depend on whether the drains are properly maintained and continue to operate.

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2/ The Drainage Authority comments that (i) yield response to drainage is now available for about 37% of the project area; and (ii) on the basis of these yield increases, the project ERR could be estimated at about 20%. The Region, however, points out that the project ERR cannot be adequately estimated due to the relatively few years through which data have been collected and the wide variability of the results recorded.

## II. MAIN ISSUES

### A. Technical Specifications

12. The drainage design procedure adopted in this project was the same as that used in the first Nile Delta Drainage Project. Two main features were controversial viz the use of envelope material around the field drains and the spacing of laterals. Regarding the use of envelope material, all tile lines constructed during the initial years of project implementation were covered with a gravel layer. However, due to some difficulty in obtaining properly graded envelope material at a reasonable cost and due to the somewhat increased construction time, EPADP, supported by the joint Egyptian-Dutch Panel, decided to stop the use of gravel filters in all drainage contracts awarded after 1978, for areas whose soils had a clay content exceeding 40%. This raised the implementation rate slightly and reduced somewhat construction costs. However, several Bank experts have continued to advocate the use of a gravel envelope around subsurface field drains in all types of soil. The issue was not resolved during the implementation of the project and results are now awaited from a program of field investigations and trials carried out by the Drainage Research Institute (DRI) in a pilot area in the eastern part of the Delta. To date results of these studies are inconclusive and it is doubtful whether reliable data will become available from this program in the foreseeable future.3/

13. In the audit's view, this technical controversy, which continued over most of the implementation period of the project, was not properly handled by the Bank's supervision missions. After the establishment of the Egyptian-Dutch Drainage Panel in 1976, and specially after their ruling in 1978 to stop the use of gravel filters in soils with a clay content in excess of 40%, the Bank should either have accepted this ruling, at least on a temporary basis, until evidence from the field or from DRI studies would have indicated otherwise, or declared the Borrower in default of the specifications agreed at appraisal and during negotiations.

14. Discussions with the Borrower by various Bank staff who argued against the Panel's findings were ineffective. The Panel was established by the Borrower to guide this large-scale drainage program on just such technical matters and the Bank should have tried to work through the Panel.

15. With regard to lateral pipe spacings, an issue which was resolved, EPADP used design tables (steady state approach) which are based on the formula of Hooghoudt. However, drain spacings, calculated according to this formula, were sometimes disregarded when tile drains were laid. A spacing

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3/ OPS staff point out that (i) the most important question--the depth at which the tile drains are installed--also remains unresolved and (ii) if an envelope is required, it must be of suitably graded material and not of small stones and boulders which proved so unsatisfactory that it would have made little difference whether it was used or not.

narrower than 40 m was considered economically unjustified by EPADP. The Bank experts objected to this arbitrary spacing decision. Over the period of project implementation, several consultants and Bank engineers have visited the project arguing against the decision. There has been a consensus of opinion by all visiting experts that the steady state approach to drain spacing was suitable and that EPADP are correct to use it. There was also full agreement that spacing calculated in the design office should be adopted in the field even if the calculated spacing was narrower than 40 m. The audit has been told that this approach to drain spacing has now been adopted by EPADP.

B. Quality of Design and Construction

16. The design of the drainage systems is the responsibility of the Field Investigation and Design Department of EPADP. In calendar year 1982 the design output of the Department was some 230,000 feddans. The technical workforce of the Department was 56 out of which 22 were engineers (12 civil engineers, 6 agricultural engineers and 4 mechanical engineers). The areas for which designs were required were divided into subprojects of 3,000-5,000 feddans each, and were entrusted to one of the engineers who was responsible for all field investigations and the preparation of the design album. Predesign investigations were carried out at gridpoints of 500 m spacing.4/ The design album contains topographical surveys, the drainage layouts, longitudinal sections, structural designs and a list of quantities.

17. Once the design album is handed over to the construction departments, the design engineer has no further involvement in the construction and operation of the works which he has designed. Thus, no systematic performance feedback reaches him from the field. The design office has recently carried out a series of studies on the efficiency of their drainage design which has provided some feedback. The audit contends that without continuous feedback no improvements in project design can be expected. This could be possible if the design engineer would remain in touch with the construction and operational phases of the project.

18. Construction quality seen during the field visits, in the more southern part of the project area, was poor. (All mission observations concern areas implemented under the second stage project. The mission can only deduce from these observations that similar practices were used in the implementation of the project under audit.) Ungraded and contaminated filter material (chunks of concrete and earth) was used around the PVC pipes, precast and cast-in-place concrete in manholes was of very poor quality, construction procedures were inefficient and insufficiently supervised. The mission was told by EPADP officials that the reason for the use of upgraded filter material by the contractors was the low price allowed to them for

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4/ In the past, field investigations were carried out at gridpoints at 100 and subsequently 300 m spacing. The present 500 m spacing is apparently the result of a severe staff shortage, mainly of well trained technicians.

grading. The audit considers this explanation unsatisfactory. If the price allowed for proper grading was considered too low by the contractors, they should have refused to accept the work. As a result, the price paid would have had to be raised. The audit considers that an additional and not less important reason for poor quality material was the lack of adequate supervision by EPADP staff in the quarries where the grading was carried out by the contractors.

19. The operational performance of badly constructed drainage systems is usually poor and the useful life of the works short. This, together with inadequate maintenance (see following issues) observed by the audit in the areas visited, could lead to serious trouble in the future. The audit was given estimates, by various officials, of unsatisfactorily performing systems which ranged from a low 15% of the Project area to over 30%. The Drainage Authority, however, does not agree with these estimates.5/

C. Maintenance

20. The quality of maintenance is dependent on budgetary allocations; it is also affected by the shortage of properly trained and motivated technicians. Budgetary constraints affect primarily the periodic cleaning of the open drains by draglines. At present such work is performed once every two years, on the average. With the very clear water flowing in the drains in the southern part of the project area, this schedule seems insufficient. Weed growth is very rapid, requiring cleaning at much shorter intervals. Unsatisfactory performance of the open drains is compounded by the great length of some of the gravity drains (Komir and El Matana drains in the Isna drainage area), which cause water levels to rise over long distances, when the drains are clogged with weeds. The resulting backwater drowns the collectors and laterals, making routine flushing difficult. It is clear that (a) the upstream portions of the long gravity drains should have had pumps installed to increase the flow rate and thereby make the conveyance more effective; and (b) all drains must be cleared of weeds at least once a year.

21. Inadequate maintenance, resulting in poorly performing drainage systems, makes it difficult to convince farmers that drainage systems are beneficial to them. Only if farmers can be convinced that the works benefit their land is there hope that the present tampering with manholes and pipes flowing into them can be reduced. The maintenance of farm drainage works needs the cooperation of the farmer beneficiaries. Without their active help, the maintenance task becomes unmanageable. More efforts should be made

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5/ See comments at pages 2 and 3 of Annex I. Also, according to para. 5.06 of the PCR, the standard of operation and maintenance has considerably improved after EPADP took over this responsibility in 1979.

by the field staff of EPADP to educate and motivate the farmers to cooperate. This requires specially trained personnel and a lot of time.6/

D. Shortage of Qualified Staff

22. Some of the "quality" problems mentioned above could probably be alleviated by employing well trained and motivated technical personnel. Unfortunately these are in short supply. Graduate Civil and Hydraulic Engineers are reluctant to join Government Service and some of those who are working in the Service are looking for a way out to better paid positions in private industry or abroad. Qualified technicians are also in short supply and the two technical schools do not produce sufficient numbers of trained surveyors, soil technicians, draftsmen, etc.

23. The mission does not believe that the present shortage of graduate engineers can be alleviated in the short term. The solution therefore must come from a well trained workforce of technicians. The Region may wish to review the applicability to Egypt of the approach successfully taken by the Bank in India to a similar problem, i.e., to organize the in-service training of all grades of supervisory and design staff. These recruits would be put through a specially designed one-year basic training course, followed by periodic refresher courses to enhance their knowledge and motivation. The course would narrowly focus on the requirements of their tasks, whether topographical surveys, soil investigations, engineering drawing, maintenance work or construction supervision. The training will be field oriented with lots of practical work to prepare the trainee to carry out his tasks in the field with little supervision. Based on Bank experience with similar training operations in India, the chances for success in Egypt are promising.

24. The audit apprised the Chairman of EPADP of the Indian Programs. The Chairman has shown great interest and wished to have further information. The audit considers that without the necessary number of well-trained and motivated technical personnel in the Authority and with the Contracting Companies the ambitious drainage program of the Borrower may have to be slowed down, with increasing priority given to maintenance and rehabilitation over new construction.

E. The Bank's Performance

25. Supervision of the project should have been improved by giving more emphasis to design parameters and to the quality of designs, construction and maintenance. This would have focussed the Borrower's attention, early in the project implementation period, on the very serious shortage of professionals at all levels in EPADP and with the contractors and on the urgency to do something about it.

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6/ The Drainage Authority points out that the malfunctioning of a collector is invariably due to roots invading the pipe through the joints or to human factors. However, the system of handling complaints at centers covering 5,000 feddans each permits prompt action to remedy the situation.

26. In evaluating the Bank's performance, it is now obvious that too much confidence was placed on the construction administration capabilities of the EPADP and on the capacity of the public sector contractors. Supervision of the project was intensive in the start-up phase and, later on, timely and satisfactory. However, a lot of time was spent by the Bank on technical arguments with the Borrower, with regard to specifications which were originally agreed with the Borrower at appraisal and during negotiations. Some of these specifications were changed unilaterally by the Borrower on recommendation of the Egyptian-Dutch Drainage Panel,7/ as established by the Ministry of Irrigation in 1976, to provide the technical guidance for the country's large drainage program. A resolution of differences between the Bank and Borrower would have been clearly preferable to unilateral action.

27. There can be no doubt that the Bank made the right choice in selecting drainage for its priority lending activity in the agricultural sector. Investment in drainage is a sound long-term investment and a necessary condition for attaining high levels of agricultural production. Over the long term, the success or failure of the drainage projects will, however, depend on whether the drains are properly maintained and continue to operate.

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7/ The Panel is composed of Egyptian and Dutch drainage experts. It meets twice a year and discusses technical and economic issues. A meeting scheduled for early September 1983 was attended by over 15 Dutch experts and 10 Egyptian officials. The World Bank sent two observers. The Panel, in this session, focussed its discussions inter alia on the economic evaluation techniques for drainage projects.

Annex 1
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ARAB REPUBLIC OF EGYPT
EGYPTIAN PUBLIC AUTHORITY
FOR DRAINAGE PROJECTS
5 a Elgoheiny St. Dokki Giza
Cable Address: Deltatile Cairo.
Chairman's Office

Mr. Shiv S. Kapur,
Director,
Operations Evaluation Department,
1818 Street, N.W.,
Washington D.C.. 20433,
U.S.A.

Dear Mr Kapur,

Re: Arab Republic of Egypt
Project performance Audit Report (PPAR)
Upper Egypt Drainage I Project(Cr.393-UAR)

Thank you very much for your letter dated February 8,1984 with which we received the draft PPAR on Upper Egypt Drainage I Project together with its Completion Report.

We have reviewed the PPAR and would like to make the following comments on main points. These comments apply equally to the issues brought out in " Audit Memorandum" and their summary presented under "High lights". We believe you will give careful consideration to our comments while finalizing the PPAR.

(a) Selection of Tile Drainage. There is no doubt that installation of buried drains is a " demanding operation". Studies carried out in Egypt, however, indicate that the annualized cost of horizontal drainage compares favourably with vertical drainage. Therefore, it will be incorrect to assume that under Egyptian conditions, subsurface drainge by buried drains is expensive compared to the alternative of achieving drainage by tubewells .

(b) Project Implementation. It is true that it took about 3 years longer to complete in paticular tile drains. This delay, however, can only partially be attributed to aspects related to construction management The project received a serious initial setback due to abnormal conditions prevailing in the region at the time of its effectiveners. It also comprised our first large-scale drainage effort in Upper Egypt and the contractors took time to train man power for manufacturing

and installing and installing cement tiles. Besides the time spent in importing custom made tile laying machines, several other factors influenced the output . The most important amongst these are severe summer weather, sugar cane occupying in the cropping pattern more than 50% of the project area and non-cooperation by the farmers in the first few years. In view of these factors, you will agree with us that observations made in para 6 of the summary do not present the matter in a proper perspective.

(c) Yield Response to Drainage . By our letter dated 3 rd February 1983 to the agriculture division , we furnished the Bank with our post - evaluation results covering 110,000 feddans provided with tile drains under this project. These results indicate average increases over 4 years after drainage to be 9% for both wheat and cotton and 15% for maize. We believe economic rate of return (ERR) if assessed on these increases would be arround 20%, which for agricultural projects is highly attractive . While similar data provided by us for about 50 % of the area covered by Nile Delta I Project was accepted and incorporated in its Completion report, we fail to understand why data covering about 37% of Upper Egypt 1 Project has been ignored. We would, therefore, suggest to reassess ERR of this project based on above data and incorporate the same in its completion report and PPAR or reasons for not evaluating this data be communicated to us. Further we may emphasize that our data tends to under estimate the benefits due to drainage as our results are based on the averages of adequately and possibly some inadequately functioning areas. In view of the above , we will suggest to modify paras 8 and 10 of the summary and related parts in other sections . Post -evaulation of the results covering 37% of the area cannot and should not be treated as sample areas.

(d) Design and Construction . We may inform that over the last few years, our design office has investigated several previously installed systems. Based on these investigations and feed back provided by our construction directorates, we have already taken step to modify designs as necessary. Our pre drainage surveys have been considered satis factory by a recent FAO/CP mission . We have also taken several steps including training of our and contractors engineers and technicians to further improve construction management and quality control. We can assure you that the quality of work is by and large satisfactory.

(e) Poorly Performing Systems and Maintenance. We do not agree with the contents of paras 19 and 22 and would suggest that these should not be included in the final PPAR . It is incorrect to assure that 15-30% of the project area may be poorly performing. Our system of having complaints in centers each covering 5,000 feddans records every poorly performing collector. Prompt action is invariably taken to remedy the situation. The malfunctioning of a collector is invariably due to roots invading the pipe through the joints or due human factors and generally not because of factors implied in para 19 and under subsection C " Maintenance ".

We would draw your attention to para 5.06 of the completion Reports which rightly commends the action taken by EPADP since taking over of maintenance in 1979. While your Credit Agreement did not stipulate such on arrangement, the Ministry of Irrigation considered it necessary to unify maintenance of open and field drains . We would have liked the completion and Audit missions to comment on the system of maintenance districts and centers established by us, with local financing.

The profuse growth of weeds in Egyptian water-ways is a serious problem . We cannot afford to increase frequency of excavation by draglines and hydraulic excavators because that enlarges the cross sections , reduces velocities, and aggrevatec the problem. We would , therefore, welcome the Bank's assistance in finding a solution to this problems.

(f) Bank Assistance . We appreciate the technical assistance provided by the Bank staff which resulted in improvement in design standards.

With best regards.

Sincerely Yours

Eng. M.A. Makhlouf
Chairman
3/4/1984

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# ARAB REPUBLIC OF EGYPT

# PROJECT COMPLETION REPORT

# UPPER EGYPT DRAINAGE I PROJECT

# (CREDIT 393-UAR)

June 28, 1983

Agriculture Division I
EMENA Projects Department

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# ARAB REPUBLIC OF EGYPT
# PROJECT COMPLETION REPORT
# UPPER EGYPT DRAINAGE I PROJECT
# (CREDIT 393-UAR)

## I. INTRODUCTION

1.01 This completion report for Upper Egypt Drainage I Project, the second phase of a multi-stage drainage program in Egypt gives a further opportunity to record and evaluate the performance on the second project in the largest single tile drainage program ever undertaken in the world. The project provided the second substantive financial assistance to the Government of Egypt's (GOE) policy of providing improved drainage throughout most of the nearly 6 million feddans 1/ of the historically irrigated area ("the old lands") in the Nile Valley below the newly completed dam at Aswan. The project aimed to provide field drainage to some 5% of this area, and, following the pattern set by the previous project, the Bank extended its participation in the drainage program by financing this and two further projects involving three credits and three loans totalling US$152 million. The four projects together cover improvement of surface drains in about 2.56 million feddans and installation of tile drains in 2.16 million feddans (about 40% of the old lands irrigated areas). Annex 1 presents salient features and status of each of the repeater projects. The project and its successors has also attracted significant amounts of aid from other donors including USAID, KfW, the Netherlands Government and the World Food Program.

1.02 This credit, the second in the vital agriculture sector, represented a continuation of Bank Group lending operations in Egypt. Credit 393-UAR 2/ for US$36.0 million was signed on June 8, 1973 and became effective on November 28, 1973. The Closing Date, originally December 31, 1979, was extended to July 31, 1981. The final disbursement from the credit was made on May 21, 1982 bringing the total amount disbursed to US$34,905,539.46. On this date, the installation of field drainage, an activity critical to full completion of the project, was accomplished in 255,000 feddans out of the 300,000 feddans originally planned.

### Agriculture Sector Setting

1.03 Agriculture continues to be the principal sector of the Egyptian economy, although it has been declining in relative terms with the growth of industry. Between the 1973 appraisal and the date of project completion, agriculture's share of total employment has fallen to 39%, its share of GDP has fallen from 27% to about 21%. The agricultural sector has faltered in the last decade, as evidenced by the fall in the average annual growth rate of around 3% in the 1960s to below 2% in the 1980s. Population (currently estimated to be 43 million) has continued to increase at an annual rate of 2.1%, and rural to urban migration has accelerated. This population increase, together with massive infusions of money repatriated by Egyptians working

1/ Or 2.4 million ha (1 feddan = 0.42 ha).

2/ At the time that the Credit was agreed the Arab Republic of Egypt was the United Arab Republic, hence Credit 393-UAR. More recent loans and credits are numbered EGT.

abroad, has increased consumer demands for more and better foods far beyond the ability of agriculture to supply. The production of controlled crops, mainly wheat, beans, lentils and cotton has been depressed by GOE controls over input distribution and output marketing and associated pricing policies. Imports of key foodstuffs have increasingly been required to complement domestic supplies. During the same period the value of agricultural exports (mainly cotton) stagnated, leading to a widening trade deficit in agricultural commodities. Therefore, the fundamental underlying challenge facing the Government is to bring about changes in technology, institutions, policies and, of necessity, improving drainage for increasing the rate of growth in agricultural production.

Land Constraints and Importance of Improved Drainage

1.04 Good land for crop production is scarce in Egypt and development of desert/saline marshy lands identified by GOE for reclamation is cost intensive with lengthy gestation periods. Therefore, the main source of increases in agricultural production in the short run must be the old lands in the Nile Valley. On these lands productivity is still constrained even today by inadequate drainage in about 3 million feddans. The priority thus lies in continuing drainage program under which some 1.6 million feddans will have been equipped with tile drains by the end of 1984. This is readily justified since no input package to increase production will be fully successful until the drainage constraint has been removed. While there is little evidence that land is going out of production as a result of salinization caused by high groundwater levels, it is clear that rising soil salinity in some areas is causing yields to decline.

1.05 Fully aware of this stark reality, the Government has given high priority to the tile drainage program in recent years. During the 5 years ending 1979, the capital expenditures on all irrigation and land reclamation activities in Egypt totalled £E 400 million (US$ 580 million). Out of this, drainage alone accounted for £E 184 million (US$ 267 million) or 46%. Annex 7, which shows the Ministry of Irrigation's (MOI) budget, indicates that over the same period the drainage projects consumed 53% on average of MOI's capital funds. The MOI current planning is to complete all on-going projects covering about 1.6 million feddans by 1983/84. Draining the remaining 2 million feddans is likely to take until 1990.

Bank's Agricultural Lending

1.06 Since 1970, the Bank has financed 12 projects in the agricultural sector in Egypt. Initially the Bank's policy was to encourage the Government to maintain and increase production levels in the old lands. This was done through the series of four drainage projects, of which 393-UAR was the second, and through the Agricultural Development Project (Credit 830-UAR). This is a pilot attempt to raise productivity in two governorates by increasing the level of farm mechanization and strengthening agricultural credit, cooperatives and extension services. Over time there has been further diversification. The Fruit and Vegetables Project (Loan 1276-EGT) of FY76 included financing for a vegetable seed farm, completion of the West Nubariya Drain, credit to fruit and vegetable processors/exporters, and associated activities. The Agroindustries Project (Credit 988-EGT) of FY80 includes financing for small and medium-sized agroindustries and replacement of municipal slaughterhouses in Cairo and Alexandria. The Fish Farming

Development Project (Credit 1111-EGT) of FY81 includes financing for the development of a large commercial fish farming venture in Lake Maryut and credit for smaller fish farms in other parts of the delta. The New Lands Development Project (Credit 1083-EGT) of FY81 marked the beginning of a further shift in lending to agriculture, being the first project primarily aimed at helping the Government's land reclamation program. It is financing the development of 24,000 feddans of desert into intensive smallholder farms of 6 feddans each. A Technical Assistance Credit in FY81 finances the establishment and training of two units for project preparation, one in the Ministry of Irrigation and one in the Ministry of Land Reclamation. A second Agroindustries Project (Ln 2243) was signed in FY83 together with an Irrigation Pumping Stations Rehabilitation Project (Ln 2270) which is the first of a series of proposed projects to modernize the irrigation infrastructure of the Old Lands.

## II. BACKGROUND

2.01 Egyptian agriculture has historically been blessed with Nile waters, which both contained very low concentration of salts and annually flooded the Nile Valley thus flushing salts from the soils. Salinity was thus never a problem. With the gradual introduction of large-scale perennial irrigation from the beginning of this century, the natural system of drainage was lost. Today, as a result of several decades of perennial irrigation, a rather high water table has gradually developed with consequent rise in soil salinity and reduction in plant production.

2.02 In order to prevent deterioration of the soil, an open drainage system was constructed, beginning in the northern part of the Delta around the turn of the century and, over the years, being extended to other parts of the country. By 1965, nearly 5 million feddans were covered with open drains. However, farmers did not fulfill their responsibility to connect each plot with drainage channels, mainly because they could not afford to lose the 10-15% of area that would have been occupied by these ditches. Accordingly, the drainage system was neither complete nor effective enough to have any significant control on the water table in clay soils. The efficiency of the system was further constrained by inadequate maintenance. Therefore, inadequate drainage of the soils increasingly became the single most important limiting factor in crop production.

2.03 As the land slopes only slightly, the operation of the drainage system required the installation of pumping stations. The number of such stations increased steadily, from 18 in 1934-35 to 52 in 1964-65, of which 35 were located in the Delta.

2.04 Recognizing the inadequacy of the conventional methods, research was initiated in 1938 at 15 experimental stations to try out covered tile drainage systems in different parts of the country. By 1952, pilot projects were extended to an area of approximately 50,000 feddans. Also in the same year,

1/ Set up in 1973 by merging the Nile Delta Drainage Authority and the Egyptian Authority for Drainage Projects.

MOI organized the "Drainage Research Bureau" for carrying out research on groundwater flow problems and on technical cum economic studies related to tile drainage. This bureau was later renamed the Drainage Research Institute (DRI).

2.05 Encouraged by the results obtained with tile drainage, a law was passed in 1956 giving the responsibility for the execution of field drainage to the Government. An ambitious 30-year program to cover all the areas under perennial irrigation with tile drains was also drawn up. However by 1965, as a result of resource constraints, including scarcity of foreign exchange, only about 300,000 feddans had been tile drained.

2.06 Between 1961 and 1965 modern techniques of tile drainage were studied and tested through a pilot project covering five areas, each up to 2,000 feddans implemented under the auspices of the United Nations Special Fund with FAO as the executing agency and ILACO from Netherlands employed as consultants. The purposes of this project, determining the technical and economic viability of tile drainage under conditions prevailing in the irrigated lands of Egypt and identifying issues on which further research was needed, were largely achieved.

2.07 The final report 1/ on the UNDP Project defined the task of the DRI as "to try out new methods of investigation, construction and maintenance." However, DRI's research on many of the important technical issues recommended in the FAO report has been limited. Reliable or conclusive answers to many of these aspects are still lacking, and constitute a weakness of the drainage program. Of particular significance is the apparent lack of any monitoring of groundwater fluctuations and groundwater movement in irrigated areas, the lack of measurements of water table and piezometric levels in drained areas or of discharges from collectors.

2.08 In 1964 a joint committee of MOI and the Ministry of Agriculture (MOA) studied the effect of tile drainage on crop yields in an 18,500-feddan area in the Delta where buried drains had been installed between 1940 and 1942. A statistical analysis showed that maize and cotton recorded yield increases of about 32% and 35% respectively, mainly because of field drainage. Similar analysis carried out regarding wheat in another area, also located in the Delta, showed average yield increase of about 27%. These results strengthened the views of the MOI to provide tile drainage in much of the irrigated lands.

2.09 The commissioning of the High Aswan Dam (HAD) in 1968 brought both development opportunities as well as challenges. Relevant to irrigated agriculture, the HAD potential opened the possibility for large scale expansion of perennial irrigation area. As regards drainage, the large additions to irrigation water supplies deriving from the HAD were to aggravate the problem thus forcing GOE to take accelerated measures for counteracting extensive deleterious effects on groundwater levels.

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1/ Pilot Project for Drainage of Irrigated Land-UAR-Final Report, FAO/SF:30/UAR-1967.

2.10 Although the priority attached to the drainage program greatly increased after 1966 and plans for draining over 1 million feddans in the Delta over the next 5 years were drawn up, progress on the drainage program continued to be slow, hampered mainly by budgetary constraints and lack of equipment. By the time the Upper Egypt I Project was appraised in 1973, the total area provided with tile drainage was about 500,000 feddans and was proceeding at the rate of about 40,000 feddans per year. It was explained to the various Bank missions that visited Egypt during the period that MOI intended to undertake an accelerated program for drainage provided foreign exchange was available for the import of machinery.

2.11 Bilharzia. Bilharzia has been a major health problem in Egypt since ancient times. Two types of Bilharzia are present, Schistosoma haematobium occuring throughout the irrigated area and S. mansoni which at present is essentially confined to the Nile Delta. The disease organism passes part of its life cycle in a water snail host. Transmission occurs through human excreta coming in contact with water inhabited by the snail hosts and by human contact with infested water. Infection is highest among children in the 10-15 year age group. The degree of infection varies locally, depending on the availability and suitability of canals and other bodies of water in which the snail host may live and breed and on the habits of the local population. Persons infected suffer debilitating symptoms and bilharzia can predispose the individual to serious complications such as cancer of the bladder and exacerbate the effects of malnutrition and diseases such as viral hepatitis.

## III. PROJECT FORMULATION

### Project Origin

3.01 The initiation of Bank-financed drainage projects followed the Bank economic mission to Egypt in 1966 when two of its members from the FAO/IBRD Cooperative Program recommended Bank consideration of a project that would include tile drains as well as the expansion of open drains and pumping stations.

3.02 The idea of a drainage project was further advanced late in 1967 by a bank mission in early 1968 by an economic mission and in July 1968 by a visit of the President. These contacts culminated in a Bank agricultural mission which visited Egypt in September 1968. This reviewed a number of project possibilities from which a drainage project for part of the Nile Delta was chosen as first priority (Credit 181-UAR), completed December 1980. Subsequently, the Upper Egypt Drainage I Project was proposed, and MOI undertook a feasibility study.

3.03 Several technical and other questions/issues raised by the agricultural mission deserve special mention because of their validity and the fact that, even today, reliable information on many of them is still lacking. The prominent issues included: lack of basic information on vertical drainage; inadequacy of experimental evidence to quantify the increase in the yields of cotton, maize and wheat and GOE inability to assign benefits to berseem that covered the largest winter crop area in the Delta; and the fact that insufficient data was made available on water-logged and saline soils and the rate at which the affected area was spreading; inadequate information on the pumping need; and lack of water charges. The agricultural mission did not

provide a comprehensive diagnosis of MOI's implementation capability and the need or otherwise for consultants, both of which became crucial at appraisal and during negotiations.

Feasibility Report

3.04 In 1972, the Minister of Irrigation forwarded a feasibility report to the Bank for a US$113.0 million project to be completed in 6 years as a part of the larger 15-year Government program. In the letter of transmittal, a request was made for financing by IDA of foreign currency costs estimated at US$20.0 million. The main components of the project were the same as proposed by the Bank agricultural mission (para 3.02). Based on yield increases of 32% with cotton, 37% with maize, and 34% with wheat, the ERR was assessed at 20%.

3.05 The feasibility report was reasonably comprehensive but was short on some essential data, details and justification. In particular, there was an absence of a satisfactory and complete justification for selection of the project area. Information on soils, groundwater levels and salinity status was fragmentary and needed to be completed and enlarged. In view of the implication contained in the report that drainage conditions in Middle and Upper Egypt are less uniform than in the delta, it was felt, and commented upon, that detailed field studies were necessary to finalize selection of each individual area. The cost estimates for foreign exchange items of the project were considered to be realistic, but the local costs were considered to be questionable, particularly in respect to construction costs of lateral and collector drains. 1/

Appraisal

3.06 The appraisal of the project was carried out in March 1972. The appraisal mission reviewed the basic assumptions made in the feasibility report, giving special attention to the managerial capacity of MOI, to the rate of implementation, and to the increases in crop yields anticipated with the project. The major issue revolved around the mission's opinion that all construction should go to ICB against the insistence by MOI that the bidding for construction of open and buried drains be restricted to quasi independent, government owned contracting firms. In the end, the mission accepted the MOI arguments but insisted that ICB be followed for the procurement of all items of equipment and construction machinery, financed by IDA, including maintenance and training of Egyptian operators and mechanics by technicians supplied by the equipment manufacturers.

3.07 Following the appraisal mission, the scope of the project and its period of implementation were debated in the Bank. As a result, it was finally decided that the project would consist of five pumping stations and a tile drained area of 300,000 feddans, the pumping stations were designed to pump surface water drainage from 232,000 feddans outside the project area and water from 89,000 feddans of tile drained area within the project area. The period of implementation was 6 years. Both these decisions were taken in order to reduce the risk as well as to learn more about possible increases in the rate of implementation before preparing further phases of the drainage

1/ "Some Engineering Aspects in the Project Report Submitted by the Executive Authority," EMENA Files-Egypt, Cr. 393-UAR, I, 1972-74, "Negotiation."

program. Limiting the size of the project caused no problems with GOE, possibly because the curtailment in the period of implementation did not affect the program of MOI or the amount of financing by IDA.

3.08 Some non-technical potential problems were identified; these included the need for a strong unified organization to run the project. Assurances were obtained from GOE that at all times a qualified and experienced Chairman for EPADP and a qualified and experienced Vice-Chairman for Operations in Upper Egypt would be appointed. Consulting services, as in Delta Drainage I, were a thorny issue. Although GOE accepted the need for consulting services, and these were included in the appraisal report, it was evident that appointment of expatriate consultants in the manner envisaged by IDA was likely to be resisted or considerably altered.

Negotiations

3.09 Negotiations took place in the period April 2-6, 1973. The two principal issues were how to give the project organization adequate authority and the employment of consultants. The first was resolved with the presentation by the Egyptian delegation of a Presidertial Decree for establishing of the Egyptian Public Authority for Drainage Projects (EPADP) as a semiautonomous body within the MOI. As regards hiring of consultants, the Borrower came to negotiations prepared to resist on this issue but ultimately agreed. However, during negotiations, the Borrower made it plain that he wished to retain individual consultants, not a consulting firm. It was agreed that the input of consulting services should be reduced to 15 man-years, and that this should form a side letter to the DCA.

3.10 Satisfactory arrangements existed for the recovery of field drainage costs. These had been agreed during the implementation of the Nile Delta I Project.

3.11 Procedural matters discussed and agreed during negotiations included amendments to local construction contracts to meet the conditions of the Development Credit Agreement including utilization and maintenance of the equipment to be financed out of the proceeds of the credit and training of contractors' mechanics and operators at the Authority's training centers. Auditing of the Authority's accounts and financial statements by GOE's Central Organization for Accounts and Audit was considered satisfactory.

The Project

3.12 The primary objective of the project approved by the Bank Board on May 17, 1973 was to improve drainage in 300,000 feddans in the Upper Egypt at a total cost of US$123.8 million equivalent with an IDA credit of US$36.0 million. The project description incorporated in the Development Credit Agreement is given in Annex 4. The project included remodeling of 775 km of existing open drains and the excavation of about 865 km of new open drains, the construction of four pumping stations and the expansion of an existing station, provision of transmission lines and power substation for the pumping stations, the reclamation of about 22,400 feddans of saline land, a Bilharzia control program covering an area of 900,000 feddans in the Governorates of Beni Suef, El Minya and Assiut, provision of necessary vehicles and equipment for the Authority and extension services and the provision of technical

assistance for training the staff of the Authority. The IDA financing was to be used primarily for the importation of construction machinery and pumping equipment including its installation and spare parts as well as for consulting services.

## IV. IMPLEMENTATION

### Development Credit Agreement and Side Letters

4.01 The Development Credit Agreement (DCA) was signed on June 8, 1973 as were the five side letters. The five side letters were as follows:

(a) IDA Certificate of Secretary Relating to Resolution No. IDA 73-55.
(b) Resolution No. IDA 73-55.
(c) External Debt Statement of ARE.
(d) Project Area Statement of ARE.
(e) Agreement by EPADP to Employ Consultants for Part A.

### An Overview of Project History

4.02 The agreed implementation schedule projected completion of the project by June 1979. The credit closing date was set as December 31, 1979. While the project objectives remained unchanged, many events conspired to cause delay. The closing date was revised once, generally to accommodate slippages in implementation. The credit was finally closed on July 31, 1981, but its accounts were kept open for making disbursements against commitments made before this date.

### Effectiveness and Start-up

4.03 No other than the standard conditions of effectiveness were required. The credit was declared effective on November 28, 1973, 5-1/2 months after signature.

### Construction of Project Works

4.04 In general, progress in implementing the project can only be viewed as poor since it took almost 3-1/2 years longer to complete the principal objectives than the originally agreed period of about 6 years. Of the three main components viz pumping stations, open drains and buried drains, it was the third which delayed full completion of the project. On the original credit closing date of December 31, 1979, the completion achieved was 97% on open drains, 80% on civil works of pumping stations and some 60% on field drainage. Aside from the time factor, there was noticeable deficiency in coordinating supporting activities. The three tile-making factories only partially served the project because they became operational only during 1980.

4.05 In general, the delays were due to weaknesses in EPADP's construction planning and management organization as well as the low implementation capacity of the public sector contractors. While EPADP failed to manage the program rigorously enough, the delays largely related to the management weakness of the contracting organizations. They lacked, and still lack, normal commercial incentives to meeting construction schedules and EPADP

has no effective means of enforcing the conditions of contracts. Project progress was also affected by events not directly related to these organizations. The October 1973 war, its impact on skilled manpower, resulting shortage of local funds, scarcity of cement supplies and the overall variable quality of staff available to the project were factors not directly under the control of the project management or of the public sector contractors. Nor could some of these problems be solved in the short run. To some extent, the farmers' resistance to destroying partially matured crops as well as heavy watering of the fields disrupted smooth operations by the contractors.

4.06 The problems faced by the project during the first few years were considerable, and required painstaking effort and persistence on the part of the Bank staff to get them resolved at Government/Authority level. Eighteen supervision missions were mounted between July 1973 and April 1982.

4.07 A possible and partial solution to the situation prevailing during the early 1970s could have been for EPADP to make more extensive use of the consultants. However, efforts made by the supervision missions to persuade EPADP to do this had no success, mainly because the Authority was unwilling to share any management responsibility. Thus when the consultant's contract expired it was not renewed.

4.08 The work on amelioration of land having saline soils has been completed. Some 11,700 feddans were completed in 1980/81 and a total of 9,000 feddans in 1981/82. This total of 20,700 feddans is less than the area anticipated in the Appraisal of the 22,400 feddans. The reclamation process involved subsoiling in combination with the application of gypsum. The quantity of gypsum applied varied with the degree of soil problems being encountered. On average about 3 tons of gypsum per feddan was applied in the reclaimed areas. The short time available between harvesting and sowing crops was the major difficulty in carrying out the soil amelioration programme, The implementation agency[1/] promised to prepare a brief report on monitoring the effect of soil amelioration on crop yields, but did not deliver. Field supervision missions noted poor quality of subsoiling operations and applications of gypsum.

4.09 As a result of the October 1973 war, there was relatively slow progress during 1974. As of September 1974, roughly 2% of the originally estimated disbursements had taken place, and none of the tile drainage had been completed. The project by then had fallen nine months behind schedule.

4.10 Annex 5 presents the construction schedule agreed during negotiations for the three major components, and as actually implemented. This presentation shows that most slippage occured on the tile laying schedule. While EPADP construction planning and control continued to be lacking in certain respects, a greater part of the responsibility must be apportioned to the inadequate construction management by the contracting agencies.

4.11 The options available to the Bank staff to do anything about this situation were, however, limited, because IDA had limited leverage for

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1/ The Executive Agency for Land Improvement Works, Ministry of Agriculture.

influencing the working of the public sector contractors. In spite of constant follow-up from Washington, project progress remained disappointing. One supervision mission even suggested posting a Resident Mission in Cairo. However, it was realized that the distinction between providing technical assistance on a day-to-day basis and taking de-facto charge of project management would be difficult to maintain and could even increase Egyptian resistance to outside interference. It became clear that direct control over project activities and decisions had to be the prerogative and the responsibility of the local EPADP staff, and that Bank staff influence could at best be indirect. Few new alternative courses of action were therefore available to the Bank to bring about a faster rate of implementation. When opportunities presented themselves, however, action was taken. For instance, when shortages of local funds continued to remain a significant delaying factor, the Bank, apart from constantly stressing the need for adequate funding to the Minister, inserted a covenant into the next drainage project (Nile Delta Drainage II) requiring the Government to establish a Special Fund from which EPADP could draw, without restriction, for implementing all IDA/Bank-financed drainage projects.

Bilharzia Control

4.12 The integrated bilharzia control program initiated in 900,000 feddans of Middle Egypt, under the project, began in 1976. This was supplemented by control work in a further 153,730 feddans under the Upper Egypt Drainage Project II. The total area now contains a population of some 4.3 million people. The control strategy applied in this project (described in detail in Annex 13, Appendix 1) has involved a three year period of intensive snail control measures - by molluscicide on an area-wide basis three times annually - together with chemotherapy of the infected population in rural and urban areas. This has been followed by a three-year 'consolidation' phase (1979 onwards), during which the integrated control strategy was continued, but with a reduced number of molluscicide applications annually, together with continuing treatment of infected people based upon annual re-examinations.

Revisions

4.13 During the course of the project, no changes were made in the project scope, its objectives and basic design. However, the original selection of the areas, as a result of changes in the behavior of groundwater over a period of about 9 years, had to be amended from time to time, excluding or reducing some and substituting equivalent new areas. It seems clear that these changes were beneficial by allowing areas where the more serious drainage problems were emerging to be given priority. Annex 5 presents by catchment unit the areas at appraisal, those revised during execution of the project and the final areas in which drainage was ultimately improved. As compared to appraisal, the area in the Beni Suef decreased by 29% those in El Fayoum and El Minya by 24% and in Aswan by 17% whilst the areas drained in Asyut, Sohag and Qena increased by 216, 14 and 1% respectively.

4.14 Whilst it is believed that the revisions helped to ensure that the drains were laid in high priority areas there is some lack of confidence that this has always been the case. Two drainage consultants, independently, have commented upon the relative dryness of the formation in which they inspected tiles being laid. Both consultants acknowledged that they visited the

construction sites when irrigation was at a minimum and hence the water table could be lower than during the periods of high irrigation applications. However, the lack of water table depth recording causes some doubt as to whether the drains are really needed in all the areas that have been provided with them. This leads to the question - are all the drains installed necessary? Whilst investigation and experience show that benefits accrue if tiles are installed this is only true if the area suffers from a high water table. This doubt reinforces the views expressed in paragraph 5.07 of the necessity for better investigation, monitoring and also for more area-specific data to be provided by EPADP for ongoing and future projects.

4.15 The original allocations for most items proved inaccurate (Annex 4). Allocations for equipment for the tile drainage construction and main drainage remodeling (Categories I and II) were originally US$16.1 million. Final disbursements on these two accounts were US$23.9 million, an increase of 48%. Allocations for machinery, equipment and civil works for pumping stations (Category III) were originally US$7.6 million while final disbursements were US$3.12 million, a decrease of 59%. Allocations for training and consultants (Category IV) were US$1.0 million but no money was expended under this head. A large increase occurred in connection with bilharzia control (Category IV) where US$4.7 million were allocated against US$7.9 million disbursed, an overrun of 68%. It was agreed that up to a US$4.2 million overrun on the Bilharzia Control Program could be covered by Upper Egypt Drainage II Project (Cr.637/Ln.1285-EGT). Given these relatively major changes, it was necessary that the original allocation of the proceeds of the credit were amended several times. In the end, an amount of just over US$1.0 million still remained undisbursed and was cancelled.

Accounting, Auditing and Reporting

4.16 In view of difficulties encountered in the Nile Delta Drainage I Project, it was realized that there was a need for setting up an adequate cost accounting system to determine the relevant costs of the works performed. As a result, special covenants were made in the Project Agreements for succeeding drainage projects. These required that EPADP would establish a new cost accounting system satisfactory to IDA. In accordance with terms of reference prepared by the World Bank staff, a new accounting system was designed in 1980 by an Egyptian firm of chartered accountants. This system is now operational. Auditing of the Authority's accounts and financial statements is carried out by the Central Organization for Accounts and Audit. Audit reports for each financial year were generally submitted to the Bank, although somewhat later than the date stipulated in the relevant covenant of the Project Agreement. However, problems causing delays in preparing these reports were recently overcome and the audits are now submitted to the Bank almost on time.

4.17 The Drainage Authority furnished, on a regular basis, quarterly progress reports. Based on suggestions by the Bank Staff, the initial reporting requirements included many unneeded details which caused considerable delays in preparing these reports. After the reporting format had been improved in 1977, by eliminating unnecessary details and by substituting simplified summary tables, these progress reports could be prepared and forwarded to the Bank almost on time. These reports were oriented to progress on implementation of works. For future projects it will be desirable that this reporting system is modified so that achievements are

compared with planned targets, together with comments on major difficulties encountered and actions taken or proposed to overcome such problems. This would increase the usefulness of the quarterly reports.

Procurement

4.18 Procurement of imported vehicles, equipment, spares for the project and steel for drainage and reclamation works were arranged in accordance with IDA procedures for international competitive bidding. Remodelling of open drains including structures, installation of tile drainage, land reclamation and buildings were carried out through contracts awarded in accordance with the normal procedures of the Government.

Final Cost Versus Appraisal Estimate

4.19 Total project costs amounted to about US$ 119.7 million including IDA disbursements of US$ 34.9. They are shown in Annex 10. Project costs by year are given in Annex 11. Since the final project local currency disbursements are not expected to be completed until June 30, 1983, the total project expenditures will not be available before September 30, 1983. However, a clear picture could be obtained from the comparison of the average local cost of drainage works per feddan of the actual completed area under the project with that estimated at appraisal. The total expenditures as of June 30, 1982, for local costs of tile drainage works covering about 274,000 feddans were LE 18.273 million i.e. LE 66.66/feddan. The total expenditures for local costs of open drainage covering some 300,000 were LE 11.35 million i.e. LE 37.63/feddan. Thus the actual local cost of construction of drainage facilities was about LE 104.3 per feddan, of which nearly 10% represents the cost of compensation for crops and land lost as a result of the project works, compared with LE 86.7 at appraisal, an overrun of 20%. The entire local cost overrun was financed by the Government. The increase in local cost was due mainly to inflation in the post-1973 period.

Disbursements

4.20 Actual disbursements on a quarter yearly basis for the full term of the project are presented in Annex 6. Some three years delay in completion of the project is reflected in the extended disbursement period. As shown in this Annex, only about 87% of the Credit was disbursed by the original target date of December 31, 1979. The credit was closed finally on May 25, 1982, cancelling the unutilized amount of some US$1.0 million.

## V. OPERATING PERFORMANCE

5.01 The drainage design procedure adopted in this project is the same as that used in the Nile Delta Drainage I Project. Two main features are of vital importance viz the use of envelope material around field drains and the spacing of laterals.

5.02 Regarding the use of envelope material, all tile lines constructed during the initial years of project implementation were covered with a gravel layer. However, due to the difficulty of obtaining the proper envelope material at a reasonable cost and due to increased construction time, EPADP

supported by the joint Egyptian-Dutch Panel, decided to stop the use of gravel filter in all drainage contracts awarded from 1978 for areas whose soils had a clay content exceeding 40%. This raised the implementation rate slightly and reduced construction costs. However several engineers have advocated the use of a gravel envelope around subsurface field drains in all types of soil. As a result of this, top priority is now given to the ongoing investigations carried out by the Drainage Research Institute (DRI) on this subject. In the light of DRI's findings and also the recommendations contained in Annex 8, EPADP will see whether changes are needed. Any such changes will of course only be reflected in later projects.

5.03 With regard to the lateral spacings, EPADP used the steady state concept for obtaining the spacing between field drains. These spacings were determined using hydraulic conductivity data collected in the field, but the laterals were actually constructed at standard spacings of 40, 50 and 60 meters. Being aware of the fact that the construction of field drainage should be based upon proved technical investigations and design criteria to provide the necessary levels of groundwater and salinity control, EPADP should revise its current standards for field drainage investigations and designs. An expert in tile drainage design visited Egypt in April, 1983 for this purpose. His recommendations should be carefully studied and followed as far as practicable, taking into account the need for a scientific and practical approach to the design procedures.

5.04 Over the period of the project implementation several consultants and Bank engineers have visited the project. There has been a consensus of opinion by all visiting experts that the steady state approach to drain spacing is suitable and that EPADP are correct to use it. There has also been a consensus that drain spacing calculated in the design office should be adopted in the field. Adopting drain spacings on grounds other than scientific and practical is bound to lead to problems, waste of money and in places underdraining. EPADP should forthwith instruct their staff working on Upper Egypt Drainage II Project to design and build tile drain systems with the design drain spacing being built to the nearest 10 meter multiple, not to the current 40, 50 or 60 meter spacing (Annex 8, paras 3-10).

Operation and Maintenance

5.05 It was agreed during negotiations that the operation and maintenance (O&M) of completed drainage systems would remain the responsibility of the irrigation departments of the Ministry of Irrigation. Under this arrangement, the O&M left much to be desired due mainly to inadequate allocation of funds, lack of equipment and organizational problems.

5.06 In order to improve this situation, the GOE transferred the responsibility for O&M of surface and sub-surface drains in tiled areas to EPADP. This took effect from 1979. Since then, EPADP has established a well structured organization to take this responsibility, and through annual maintenance programs for open and field drains the standard of maintenance has considerably improved. Also, with better allocation of funds and more effective control of field work, the standard of O&M has considerably improved.

5.07 For the maintenance of open drains, mechanical means were used extensively and successfully. However, maintenance of field drains is still done manually. In view of the continuous shortage in hand labour and, to

upkeep the efficiency of subsurface drains, six flushing machines have been purchased very recently. The number of machines will be increased to 24 machines by the end of 1983 all to be used in the maintenance of tile drains. If the use of these machines proves to be successful, EPADP is expected to shift the maintenance of all field drains from manual to mechanical.

Monitoring

5.08 Monitoring of drain performance has been carried out on the basis of observing crop response. Such an approach to monitoring tile drainage projects has advantages and disadvantages. It enables sound economic predictions to be made but does not measure tile drainage performance directly. It is also very difficult to isolate those crop responses attributable to drainage. The results of this method of monitoring are still being analyzed and hence all projections of yields attributable to drainage are provisional. It is most desirable that direct monitoring of tile drain performance should be implemented as soon as possible. Such monitoring will assist to:

(a) Identify areas where the drains are inefficient.
(b) Provide data on drain performance that can be used to provide more efficient design of future projects.
(c) Provide a guide to how well the whole drained area is performing.

5.09 The need for direct monitoring of tile drain performance should be stressed in future projects at project preparation, appraisal and negotiation stages. Monitoring should be carried out on a number of representative areas. It will be better to have small area coverage with good recording of data, than to attempt to obtain records for the whole area. Direct monitoring on representative areas should include the following data collection:

(a) recording date and duration of irrigation for each plot in the area;
(b) record amount of water applied;
(c) monitor water table depth at selected places;
(d) monitor depth to water in all manholes;
(e) establish consumptive use of crops within the area on a continuous basis; and
(f) carry out the same measurements, where possible, on an underdrained control area.

5.10 In addition to monitoring drained areas, it is important that EPADP appreciate the need to keep records of water table movement in presently undrained areas. If this is properly carried out EPADP will be able to prove which areas need drainage and also to prioritize individual areas.

5.11 This work should be done by installing a grid of sub-surface water level pipes in the areas that are presently undrained. Such pipes should be 5 meters long, 125 mm in diameter and have fine holes pierced in their sides for the bottom 2.5m. They should be inserted in augered holes with a sand screen placed around their circumference. The top of every pile should be related to survey datum. The sub-surface water level pipes should be installed as a grid giving 10 5-10 km sides north and south and 3-km sides east and west.

5.12 The water level in the pipes should be read once each month and the results tabulated and plotted as a map to give water table contour maps and depth to water table maps. Such maps should be drawn for the maximum and minimum situations each year. In addition trends should be examined by analysing the behavior of the water table in individual and groups of pipes.

5.13 It is evident that in past studies not nearly enough attention has been paid to identifying areas most needing drainage. This has not only led to many revisions of areas to drained in the history of this project but has also resulted in money being wasted when drainage has been provided to areas of relatively low water table. Even at this stage, when so much land drainage work has been done in Egypt, it is virtually impossible to obtain good, consistent and well presented data and maps showing the position and trends of the water table. It will make it very difficult to justify further money being spent on further projects unless EPADP provide the data and analyses briefly described above.

Evaluation

5.14 To evaluate the effect of drainage projects, an Evaluation Division was established within EPADP in 1970. An evaluation program was set up by EPADP in cooperation with the Ministry of Agriculture, for the assessment of the overall effect of tile drainage - as it is presently designed and constructed - on crop production in all tile drained areas covered by the Nile Delta Drainage I Project. Later on, the same methodology was followed for the evaluation of the effect of drainage works completed under the Upper Egypt Drainage I Project and succeeding Bank financed projects, and an Evaluation Committee for the drainage projects including representatives of the Ministry of Agriculture was formed in 1973. According to the above mentioned program (EPADP's Ex-Post Evaluation Program), yields of the main crops were assessed by the Ministry of Agriculture using the method of random sampling. From the individual crop cutting results, yield data were recorded as averages per subarea of the project before and after drainage. These yields were compared with yield data collected in similar adjacent undrained areas outside the project over the same time period. Reports on cropped area, production and yields including other agricultural information were submitted to the Bank annually.

5.15 Due to the scatter in yield records, a study was carried out by EPADP in cooperation with DRI in 1978 to provide a statistical analysis of the data collected in some drained areas under the Nile Delta Drainage I Project. At the same time, a new evaluation program was instituted with aid from the Netherlands Government to examine the impact of drainage taking into account also the effect of other factors. The data collection of this so-called "crash" program covering few representative areas (6 villages) in the Delta, was completed in December 1981. Some interesting results have emerged from this program, and have been published in a series of reports and notes. The final report on this program was published recently in December 1982. In addition, EPADP has continued ex-post evaluation using data collected per subarea of the project. The data collected in some drained areas under the Nile Delta Drainage I Project have been analysed to give the best estimates for the effect of tile drainage on crop production in different years following execution. The results of all these studies were reported to the Bank in 1978, 1980, 1981 and 1982.

5.16 Fully aware of the problems associated with yield measurements, and that yield records need to be supported by some more direct physical measures of the project's effectiveness such as groundwater levels and soil salinity, a Supreme Committee was established in 1979 to look into setting up a plan for a broad approach to the study of drainage effects on crop production, soil and water parameters. With the Chairman of EPADP as its president, its members are representatives of EPADP, Universities, Academy of Science, Ministry of Irrigation, Water Research Center, Ministry of Agriculture and other research institutes belonging to them.

5.17 In addition to data collection activities of EPADP's ex-post evaluation program covering drained areas under the Upper Egypt Drainage I Project, a study had been conducted in 1979 by EPAPD in cooperation with the Soil and Water Research Institute (SWI), Ministry of Agriculture, on the influence of tile drainage on soil salinity in some drained areas of the project. The results showed field drains to be very effective in the reduction of soil salinity. EPADP intends to continue these investigations through a long-term program that will be able to monitor and evaluate the drainage effects on the improvement of soil characteristics in different representative areas of the drainage projects. This program will be implemented by the SWI in cooperation with EPADP which will finance the costs involved. The results of these studies will be correlated with the results of the crop yield measurements to reach definite conclusions.

Cost Recovery

5.18 Section 3.06 of the Credit Agreement required the Government to make suitable arrangements to ensure the recovery from users of irrigated land drained under the project of: (a) the maintenance costs of field drainage, and (b) the capital invested in tile drainage over a period of 20 years without interest. The principal legal basis for recovering such costs is provided by the Irrigation and Drainage Law No. 74/1971. The process for the recovery of field drainage costs is time consuming. Although no specific data is available regarding the project area alone, a total of LE 4,087,968 had been recovered from the beneficiaries of drainage works as of December 31, 1982 of which some LE 2,936,197 had been recovered as of February, 1981. As the cost recovered so far is only a fraction of the amount due, positive steps must be taken in the near future to improve collections and to recover the accumulated arrears.

Achievements of Integrated Bilharzia Control Program

5.19 A large measure of 'transmission' and 'disease' control was achieved in the project area during the initial intensive phase of intervention, as shown by the sharp fall in overall prevalence of infection which occurred (29.4% to 16.6% in two years). This rapid downward trend was not subsequently maintained, however, and the overall prevalence rate of 13.4% estimated in 1982 is still close to the rate of 13.9% observed in 1981. The results of the fixed sample surveys show a lower overall rate (11.9%), which should be compared with 11.6% in 1981 and 11% in 1980. Thus available crude data show that overall prevalence of S. haematobium in the project area now lies between 12% and 14%, representing a fall greater than 50% since control operations were first applied.

5.20 Available data on 'intensity' of infection, indicate that marked changes are occurring, with reductions in levels of intensity in many parts of the project area, and that a large measure of disease control has been achieved.

5.21 Incidence data for 1982 show that an overall increase in transmission occurred compared with the 1980/81 period, which it is considered is attributable to the failure to complete the agreed molluscicide regimen during 1982. The results of special treatments of school-age children show the reductions in prevalence of infection achieved, but highlight the rapid rates of re-infection which are taking place (within six months) owing to inadequate transmission control. The continued identification of cases of S. mansoni in Beni Suef is a matter of concern, and the potential spread of its transmission, unless adequate snail control measures and epidemiological surveillance are undertaken, must be recognized.

## VI. INSTITUTIONAL PERFORMANCE

### Egyptian Public Authority for Drainage Projects

6.01 In order to unify the organizations working on drainage in Egypt, IDA agreed in late 1972 to the GOE proposal, to merge the Nile Delta Drainage Authority the organization responsible for drainage in the Delta, with the Egyptian General Authority for Drainage Projects which was responsible for drainage in Upper Egypt. Accordingly, the Egyptian Public Authority for Drainage Projects(EPADP) was established by a Presidential Decree issued in February 1973 with responsibility for executing all drainage works in Egypt. EPADP is empowered to carry out all field investigations, planning, design, evaluation, procurement, construction, budgeting and operation of projects accounts. The Association's agreement was influenced by the fact that the second IDA Credit for drainage, Upper Egypt Drainage I, was under consideration and IDA did not want to deal with two organizations. Secondly, it seemed that such a unified organization would best meet the need to more fully utilize the top management and allow more efficient use of construction equipment and repair facilities. The present organization structure of EPADP is shown in Annex 12.

6.02 During the course of the project, the number of engineers employed for implementation was considerably below the strength needed. It was difficult to make up this shortage. This was because of the low wage structure of EPADP, and the persistent outflow of qualified Egyptian engineers to foreign countries. This affected both the quality of staff as well as the intensity of construction supervision. However, the payment of incentives for technical staff at all levels could enable EPADP, to some extent, to face this problem.

6.03 The IDA/Bank drainage projects have made some positive impact in shaping EPADP organizational structure as well as bringing about some gradual improvements in its operational character. The Egyptian staff associated with the project received valuable on the job training in planning, design and construction of drainage works as well as in procurement. However, the Authority's performance in construction planning, scheduling, management and supervision still needs improvement. Aware of this reality, some positive

steps have been taken by EPADP in 1982 by arranging periodic meetings with the chairmen of the contracting companies to improve the progress of implementation. Furthermore, the recommendations made by the two Dutch experts - who visited Egypt for the first time in January 1982 - for improving the productivity of equipment, will be carefully considered. Also, a one week training course in construction planning and management had been conducted very recently by the Dutch experts to train some 18 engineers from EPADP, DRI and the contractors. All these measures will hopefully lead to substantial improvement in future projects progress and quality control.

Ministry of Health

6.04 Overall management control by the Ministry of Health has been inadequate. There should be much greater motivation and involvement of senior personnel in project activities within the respective Governorates. Far too many technical procedures, data collection, recording etc. are performed by subordinate personnel with only cursory professional supervision.

6.05 It must be emphasized that this control program is a very large-scale public health exercise, and not a research-oriented pilot project. The Ministry of Health has always resisted any proposal that a larger and more effective project staff be superimposed upon the general infrastructure of health services in the Governorates, and believes that overall evaluation must be obtained through the available system. Limited evaluation teams are now operating in the Governorate centers, but more direct supervision of these is necessary. The enormous volume of raw data are now proving extremely difficult to handle in the absence of automated data banking and computer analysis which has been constantly urged during the past six years.

## VII. BENEFITS AND ECONOMIC EVALUATION

Estimated Crop Yield Benefits from the Project

7.01 During execution of the Project, yields of the main crops namely wheat, cotton and maize have been assessed by random sampling, within each subarea of the project before and after drainage. Yields in similar undrained areas outside the project area over the same time period have also been recorded. By comparing variations in yield levels for each crop and year inside and outside the project areas, the net yield increases due to drainage as apart from other factors could be estimated. The results indicate that yields have increased due to field drainage in almost all tile drained areas, but the magnitude of the increase varied greatly with the crop, location, yield levels before drainage and other factors that affect crop production. Areas provided with tile drainage systems under this project during the initial years of project implementation were relatively small areas scattered over six Governorates. Consequently, areas cultivated with each of the above mentioned crops in the evaluated areas were also relatively small areas. Collection of yield data will have to be continued over a long period and analyzed before producing definite conclusions. However, a study was completed by EPADP in January 1983 using the available data to provide a statistical analysis of the net yield increases due to drainage in each of the years through 1979/1980 following installation of tile drainage systems in 17

subareas covering some 110,000 feddans of the project. The results showed the average increases over 4 years (1977-1980) after drainage to be 9% for wheat, 9% for cotton and 15% for maize. Although these results indicate that tile drainage has a considerable positive effect on crop yields, the values given are considered preliminary results because the survey results have not been rigorously analysed. As the data collection activities continue, further information will be available and better estimates of the impact of tile drainage on crop yields could be achieved. This will be valuable for analysing the benefits of later projects.

Project Economic Rate of Return

7.02. No attempt has been made to estimate the project's economic rate of return, partly because of lack of a sufficiently long time series and the limited number of records to give meaningful estimates of yield increases resulting from the project, but also in order to emphasise the danger of continuing such a large drainage program without sufficient monitoring to provide reasonable estimates of the benefits. It would clearly be irresponsible to base the continuation of the massive Egyptian drainage program, of which the Upper Egypt Drainage I project is a time slice, on a favorable but unreliable estimate of the economic rate of return. In the case of the completion report of the Nile Delta Drainage I project (CR181-UAR) dated July 18,1981 an economic rate of return of 17% was calculated based on a larger data base and longer time series. When estimated future losses in production in undrained areas were taken into account that would occur from increasing salinity and water logging, the economic rate of return increased to 25%. Happily, two additional years of yield data available since the completion report was prepared confirm that the areas drained by the Delta Drainage I project continue to yield about 15% more than the undrained control areas. This confirms the observation made in the completion report of 1981 that yields seem to increase 10-15% during the initial year after installation of tile drains, and thereafter maintain the same differential over undrained areas.

7.03 In the case of the Upper Egypt Drainage I project, the subject of this completion report, it is probable that the worst drained areas have been included (para 4.13) and that satisfactory economic rates of return have resulted. But it is also possible that drains have been installed in some areas which do not yet require buried pipes such as in some of the more free draining soils adjacent to the Nile River. In this case an unsatisfactory rate of return will result from making the investment before it is needed. However, since an increase in yields as low as 5% would provide an economic rate of return of about 12%, it is probable that the economic rate of return is satisfactory in the Egyptian agricultural context. Thus, to conclude, the economic rate of return has not been estimated, not because it is likely to be unsatisfactory, but to highlight the need for supplementary physical measures of the benefits of drainage to add confidence to the yield data. These are principally the effects on the superficial ground water level and on soil salinity, as has already been discussed (paras. 5.08-5.13).

Physical Benefits of Drainage

7.04 The PCR for the Nile Delta Drainage I project emphasised the need for physical monitoring of depth to water table and salinity to supplement the collection of yield data, as did also the Irrigation sub-sector review of May

1982, but little systematic monitoring has resulted. However, the study carried out in 1979 by EPADP in cooperation with the Soil and Water Research Institute (SWI) of the Ministry of Agriculture on the influence of tile drainage in soil salinity, indicates that tile drainage has a strong positive effect on soil improvement and productivity (para 5.17). It is encouraging that SWI carried out such a study. Similar work now needs to be carried out on a systematic basis, and adequate funding provided from the ongoing and future planned drainage projects.

Farmers Benefits

7.05 Calculations were made in the completion report for the Nile Delta Drainage I project to show the level of farm benefits. These indicated a net increase of LE 40/feddan, comprising LE 25/feddan inside the project area and losses averted of LE 15/feddan compared with undrained areas outside the area over four years of implementation. Farmers are liable to pay a drainage tax of LE 7/feddan following drainage. This is less than the full economic rent but the present pricing structure results in such a high level of agricultural taxation that any discussion of increasing recovery from farmers can only be looked at in the wider context of agricultural pricing policies as a whole. These pricing policies during the project period resulted in a substantial net taxation of agriculture, estimated at some 30% in the mid-seventies. They acted as a disincentive to the increased use of farm inputs and to that extent must have acted as a brake on the full attainment of the benefits of drainage by farmer beneficiaries. The last three years or so, however, have seen a diminution of this burden of taxation as a proportion of value added and an increased use of fertilizers, though to what extent this can be correlated with drainage is impossible to say. While drainage is a necessary condition for the intensification of agriculture, it is not sufficient by itself. As policies and services to farming improve, so will the potential benefits from drainage increase.

Benefits from Bilharzia Control

7.06 As already noted (paras 5.19-5.21) the overall prevalence of S. haematobium fell dramatically from 29.4% to 16.6% in two years during the initial intensive phase of intervention. The fact that the overall prevalence has not fallen below 12-14% and that rapid rates of re-infection remain after three subsequent years is some cause for concern. The presently applied strategy may be regarded as cost-effective in terms of an annual per capita cost at circa US$1.0 compared with other programs, because of the high population density in the area under control, although relatively expensive if the total health expenditure of about US$4.50 per capita is considered. It may be, however that the increased costs of intensive molluscicding would be more cost effective in reducing overall prevalence than the present policy of seasonal focal molluscicding.

## VIII. BANK PERFORMANCE

8.01 In evaluating the Bank's performance consideration must be given to the fact that this was the second IDA-assisted project in the agricultural sector. It was an ambitious attempt to continue implementation of the largest single tile drainage operation ever undertaken in the world by a newly established agency of the Government. Looking back, it is apparent that in

managing the massive task of implementing the project, both the Bank and the Government placed too much confidence on the construction administration capability of the MOI personnel and on the capacity of the public sector contractors.

8.02 Supervision of the project was intensive in the start-up phase and later on timely and satisfactory. During the initial stages, the Bank provided extensive assistance to the Authority in preparing bid documents for procurement of equipment under ICB procedures. Although the use of consultants by the Authority had become a contentious matter during the Nile Delta Drainage I project, the Bank staff succeeded in maintaining a continued good rapport with the Egyptian officials. Because of the the problems and delays faced by the project, the Bank had to maintain a heavy supervision load during project implementation. The well-timed supervision missions were instrumental in drawing attention to potential difficulties and generally eliciting appropriate actions.

8.03 Although with a delay of three years, the achievement of the project appraisal objectives shows that the flexible position taken by the Bank was correct in the given circumstances. However, since the Bank is likely to be involved in the drainage program for some time to come it is critical that ways be found to assist Egyptian contractors engaged in installing the drains to devise ways and means for upgrading their construction management capability and capacity. Further effort is also needed to upgrade implementation planning, control and reporting systems. Efforts made during the course of the project towards achieving these objectives have been relatively unsuccessful but, since they are the keys to accelerating the drainage program, it is important that the pressure for improvement be maintained.

8.04 In three important aspects - provision of gravel envelopes, drain spacing and monitoring - the Bank's counsel has not been heeded by the Government in spite of frequent reminders from Bank supervision missions. This completion report provides an appropriate moment to consider, first, whether remedial action should have been taken during project implementation, and second, whether action should be taken in ongoing and future projects.

8.05 Gravel envelopes have been discussed throughout project implementation by the Bank, EPADP and the joint Egyptian-Dutch Drainage Panel DRI has also carried out a considerable amount of pilot work (para 5.02). Although drainage specialists participating in Bank supervision missions have argued in favor of greater use of gravel envelopes, the Government's position is also tenable, and Bank and Government may fairly agree to differ. As to the future, a number of specific recommendations are made in Annex 8, paras 12-17.

8.06 The second issue, spacing of lateral tile drains, also concerns design, and has been reviewed frequently. There is no argument between Government and Bank concerning the design studies carried out and the steady state design methodology adopted. The problem is that irrespective of the calculated spacing of the laterals, they are constructed with the maximum and minimum spacing of 60 and 40 meters respectively (para 5.03). In the case of the Upper Egypt Drainage I project an area of maybe about 40,000 feddans is likely to have been underdrained. In the Delta where the incidence of heavier

soils is much greater the problem is likely to be much more extensive and severe, leading to ineffective drainage, and enormous costs to rectify the situation later on. Thus, although in Upper Egypt only a limited amount of underdraining has probably occurred, the Bank should now take a firm stand on spacing of laterals, if Bank financing is to be continued.

8.07 The third issue frequently raised by the Bank concerns monitoring and evaluation. EPADP agreed with the Bank in July 1977 to evaluate the effects of drainage works on crop yields and soil in the Upper Egypt I and II, and Nile Delta I and II Drainage projects (Section 2.06 of the Nile Delta Drainage II Project Agreement. In addition to EPADP's ex-post evaluation program, a monitoring program was established in 1978 in DRI, with Dutch bilateral assistance, and an interministerial Supreme Committee in 1979 (paras 5.14-5.16). The joint DRI-Dutch "crash" program was discontinued in 1982 and DRI staff reassigned to other duties, partly for lack of active support from the Bank. It should now be reestablished, and if necessary, funded from the ongoing Bank drainage projects. It also needs to be supplemented with collection of groundwater data from outside the drained areas to be used in selecting future priority areas to be drained.

Bilharzia Component

8.08 Bank supervision missions have been extremely valuable in stimulating the necessary organization of control inputs, data collection and evaluation. Indeed it is most unlikely that the present level of control would have been achieved without them. Consideration should however be given to greater direct involvement of Bank staff for supervision in any future program of this kind and scale, since the main supervision effort was carried out by a consultant in tropical diseases working for the concerned EMENA agricultural division, and little specialist support was provided by the Population, Health and Nutrition Department.

## IX. LESSONS LEARNED

Drainage

9.01 There can be no doubt that the Bank made an appropriate choice in selecting drainage for its first lending activity in the agricultural sector and for staying with drainage for three subsequent projects. Investment in drainage is a sound long term investment and a necessary condition for attaining high levels of agricultural production.

9.02 The consultants recruited under the Nile Delta Drainage I project were not used effectively, and although 15 man-years of consultancy was included in the Upper Egypt Drainage I project, when the consultant contract under the Nile Delta I project terminated, the consultant's contract was not renewed. This put a much greater burden for technical supervision into the Bank supervision missions, and although the Bank has spent considerable sums recruiting top drainage specialists to participate in supervision, the duration of supervision missions is normally too short to be able to make very firm technical recommendations. As a result, although Bank staff and consultants often argued in favor of proper technical standards, the supervision missions have lacked the confidence to recommend sanctions. Since in the long run it is the Egyptians themselves who are the losers, when say,

drain spacing is determined politically rather than on the basis of design calculations, the Bank should now insist on periodic visits by short-term consultants to be paid for out of project funds. They would be used to assist EPADP in resolving those technical design issues such as drain spacing, drain depth, envelope material or drainage facility all of which are discussed in Annex 8. By staying in the country for a longer duration than is possible during Bank supervision missions, say 4-5 weeks they could also usefully address the construction issues such as concrete and PVC pipe manufacturing and installation, trenchless drain laying machines, etc. discussed in Annex 9. There are a number of precedents in which short-term consultants have been used successfully where full time consultants have not been acceptable. The reports of these consultants should also provide a basis for firmer action by the Bank leading to improved implementation and reduced Bank supervision costs.

9.03 The need for systematic collection of groundwater and soil salinity data to supplement crop yield data has been highlighted in this report. In addition, simple physical monitoring of groundwater and soil salinity conditions outside the presently drained areas should be incorporated in any future loan agreement as a means of identifying future areas to be drained.

9.04 Over the longer term, the success or failure of the drainage projects will depend on whether the drains which have been installed are properly maintained and continue to operate properly. Effective monitoring of maintenance has yet to be established and should be addressed by future supervision missions of the other two ongoing drainage projects.

Bilharzia Control

9.05 The infrastructure of health units and centres has enabled the chemotherapy delivery system to operate, but it is very variable in quality and could be improved by the creation of special case-finding treatment teams.

9.06 The multiple-dose drug regimen required for metrifonate imposes a ponderous treatment schedule, but more direct supervision of medical personnel would ensure higher compliance rates and improved results. The cost effectiveness of chemo-therapy per se may be increased by using a 'single' dose drug, but this is not a panacea and should not be adopted without careful consideration of the cost implications and examination of the weaknesses inherent in the infrastructure of the health units, which are believed to be largely responsible for the apparent failure to achieve better and more consistent progress.

9.07 The results to date show that overall prevalence of S. haemotobium in the project area is greater than 11%, and that difficulty is being experienced in reducing it, although intensity of infection has apparently dropped. Adoption of snail surveillance and focal mollusciciding during the summer phases of operations, at the beginning of the consolidation phase, played a significant role in the partial breakdown of transmission control. This is now compounded by other technical difficulties, e.g. fish farming, resulting in failure to achieve adequate coverage of the irrigation and drainage areas during the spring and autumn operational periods.

9.08 Control strategies involving continuation of molluscicide activity must represent a significant drain on Ministry of Health resources, since both foreign and locally procured molluscicides involve relatively large foreign exchange outlays. It is unlikely that snail surveillance and focal molluscicide can ever be effectively carried out in large-scale irrigation systems with high population density and almost universal human water contact. In the absence of much more efficient organization, however, it is most unlikely that a control program, based upon chemotherapy only, would be more cost-effective than an integrated approach involving molluscicides.

9.09 The proposed extension of control activities in Giza and East Delta, Beheira, etc. will pose many problems for the meagre Cairo-based headquarters staff, since there is a shortfall of adequately trained technical staff and support personnel. The inconsistent payment of adequate incentives for special duties, is a contributory factor at Governorate level.

9.10 There is now a need to prepare a revised strategy for the next few years, to agree on both intensity of molluscicide operations and type of chemotherapy. The Bank could provide a leading role in organizing such a meeting which should include representatives of WHO as well as senior Egyptian Ministry of Health personnel.

ANNEX 1

ARAB REPUBLIC OF EGYPT
PROJECT COMPLETION REPORT
UPPER EGYPT DRAINAGE I PROJECT
(CREDIT 393-UAR)

Principal Features of Nile Delta II and Upper Egypt I and II Drainage Projects

| Description | Upper Egypt I | Nile Delta II /1 | Upper Egypt II /2 |
|---|---|---|---|
| Loan/Credit No. | - Cr. 393-EGT | Ln. 1439-40/ Cr. 719-EGT | Ln. 1285 Cr.637-EGT |
| Signing Date | 06/08/73 | 07/15/77 | 06/11/76 |
| Effective Date | 11/28/73 | 04/17/78 | 01/31/77 |
| Estimated Project Completion at Appraisal | 06/79 | 12/82 | 12/81 |
| Expected Project Completion Date | 06/83 | 06/87 | 06/86 |
| Original Loan/Credit Closing Date | 12/31/79 | 12/31/83 | 12/31/83 |
| Extended/Expected Loan/Credit Closing Date | 07/31/81 | 06/30/87 /3 | 06/30/86 /3 |
| Appraisal Cost Estimate (US$ Million) | 123.8 | 207.0 | 282.0 |
| Revised Estimated as Per Latest Supervision (US$ Million) | 119.6 | 207.0 | 221.4 /4 |
| Loan/Credit (US$ Million) | 36.0 | 66.0 /5 | 50.0 /5 |
| Disbursement as of 12/31/82 (US$ Million) | 34.9/6 | 27.9 | 33.6 |
| Project Area (feddans) | 532,000 | 810,000 | 500,000 |
| Major Project Works | | | |
| A. Remodelling/Construction of Open Drains | | | |
| (i) Area (feddans) | 532,000 | 810,000 | 500,000 |
| (ii) Remodelling Drains-Km | 775 | 1,565 | 1,226 |
| (iii) New Drains-Km | 865 | - | 345 |
| (iv) Completion 09/30/82 | 100% | 71% | 78% |
| B. Field Drains (feddans) | 300,000 | 400,000 | 500,000 |
| Completed 09/30/82 | 85% | 20% | 17% |
| C. Pumping Stations | 5 | 6 | 1 |
| Completed | 95% | 28% | 91% |
| Reclamation of Saline Land (feddans) | 22,400 | - | 12,000 |
| Bilharzia Control Program (feddans) | 900,000 | Extension to 1.2 million feddans including Upper Egypt I & II areas | 120,000 (Extension) |

/1 KfW financing by an additional DM 100 million loan.
/2 Additional US$30.0 million financing provided by USAID for procurement of equipment for three PVC pipe making factories as well as of 6,000 tons granulate material.
/3 Loan Closing Date expected according to latest schedule of EPADP.
/4 Applying parallel market exchange rate.
/5 Bilharzia Control Component included in various Credits/Loans is:

| | |
|---|---|
| Upper Egypt I | US$7.9 million |
| Upper Egypt II | US$5.1 million |
| Nile Delta II | US$10.4 million |

/6 May 28, 1982.

ANNEX 2

# ARAB REPUBLIC OF EGYPT
# PROJECT COMPLETION REPORT
# UPPER EGYPT DRAINAGE I PROJECT
# (CREDIT 393-UAR)

## Project Description From the Credit Agreement

The Project consists of:

Part A

A drainage and reclamation program including:

(i) drainage of areas totalling 300,000 feddans by the installation of 30,000 km of buried field tile drains and 4,000 km of collector drains, and the provision of vehicles and construction and maintenance equipment required therefor;

(ii) the improvement of about 775 km of existing open drains and the excavation of about 865 km of new open drains and the provision of vehicles and equipment required therefor;

(iii) the construction of four pumping stations and the expansion of an existing station;

(iv) provision of transmission lines and power substations for the pumping station;

(v) the reclamation of about 22,400 feddans of severely saline land by gypsum treatment and leaching, and the provision of the equipment required therefor;

(vi) the provision of equipment and vehicles for the Authority and for extension services; and

(vii) the provision of technical assistance for the training of the staff of the Authority in drainage works.

Part B

A bilharzia control program including:

(i) snail control through a program of regular area-wide applications of molluscicides in an area of about 900,000 feddans in Beni Suef and El Minya governorates

PROJECT COMPLETION REPORT
UPPER EGYPT DRAINAGE I PROJECT
(CREDIT 393-UAR)

The Drainage Areas - Appraised and Revised

| Governorate | Name of the Catchment Unit | Project Area (fed) Appraised | Final Areas (fed) Tile Drained | % of Appraisal Area | Remarks |
|---|---|---|---|---|---|
| Beni Suef | | | | | |
| | Ehnasya | 33,000 | 8,000 | 24% | 25,000 fed. shifted to Upper Egypt II Project |
| | Beni Saleh | 2,000 | 2,000 | 100% | |
| | Beni Suef Gharb-North | 6,000 | - | 0 | Area excluded |
| | Ebshana | - | 1,000 | - | Area increased |
| | Hakamna & Beni Bikheet | - | 8,000 | - | Area shifted from Upper Egypt II Project |
| | Mosa-Aref | - | 4,000 | - | Area shifted from Upper Egypt II Project |
| | SUBTOTAL | 48,000 | 34,000 | 71% | |
| El-Fayoum | Tagen III | - | 3,400 | - | New area included in the project |
| El Minya | | | | | |
| | Beni Saleh | 8,000 | 6,000 | 75% | Adjusted area |
| | Abo Rahab | 25,000 | 15,500 | 62% | 9500 fed-shifted to Upper Egypt II Project |
| | Beni Mazar | 4,000 | - | 0 | Area excluded |
| | El Minya Gharb-North | 18,000 | 13,000 | 72% | Adjusted area |
| | El Minya Gharb-South | 4,000 | 9,500 | 237% | Adjusted area |
| | Kabkab | 25,000 | 10,030 | 40% | 14,970 fed. shifted to Upper Egypt II Project |
| | Beni Mazar | - | 10,000 | - | Area shifted from Upper Egypt II Project |
| | SUBTOTAL | 84,000 | 64,030 | 76% | |
| Asyut | | | | | |
| | Asyut | 12,000 | 14,000 | 117% | Adjusted area |
| | West El Kosia | - | 4,500 | - | New area included in the project |
| | Abu Gabal & Moheet, Tatalia | - | 16,400 | - | Area shifted from Upper Egypt II Project |
| | Biblaw & Nazlet Farag | | 3,000 | - | Area shifted from Upper Egypt II Project |
| | SUBTOTAL | 12,000 | 37,900 | 316% | |
| Sohag | | | | | |
| | Sohag | 50,000 | 50,000 | 100% | |
| | Sohag II | - | 5,000 | - | Area shifted from Upper Egypt II Project |
| | Tahta | | 2,000 | - | Area shifted from Upper Egypt II Project |
| | SUBTOTAL | 50,000 | 57,000 | 114% | |
| Qena | | | | | |
| | Nag Hammadi | 15,000 | 7,100 | 47% | Area reduced |
| | Dishna (Hammad) | 24,000 | - | 0 | Area shifted to Upper Egypt II Project |
| | Qena (Keft) | 5,000 | 3,000 | 60% | Area reduced |
| | Qus (Hegaza) | 13,000 | 15,950 | 123% | Adjusted area |
| | Isna | 6,000 | 6,000 | 100% | |
| | El Fotohiya & El Rayayna | - | 15,000 | - | New area included in the project |
| | Danfeek | - | 1,100 | - | New area included in the project |
| | Komer (El-Zinega) | - | 3,000 | - | Area shifted from Upper Egypt II Project |
| | Nag Hammadi III | - | 3,050 | - | New area included in the project |
| | Keft II | - | 2,850 | - | Area shifted from Upper Egypt II Project |
| | El Asshy | - | 5,000 | - | New area included in the project |
| | Minshat El Ammary | - | 1,500 | - | New area included in the project |
| | SUBTOTAL | 63,000 | 63,550 | 101% | |
| Aswan | | | | | |
| | Idfu | 8,000 | 4,000 | 50% | Area reduced |
| | Kom Ombo | 35,000 | 34,520 | 99% | Adjusted area |
| | Khor El Sail | - | 1,600 | - | New area included in the project |
| | SUBTOTAL | 43,000 | 40,120 | 93% | |
| | TOTAL | 300,000 | 300,000 | 100% | |

ANNEX 4

ARAB REPUBLIC OF EGYPT
PROJECT COMPLETION REPORT
UPPER EGYPT DRAINAGE I PROJECT
(CREDIT 393-UAR)

Allocation of Proceeds of Credit

| | Category | Credit Agreement | Final Disbursement |
|---|---|---|---|
| I. | Cost of tile drainage construction and maintenance equipment, vehicles & materials | 9,400,000 | 22,059,132.28 |
| II. | Cost of equipment, vehicles and materials for open drainage construction and agricultural extension service | 6,700,000 | 1,816,945.13 |
| III. | Cost of pumping stations-transmission lines, materials, equipment & installation- and reclamation of saline land equipment | 7,600,000 | 3,124,934.74 |
| IV. | Cost of Bilharzia control equipment, vehicles and materials | 4,700,000 | 7,904,527.31 |
| V. | Consultants and training of drainage personnel | 1,000,000 | |
| VI. | Consultants for the Bilharzia control program | 600,000 | |
| VII. | Unallocated | 6,000,000 | |
| | Total Allocation/Disbursement | 36,000,000 | 34,905,539.46 |
| | Cancellation | - | 1,094,460.54 |
| | Total Credit Amount | 36,000,000 | 36,000,000 |

ARAB REPUBLIC OF EGYPT
PROJECT COMPLETION REPORT
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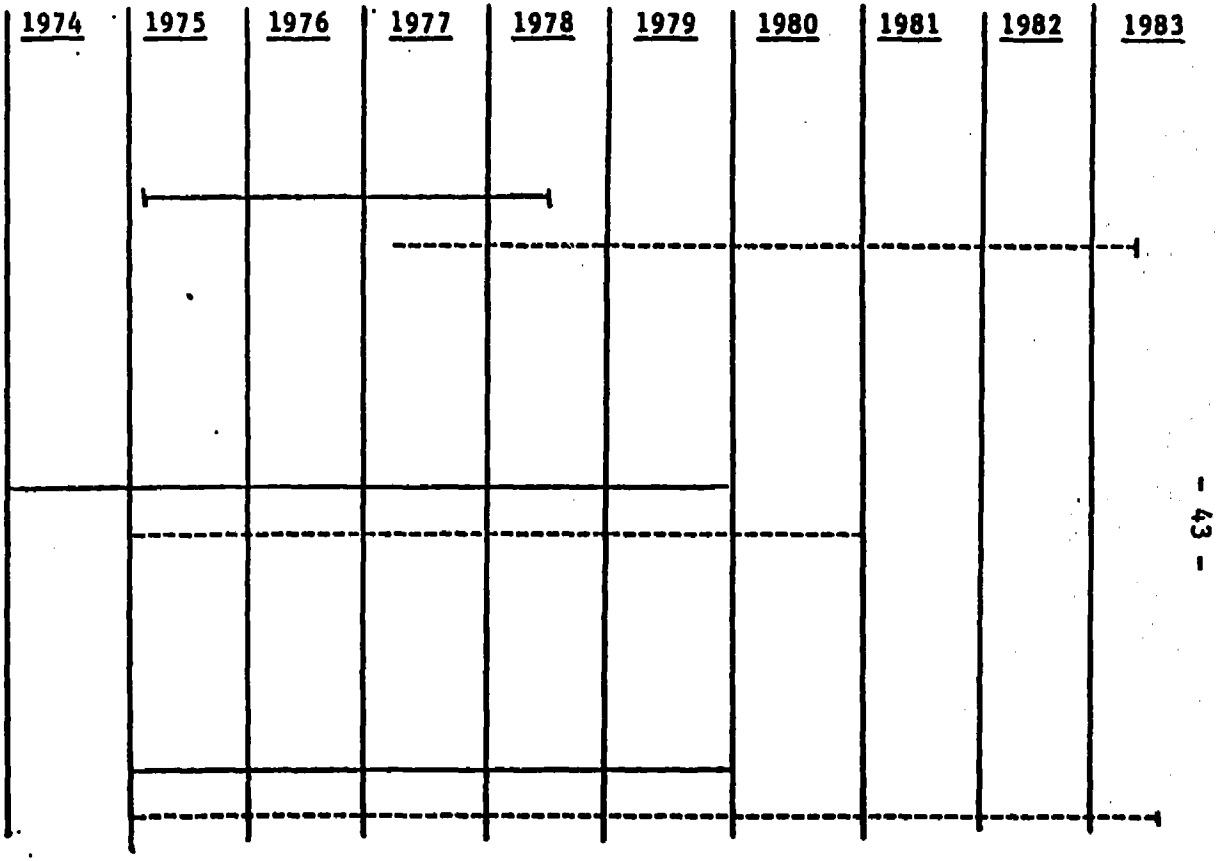
Construction Schedule Actual vs. Scheduled

| Item No. | Description |
|---|---|
| I | Pumping Stations |
| | Appraisal |
| | Actual |
| II | Open Drains |
| | Appraisal |
| | Actual |
| III | Tile Drains |
| | Appraisal |
| | Actual |






ANNEX 5

ARAB REPUBLIC OF EGYPT
UPPER EGYPT DRAINAGE I PROJECT - CREDIT 393-EGT

Appraisal Estimate & Actual Commulative Disbursements

| IDA Fiscal Years and Quarters | Accumulated Disbursement US $ million Appraisal Estimate | Actual | Actual as % of Appraisal Estimate |
|---|---|---|---|
| 1973/74 | | | |
| March 31, 1974 | 0.4 | - | 2 |
| June 30, 1974 | 1.0 | - | 2 |
| 1974/75 | | | |
| September 30, 1974 | 2.0 | 0.04 | 2 |
| December 31, 1974 | 3.5 | 0.05 | 2 |
| March 31, 1975 | 5.2 | 0.70 | 13 |
| June 30, 1975 | 7.4 | 1.10 | 15 |
| 1975/76 | | | |
| September 30, 1975 | 9.7 | 3.00 | 31 |
| December 31, 1975 | 12.0 | 3.90 | 32 |
| March 31, 1976 | 14.0 | 7.70 | 55 |
| June 30, 1976 | 17.0 | 12.40 | 73 |
| 1976/77 | | | |
| September 30, 1976 | 19.0 | 15.55 | 81 |
| December 31, 1976 | 20.5 | 16.46 | 80 |
| March 31, 1977 | 22.5 | 17.16 | 76 |
| June 30, 1977 | 25.0 | 17.43 | 70 |
| 1977/78 | | | |
| September 30, 1977 | 27.1 | 17.50 | 65 |
| December 31, 1977 | 29.6 | 20.21 | 68 |
| March 31, 1978 | 31.0 | 20.42 | 66 |
| June 30, 1975 | | | |
| 1978/79 | | | |
| September 30, 1978 | 33.1 | 24.54 | 74 |
| December 31, 1978 | 34.1 | 27.20 | 80 |
| March 31, 1979 | 34.6 | 28.70 | 80 |
| June 30, 1979 | 35.3 | 29.50 | 84 |
| 1979/80 | | | |
| September 30, 1979 | 35.6 | 30.20 | 84 |
| December 31, 1979 | 36.0 | 31.17 | 87 |
| March 31, 1980 | - | 31.98 | 89 |
| June 30, 1980 | - | 33.0 | 92 |
| 1980/81 | | | |
| September 30, 1980 | - | 33.2 | 92 |
| December 31, 1980 | - | 33.3 | 93 |
| March 31, 1981 | - | 33.6 | 93 |
| June 30, 1981 | - | 33.9 | 94 |
| 1981/82 | | | |
| September 30, 1981 | - | 34.0 | 95 |
| December 31, 1981 | - | 34.1 | 95 |
| March 31, 1982 | - | 34.1 | 95 |
| (May 28, 1982) | - | 34.9 1/ | 97 |
| Closing Date | 12/31/79 | 5/25/82 | |

1/ Actual amount disbursed as of May 28, 1982 was $34,905,539.46 equivalent. The amount of $1,094,460.54 was cancelled.

ARAB REPUBLIC OF EGYPT
PROJECT COMPLETION REPORT
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(CREDIT 393-UAR)

Recurrent and Capital Expenditures 1975-80

| Ministry of Irrigation | 1975 | | 1976 | | 1977 | | 1978 | | 1979 | | 1980 (6 mo.) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recurrent | Capital | Recurrent | Capital | Recurrent | Capital | Recurrent | Capital | Recurrent | Capital | Recurrent | Capital |
| | ('000 LE) | | | | | | | | | | | |
| Central Administration | 324 | - | 339 | - | 210 | - | 192 | 72 | 267 | - | 122 | - |
| Irrigation Department | 15,228 | 14,000 | 16,253 | 10,924 | 22,073 | 15,804 | 31,977 | 30,108 | 34,629 | 27,354 | 23,678 | 23,296 |
| Mechanical and Electrical Dept. | 9,606 | 1,064 | 13,100 | 1,082 | 10,492 | 1,440 | 12,343 | 10,344 | 15,238 | 15,525 | 6,375 | 6,130 |
| Drainage Authority | 3,504 | 21,435 | 2,172 | 20,035 | 2,964 | 34,378 | 4,277 | 41,257 | 6,032 | 66,568 | 3,285 | 28,787 |
| Water Research Center | - | - | 385 | 95 | 656 | 607 | 807 | 1,208 | 941 | 2,312 | 505 | 505 |
| Survey Authority | 4,143 | 233 | 4,996 | 200 | 5,195 | 260 | 6,066 | 362 | 7,185 | 378 | 3,766 | 376 |
| Aswan | 1,536 | 394 | 1,359 | 620 | 1,741 | 1,952 | 1,321 | 12,424 | 1,926 | 14,640 | n.a. | - |
| TOTAL | 34,341 | 37,126 | 38,804 | 32,956 | 43,331 | 54,441 | 56,983 | 95,775 | 66,218 | 126,777 | 37,731 | 59,094 |
| Drainage as Percentage of MOI Capital Funds | | 57.7% | | 60.7% | | 64% | | 43% | | 52.5% | | 48.7% |

Source: Ministry of Irrigation.

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ANNEX 8

# PROJECT COMPLETION REPORT
# UPPER EGYPT DRAINAGE I PROJECT
# ARAB REPUBLIC OF EGYPT

## Design Issues

### Introduction

1. All four tile drainage projects constructed or in the course of construction in Egypt have generated intense discussion regarding the correct approach to design of the drainage system. This Annex concentrates upon four aspects of the drainage design, three of which relate to design at lateral level and the fourth to conceptual design of the whole system. These aspects are:

Drain spacing
Drain Depth
Envelope Material
Drainage Facility

2. It is too late to alter the design of the drainage system for this project. The preparation of this Project Completion Report provides the opportunity to review the more important aspects as implemented and discuss how these may need alteration in future projects.

### Drain Spacing

3. At appraisal drain spacings were provisionally calculated upon sparse data. The spacings, related to percentage of area requiring a particular spacing was as shown below, from which it can be seen that 40.9% of the area would be occupied by tile spacings of less than 40m.

| Spacing (m) | 20 | 30 | 40 | 50 | 60 | 60+[1/] |
|---|---|---|---|---|---|---|
| % Project Area | 22.6 | 18.3 | 16.2 | 25.0 | 12.8 | 5.1 |

4. Project areas both in size and location were changed during implementation. Later more detailed soil permeability tests for Upper Egypt II Tile Drainage Project, carried out over an area of 250,000 feddans showed that only 16% of the area required drains at less than 40 m spacing. It is thought that the soils of both projects are likely to be similar. The tile lines in this project have been installed at 40, 50 and 60 m spacing. There is little doubt that a substantial area of the project has been "underdrained" in the sense that lateral spacings are in some cases too wide - possibly 48,000 feddans or more. The decision of EPADP to install at standard spacing of 40, 50 and 60 m appears to have been dictated by political rather than technical considerations.

5. There is general agreement that the steady state analyses used by EPADP for tile spacing is suitable for the conditions likely to be encountered. Spacing tile lines too widely apart will mean that the water table will not be kept as low as postulated in the Appraisal Report (0.7 to 0.8m below ground level at a point midway between upper end of tile laterals immediately after irrigation). Thus the prime reason for installing tile drainage is being lost.

6. It is recommended that for any future project GOE assurance should be obtained that tile spacing should be entirely based upon technical considerations. It is further recommended that the Bank should be provided with sample calculations written in English for each area designed showing how EPADP arrived at the drain spacing.

Drain Depth

7. The depth of drain below ground level, accepted in the Appraisal Report was 1.4m below ground level at the upper end of the lateral tile line and about 1.8 m below groundlevel where it joins the collector drain. This has been done during construction. Drain depth has a very definite relationship with drain spacing - in most instances the deeper tiles are placed below ground level the wider apart they may be spaced to obtain the same drainage effect. The limitation upon the depth a tile is placed is dependent upon:

(a) Construction Restraints
(b) Economics (depth versus spacing)
(c) Tile diameter and likely discharge rate
(d) Depth below ground level of water surface in open drain

8. The last of the above restraints is of particular relevance to projects in Egypt. The tile drainage projects to a great extent make use of the alignment of the existing open drainage system. This existing system was designed many years ago to cater for surface drainage. At that time the drains were designed to have their water surface level 1.5m below ground level. For the tile drainage projects this depth was increased to 2.5m by excavating the original drains, rebuilding structures upon them, etc.

9. In some cases the open drains discharge by gravity and in other cases have to be pumped. The discharge capacity of the six pump stations used in this project varies between a maximum of 16 $m^3$/sec at Ihnasya (4 units each of 5.4 $m^3$/sec - which allows one idle unit) to a minimum of 7 $m^3$/sec at Beni Saleh (4 units of 2.4 $m^3$/sec). The heads pumped (static) range from 6.1 to 3.1 m. None of the pump stations is particularly large.

10. It is recommended that consideration be given in future projects to providing deeper surface drainage so as to provide the opportunity of increasing the installation depth of tile lines.

Drainage Facility

11. Drainage Facility is a term used to define the ability of a drainage system to work efficiently, it thus implies a free, unimpeded flow of drainage water throughout the system. Such free flow relates back to the installed depth of tile lines and the level to which the open drain water surface is below ground level. It would appear that in the design of the open drain disposed system the number of pump stations was kept to a minimum. It is believed this was done in order to reduce reliance upon machinery, and the operational cost of the project. Whilst the force of these reasons is acknowledged it would be interesting to know if the economics and efficiency of the project could have been improved if more pumping stations had been provided. The reason this point is queried is because it has been argued that

to take the open drain water level down to greater than 2.5m below ground level would result in prohibitively expensive drains occupying a great deal of land area. However it is thought that if pump stations were provided frequently enough the extra expense and loss of land might not be all that great, especially if the 'high level outfall drain' concept was used for the main arterial drain. Additional pump stations would be a nuisance to maintain but would certainly not be impractical. There are large numbers of very small electric pumps being installed in Upper Egypt replacing saqias for irrigation. A few larger properly designed pump stations should not pose nearly so many problems.

Envelope Material

12. The Appraisal report assumed the provision of a gravel envelope to all tile drain laterals. This gravel envelope was stated to be of two kinds. For soils with a clay content of less than 45%, a well graded gravel with a size between 0.4 and 1.2 cm. diameter was to be used. For heavier soils larger size gravels up to 3 or 4 cm were considered permissable.

13. The Egyptian-Dutch Advisory Panel for Land Drainage in Egypt decided that gravel envelope could be omitted for tile lines which were laid in soils which had a clay content greater than 40% to the drain depth. The gravel used, judging from reports and from the Completion Report Mission's visit to Upper Egypt, did not meet either of the criteria laid down by the Appraisal Report. The gravel used was very variable in grade but in general seemed to range from sand through to 10 cm stones with, occasionally, half bricks being observed in the envelope being laid. The effect of the Advisory Panel's decision and the lack of quality control on gravel grading has resulted in most of the tile lines not being enveloped in gravel and those that are seem usually to be enveloped in gravel of a different grading to that specified.

14. The necessity for a gravel envelope in the soils being drained in Egypt does not appear to have been established. Whilst gravel envelopes are usually specified by drainage engineers working in arid zones this appears to be normally done because a large amount of arid zone soils are unstable. So far as can be established the soils in Upper Egypt I and II project areas do not seem to have been judged on the basis of stability. Appendix 4 of the Appraisal report does give a guide however. It would appear from this appendix that Soil Profile Unit Types VII and VIII are likely to be unstable. There are a total of 6050 feddans of Unit Types VII and VIII in the originally proposed project area.

15. Experiments have been carried out in Lower Egypt by the Advisory Panel on Land Drainage in Egypt (Technical Report No. 18, "Mashtul Pilot Area" January 1983) to determine the effect of ground envelope on lateral drain efficiency. These tests were carried out comparing the performance of tiles laid with gravel envelope against those laid without envelope. The results were inconclusive, the headloss fraction (h4o-ho/hm-ho) in both envelope and non envelope cases being in the 0.5 to 0.6 range (poor) with the results slightly favouring the drains with no envelope. These tests are being repeated. It is most desirable to see if either case deteriorates markedly with time. The tiles and envelopes currently being tested at Mashtul were laid sometime between 1978 and 1980. The tests were carried out in the Winter Season 1981/82.

16. During the Project Completion Report Mission's visit the opportunity was taken to inspect the performance of tile drains laid many years ago (near Mohammed Noor Drain, Bekinsha Area) and also similar drains in Upper Egypt (Near Komer Drain, Esna Area). The drains in the Bekinsha Area which had been built 30 years ago were constructed of cement tile with no envelope. The collectors and outfalls inspected were flowing freely with clear non-turbid water. There was little sediment in the manholes. The drains inspected in Upper Egypt also were flowing freely and contained some, but not a lot, of sediment in the manholes. This contrasted considerably with inspection of some of the Upper Egypt I and II areas where a relatively large number of manholes were observed to have debris and sediment in them.

17. In view of the large area that is still to be drained in Egypt it is important that the subject of gravel envelopes should be clarified as soon as possible. The following recommendations are made:

(a) The work being carried out by the Advisory Panel on Land Drainage should be continued in an enlarged and more rigorous manner.
(b) Monitoring of field drainage performance should be carried out. This will have to be a qualitative exercise aimed at identifying any significant difference between areas which were built with gravel envelope and those which were not.
(c) Where gravel envelope is installed in the future it should be in the grade range of 2 to 12 mm diameter. If none can be located then arrangements should be made for suitable screening plant, and if necessary, crushing plant to provide the correct grade of gravel.
(d) In the Upper Egypt Drainage II Project or others still to be funded an investigation should be carried out by installing areas of tile drain with very strict supervision, and then observing stability of soils by observation over a number of years.

Conclusions

18. The recommendations contained in this annex should be considered when dealing with ongoing and future projects for tile drainage in Egypt. It would be appropriate to agree the details of the following subjects with GOE at Appraisal/negotiation stage:

(a) Drain Spacing and Drain Depth
(b) Surface Drainage Design and Concepts
(c) Gravel Envelopes

PROJECT COMPLETION REPORT
UPPER EGYPT DRAINAGE I PROJECT
ARAB REPUBLIC OF EGYPT

## Construction Issues

### Introduction

1. During the visit of the Project Completion Report Mission to Egypt some time was spent observing construction of the Upper Egypt Drainage II Project. The form of construction was the same as used in Upper Egypt I but because the project started later the contractors and EPADP had more experience of the work. Observations of the standard of construction on Upper Egypt Drainage II project lead to the belief that a short Annex dealing with some construction issues might be timely.

### PVC Pipe Manufacturing and Installation.

2. Two of the three PVC pipe making plants in Upper Egypt were visited and also one in the Delta area. The extruding and perforating procedures were examined. The description of the lack of quality control in the manufacture of this type of pipe has been clearly discussed in another report (Peters and Winger, October 1982). Many of the same faults in manufacture were occuring:

i) Perforating knives not always cutting the tube.
ii) Ragged perforations.
iii) Perforation not always in the valley of the corrugation.
iv) Crushed pipe included in stored material.

3. In the field it was noticed that very little pipe was being rejected and in many cases pipe with far less than the optimum number of slots per unit length was being installed. Connections between pipe ends were joined in three different ways:

i) With a purpose made "click" coupler.
ii) By slitting the end of one pipe and inserting the end of the other in relying upon the elasticity of the pipe and the mechanical grip of the corrugation to make the joint. Sometimes the joint was bound with wire or string.
iii) By using a short slit length of the pipe as a sleeve. Sometimes thejoint was bound with wire or string.

The purpose made "click" coupler is by far the best joint and because an adequate supply of these joints were said to be available their use is recommended for all jointing.

4. The use of the best quality PVC properly slotted pipe is absolutely fundemental to the successful implementation of a tile drainage project. If quality control is not maintained for this item it is certain that much of the benefit from tile drainage will be lost and much money uselessly expended.

5. It is recommended that the following measures be implemented both now and on future projects:

i) Proper Quality Control at the Factory with a full range of testing equipment available at each factory.
ii) Contractors to be instructed to refuse all substandard pipe when collecting from the factory.
iii) EPADP site engineers to inspect all pipe brought to contractor's stores and to reject and have sent back to the factory all sub standard pipe. (The pipe should be damaged before return to prevent attempts at reuse.)
iv) EPADP site engineers at construction sites to examine all pipe brought on to site and have it destroyed.
v) The pipe plant manufacturers to send technicians to each factory to:
   (a) Instruct pipe factory staff on the proper operation, maintenance and adjustment of the pipe making equipment.
   (b) To consider whether modifications can be made to the pipe making equipment to ensure more consistent results.

6. Connection of PVC pipes to concrete pipe has been improved by the use of a modified salt glazed earthware joint. However, a problem exists in maintaining grade of the PVC pipe near the joint. On several occasions it was noted that the pipe trench was not carried right through to the collector joint, with the result that PVC pipe was arched upwards just prior to entering the collector joint. This is a defect in construction which will impede flow into the collector and will also encourage deposition of sediment in the PVC pipe. Supervision of construction should be made much stricter to avoid problems of this nature.

Concrete Pipe-Manufacture.

7. Concrete pipe is made by the hand, packer-head and spun process. Smaller diameter pipe is always made by the hand, packer head process. These pipes in general appeared to be well made and reasonably well cured, however insufficient attention was being paid to making the ends of the pipe smooth so that they would fit snugly together when laid. The pipes should always be finished smooth. This is an easy operation if finishing operations are carried out whilst the pipe is still green.

Concrete Pipe-Installation.

8. A problem exists in jointing collector pipes. The joint is either made with a bitumen impregnated felt wrapped around the pipe joint or by a cement collar fashioned by hand around the pipe joint. In one case the pipe joint was being wrapped with the bitumen felt and then having a cement joint applied. The problem with the jointing is that in many cases the joint did not go completely around the pipe joint - the invert at times not being covered by the joint. If the invert part of the joint is not properly sealed there is a risk of flow from the collector creating an area of scour and settlement under the joint. This is a detail that proper site supervision should easily put right.

Backfill in Trenches.

9. When the drain pipes have been laid earth excavated in the process of digging the pipe trenches is used to backfill the trenches. In almost all cases observed the minimum amount of soil is replaced. This results in the trench being backfilled with very loose material. When the land is irrigated after construction of the pipe system the loose backfill is rapidly turned into a mud that settles and eventually dries out. It is considered that the present method of backfilling is undesirable because:

i) It encourages the finer portion of the soil to be washed into the tiles.
ii) It encourages the creation of a 'crust' or 'pan' around the tile.
iii) It increases the possibility of tile movement.

10. It is recommended that the backfill should be placed immediately after the tile has been laid. The backfill should be compacted moderately so as to avoid a large amount of settlement but not so much as to endanger the tile pipe.

Trenchless Installation of Tiles

11. There are available effective trenchless drain laying machines which use a floating long beam plough. These machines lay the PVC pipe either by putting the pipe in, or for smaller diameter (below 200mm diameter) they can be laid using a "feed down" technique which passes the tube from reels on the tractor down a shute to the bottom of the plough blade. With the "feed down" technique gravel can be laid around the top and sides of the tile but not underneath.

12. It would seem that trenchless laying could prove useful in Egypt. The soils are generally suitable for this type of installation. The problems over backfill would be avoided and by carrying out the entire installation in one pass, work could be increased in rate compared with the trench excavating process. Small machines normally lay pipe up to a depth of 1.7m and larger machines to about 2.7m. There have been verbal references to such machines being used on a trial basis in Egypt and not having performed well. These should be further investigated. In future tile drainage projects it is recommended that consideration should be given to installing some of the tile by trenchless laying.

ARAB REPUBLIC OF EGYPT
PROJECT COMPLETION REPORT
UPPER EGYPT DRAINAGE I PROJECT
(CREDIT 393-UAR)

Appraisal and Actual Cost Estimates

| Description | Appraisal Cost Estimate | | | Actual Cost Estimate | | |
|---|---|---|---|---|---|---|
| | Local /1 | Foreign | Total | Local /2 | Foreign /3 | Total |
| | US$ million | | | | | |
| **Drainage Works** | | | | | | |
| Tile Drainage | | | | | | |
| Equipment | 0.9 | 9.4 | 10.3 | - | 22.1 | 22.1 |
| Construction | 29.6 | - | 29.6 | 31.1 | - | 31.1 |
| Main and Branch Drains | | | | | | |
| Equipment | .5 | 5.3 | 5.8 | - | 1.8 | 1.8 |
| Construction | 26.2 | - | 26.2 | 19.7 | - | 19.7 |
| Crop and Land Compensation | - | - | - | 5.0 | - | 5.0 |
| Pumping Stations | 4.9 | 7.7 | 12.6 | 7.2 | 3.1 | 10.3 |
| Workshops | - | - | - | 2.3 | - | 2.3 |
| Administration building | - | - | - | 1.8 | - | 1.8 |
| Housing | - | - | | 3.4 | - | 3.4 |
| Reclamation of Saline Land | | | | | | |
| Equipment | - | 0.8 | 0.8 | - | - | - |
| Materials and works | 1.7 | - | 1.7 | - | - | - |
| Agricultural extension service | | | | | | |
| Equipment | - | 0.2 | 0.2 | - | - | - |
| Consultants and training | 0.2 | 1.0 | 1.2 | - | - | - |
| Administration and overhead | 6.1 | 0.4 | 6.5 | 12.2 | - | 12.2 |
| Contingencies | | | | | | |
| Physical | 7.0 | 2.2 | 9.2 | | | |
| Price escalation | 9.0 | 2.6 | 11.6 | | | |
| Subtotal | 86.1 | 29.6 | 115.7 | 82.7 | 27.0 | 109.7 |
| **Bilharzia Control Program** | | | | | | |
| Equipment, vehicles and material | 0.9 | 4.7 | 5.6 | - | 7.9 | 7.9 |
| Consultant, administration overhead | 0.5 | 0.5 | 1.0 | 2.0 | - | 2.0 |
| Contingencies | | | | | | |
| Physical | 0.1 | 0.5 | 0.6 | - | - | - |
| Price escalation | 0.2 | 0.7 | 0.9 | - | - | - |
| Sub-total | 1.7 | 6.4 | 8.1 | 2.0 | 7.9 | 9.9 |
| Grand Total | 87.8 | 36.0 | 123.8 | 84.7 | 34.9 | 119.6 |

/1 Using official exchange rate at appraisal of LE 1.00 = US$ 2.57
/2 Using the following exchange rates: 1973-75 US$ 1.00 = LE 2.57, 1976 US$ 1.00 = LE 2.21; 1977 US$ 1.00 = LE 2.07, 1978 US$ 1.00 = LE 1.85; 1979-82 US$ 1.00 = LE 1.43.

ARAB REPUBLIC OF EGYPT
PROJECT COMPLETION REPORT
UPPER EGYPT DRAINAGE I PROJECT
(CREDIT 393-UAR)

Project Cost by Year (US$ million)

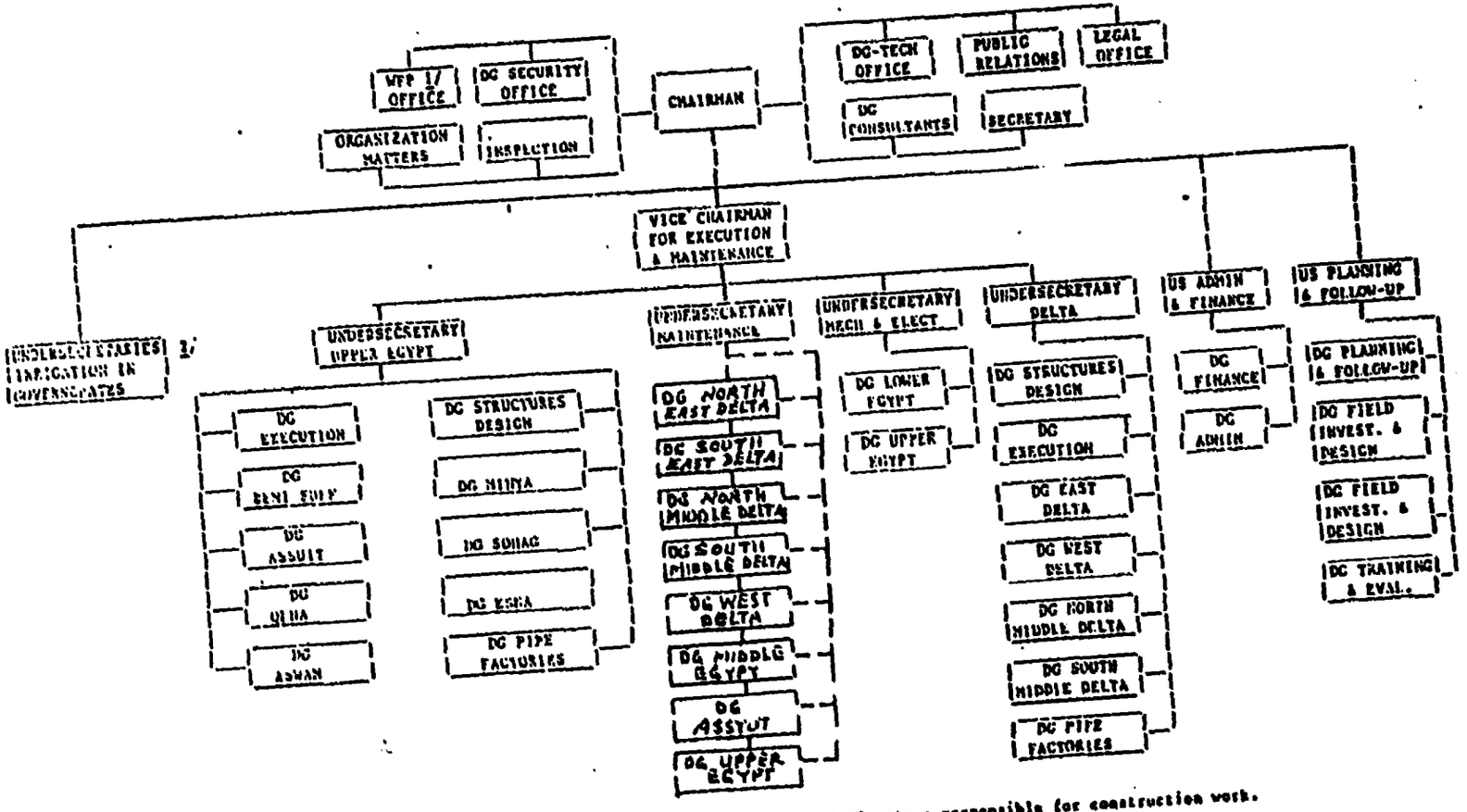
| Year | Local 1/ | Credit | Total |
|---|---|---|---|
| 1973 | 1.5 | - | 1.5 |
| 1974 | 4.5 | 0.1 | 4.6 |
| 1975 | 6.9 | 3.8 | 10.7 |
| 1976 | 9.0 | 12.6 | 21.6 |
| 1977 | 17.5 | 3.7 | 21.2 |
| 1978 | 12.6 | 7.0 | 19.6 |
| 1979 | 11.4 | 4.0 | 15.4 |
| 1980 | 7.4 | 2.1 | 9.5 |
| 1981 | 8.5 | 0.8 | 8.8 |
| 1982 | 5.4 | 0.8 | 6.2 |
| Total | 84.7 | 34.9 | 119.6 |

1/ Local costs converted to dollars at same rates as in Annex 10.

ARAB REPUBLIC OF EGYPT

DRAINAGE PROGRAM

EPADP - 1983 Organization Chart




1/ WFP--World Food Program
2/ UnderSecretaries Irrigation in Governorates provide general supervision of General Directors responsible for construction work.



ANNEX 12

ANNEX 13

PROJECT COMPLETION REPORT
UPPER EGYPT DRAINAGE I PROJECT
ARAB REPUBLIC OF EGYPT

## Bilharzia Control 1/

1. The integrated bilharzia control programme initiated in 900,000 feddans of Middle Egypt, north of Dairut, under the I.B.R.D. Upper Egypt Drainage Project I, began in 1976. This was supplemented by control work in a further 153,730 feddans between Assiut and Dairut in 1977 under the Upper Egypt Drainage Project II. The total area now contains a population of some 4.3 million people. The control strategy applied in this project (described in detail in Appendix 1) has involved a three year period of intensive snail control measures - by molluscicide on an area-wide basis three times annually - together with chemotherapy of the infected population in rural and urban areas.

2. This has been followed by a three year 'consolidation' phase (1979 onwards), during which the integrated control strategy was continued, but with a reduced number of molluscicide applications annually, applied on an area-wide basis in the spring and autumn, and supplemented by surveillance and focal molluscicide during the summer period - together with continuing treatment of infected people based upon annual re-examinations. Following the consolidation phase, on-going maintenance control measures will be applied with possible further reduction in area-wide molluscicide, but with continuing monitoring and treatment of infected cases. The composition of the control strategy and the increments of intervention during maintenance operations will, of course, depend upon the level of control achieved and on-going epidemiological evaluation.

3. The control strategy applied, the organization and management, and the detailed chemotherapy and snail control measures used, are given in Appendix 1. The epidemiological evaluation carried out, including the parameters measured and the techniques employed, are described in Appendix 2.

4. The management organization and components, comprising the control delivery system, are shown in Table 1.

### Results

5. These are presented in Tables 2 - 12 for the Governorates of Beni Suef and Minya (under Upper Egypt Drainage Project I) but necessarily includes the small addition of Assiut North (Upper Egypt Drainage Project II) which has been recorded in the data as part of the overall epidemiological evaluation of the Middle Egypt Bilharzia Control Programme.

6. The prevalence of bilharzia infection is generally higher in males than in females, rises to a maximum at the age of 10-15 years, and starts to fall gradually after the age of 20 years. In 1955 a study made in 23 villages distributed in different parts of Middle and Upper Egypt showed that overall prevalence of urinary bilharzia was 40% in males and 35 % in females. This

1/ Prepared by Prof. G. Webbe (consultant).

sex difference may be explained by the greater degree of exposure to infection in males due to occupational and social factors. The prevalence rose from 17% in the 2-4 age-group to 47% in the 5-9 year age-group and reached a peak of 60% at 10-14 years. Thereafter a gradual decline in prevalence was noted until it reached 20% at the age of 50 years and over.

7. The overall prevalence recorded in 1955 was approximately 10% less than that recorded in 1937. A further decline in overall prevalence of S.haematobium in Middle and Upper Egypt apparently occurred between 1955 and 1965 (circa 10%). returns from Governorate Endemic Disease Hospitals in Middle Egypt for 1963, 1970 and 1971 indicate a decline in overall prevalence of S.haematobium which is probably attributable to the relatively intensive chemotherapy being practised throughout the country since 1963. Data from rural Health Units in Beni Suef and Minya also show reductions of 10% and 9.5%, respectively, in overall prevalence between 1964 and 1971, but these figures only reflect the prevalence of infection in the proportion of the rural population reporting sick at Health Centres and Units, and they must be regarded as an under-estimate of overall prevalence in many areas. In view of the observed pronounced local variations in prevalence, such data probably severely understate the situation occuring within certain districts in Middle and Upper Egypt.

8. The prevalence rates of S. haematobium estimated by sample surveys in 58 villages covering all districts in the project area (1977-82) are given in Table 2.

9. The overall prevalence rate estimated for 1982 (13.4%) is 16% lower than that recorded in the initial survey in 1977 (29.4%), representing a percentage change of 54.4%. It is noteworthy, however, that the estimated prevalence rate of 1979 (16.6%) representing a percentage change of 43.5%, occurred only two years after intervention measures were fully applied, and that prevalence has only dropped a further 3.2%, representing a percentage change of 6.6%, during the last three years.

10. The results of the examination of fixed sample 'cohorts' during 1977-82 are given in Table 3.

11. These results indicate generally lower prevalence rates in the respective Governorates than the rates estimated in the sample surveys. The overall rate in 1982 was 11.9% compared with 11.6% in 1981 and 11.0% in 1980. In Table 4, a comparison is made of the total numbers of school children examined and the percentages found infected from 1978 to 1983. The data show the reductions in prevalence achieved following treatments, but highlight the rapid re-infection rate taking place. In both Beni Suef and Minya the numbers of infected children have increased. The available evidence shows that the majority of those re-infected have light infections, but clearly transmission control is variable and inadequate. Many re-infections have occurred within six months following special treatment campaigns.

12. Intensity data are recorded in Table 5. A fall in the geometric mean ova counts is apparent in the October 1982 data from Beni Suef and Minya. The observed downward trends in intensity are encouraging in relation to disease control, and an improvement in Minya in terms of the February 1982 figures.

13. In Table 6, a comparison is made of Incidence data for 1980/81 and 1981/82. While a fall of 3.3% occurred in Beni Suef, compared with the 1980/81 figure, the conversion rates in Minya and Assiut (North) both showed increases, with an overall increase of 2.7% compared with the 1980/81 figure.

14. The distribution of villages according to prevalence in the primary examination (1977) and in the 1979 survey is shown in Table 7. There is a pronounced shift in the number with a prevalence rate below 20% (209 or 65.3%) compared with 87 or 27.2% in 1977. The number of villages in the sample with prevalence rates greater than 20% in 1979 was still high (111), although the general trend was regarded as a good one. In 1982, however, a number of villages (20) or 10% were identified with prevalence rates greater than 33%, which emphasises the focal characteristic of transmission throughout the project area both in 'time and place.'

S. mansoni.

15. The result of urine and stool examinations carried out in villages of three districts in Beni Suef Governorate are given in Table 8. It is clear that transmissionn of the infection continues although some villages are known old foci of S. mansoni transmission. All positive cases have been treated with praziquantel (Biltricide$^{R}$) at 40 mg/kg. body weight.

Chemotherapy.

16. The number of people examined and those found to be infected with S. haematobium at rural health units and centres (1977-1982) are given in Table 9.

17. The overall prevalence of S. haematobium in the project area, based on the examination of 1,603,232 people, was estimated to be 15.5%.

18. The post-treatment follow-up examinations carried out three months after the final dose of drug, indicate that high cure-rates were achieved, greater than 90% in Beni Suef and Minya and greater than 75% in Assiut (North).

19. The results show, however, that variable compliance rates were achieved, and the recorded cure-rates are surprisingly high in Beni Suef and Assiut (North), in view of the poor compliance rates of the third drug applications (approximately 52% and 50% respectively). Further, the high compliance rates in Minya, and the cure rate apparently achieved at three months (97%) is inconsistent with the high prevalence rates recently reported from villages in Minya and Beni Suef (prevalence greater than 33%).

20. The prevalence rates of S. haematobium given in the returns from Endemic Diseases Hospitals are shown in Table 10. These have fallen since the onset of control measures from 1967/77 onwards but continue to reflect appreciable levels of transmission in Beni Suef, Minya and Assiut (North).

21. More than 1.5 million infected cases have been treated (including re-treatments) since 1977, and these have generally been characterized by high cure rates greater than 85%, following re-examination three months after completion of therapy.

22. The chemotherapy delivery system is unquestionably ponderous but relatively cost-effective (circa 0.3 $U.S. per complete treatment). While

patient recording in the villages and schools is generally good, case-finding is a major problem and, in the absence of special treatment teams, this depends essentially upon the enthusiasm and energy of local health staff. The problems associated with having to give the drug on three occasions at fortnightly intervals are formidable, but the results indicate that substantial reduction in egg output is being achieved with a consequent large measure of 'disease control'. Nevertheless, re-infections are occurring, particularly in older persons who have daily occupational and domestic water-contact activities.

Snail Control.

23. A high level of technical efficiency has been developed in applying molluscicide and involving water-management in the extensive irrigation and drainage systems for the purpose of snail control. The density of snail populations in branch canals and distributaries, main drains and field drains has generally been reduced by greater than 98% of the density level prior to chemical applications during the area-wide campaigns in each of the three annual phases of operations. These operations were beset by difficulties during 1976/77, including shortages of equipment and transport, but the molluscicide was carried out within the prescribed time-schedules and a substantial degree of transmission control was achieved.

24. Snail surveillance throughout the system has shown that very low levels of infestation were maintained for some 10-12 weeks following the area-wide applications of chemical and it is considered that a high level of transmission control was achieved during the intensive phases of intervention measures 1976-1979. In 1979 the summer phase of area-wide molluscicide was discontinued and surveillance and focal molluscicide, based upon the detection of snail infested canals and drains, was substituted. This practice has been continued during the consolidation phase of operations in Middle Egypt to date.

25. Epidemiological data now show that the level of transmission control achieved during the first years of control operations, 1976-1980, has not been maintained. Various factors have been identified as contributing to this situation including: the introduction of the surveillance and focal molluscicide strategy for the summer period in the consolidation phase; failure to complete the area-wide applications in a precise time-scale based upon synoptic information; and recent failure to treat major areas in Minya Governorate, under the command of the Sirry Canal during the Spring and Autumn phases because of fish-farming. Poor distribution of molluscicide supplies also affected the time-scale of operations and clearly headquarters' supervision has been inadequate. As previously recommended, much more attention must be given to peri-domestic human water-contact sites and transmission foci with a high level of snail surveillance and management control, if focal molluscicide is to be introduced. Although it may show a saving of chemical and is much cheaper than an area-wide application, its cost-effectiveness depends essentially upon an efficient infra-structure and good supervision and may prove to be very low unless these criteria are met.

26. Snail survey data prior to the 1983 Spring molluscicide applications are given in Table 11. The numbers of canals and drains infested with snails in Assiut and Minya are appreciable and, in contrast to the lower levels of infestation found in Beni Suef. The presence of Biomphalaria alexandrina, in

some canals and drains throughout the system, is noteworthy. Table 12 shows the average density of B. truncatus and Biomphalaria sp. snails in all water courses sampled in the respective Governorates, prior to the 1983 Spring phase of control operations, from 1976-1982 in Middle Egypt, and from 1981 in Upper Egypt. A marked reduction in overall density of snails was achieved in Beni Suef, which was also the case in Minya and Assiut (North) until the end of the intensive phase of operations in 1979.

Summary and Appreciation.

Achievements.

27. A large measure of 'transmission' and 'disease' control was achieved in the project area during the initial intensive phase of intervention, as shown by the sharp fall in overall prevalence of infection which occurred (29.4% to 16.6% in two years). This rapid downward trend was not subsequently maintained, however, and the overall prevalence rate of 13.4% estimated in 1982 is still close to the rate of 13.9% observed in 1981. The results of the fixed sample surveys show a lower overall rate (11.9%), which should be compared with 11.6% in 1981 and 11% in 1980. Thus available crude data show that overall prevalence of S. haematobium in the project area now lies between 12% and 14%, representing a fall greater than 50% since control operations were first applied.

28. Available data on 'intensity' of infection, indicate that marked changes are occurring, with reductions in levels of intensity in many parts of the project area, and that a large measure of disease control has been achieved.

29. Incidence data for 1982 show that an overall increase in transmission occurred compared with the 1980/81 period, which it is considered is attributable to the failure to complete the agreed molluscicide regimen during 1982. The results of special treatments of school-age children show the reductions in prevalence of infection achieved, but highlight the rapid rates of re-infection which are taking place (within six months) owing to inadequate transmission control. The continued identification of cases of S. mansoni in Beni Suef is a matter of concern, and the potential spread of its transmission, unless adequate snail control measures and epidemiological surveillance are undertaken, must be recognized.

30. It must be emphasized that this control programme is a very large-scale public health exercise, and not a research oriented pilot project. The Ministry of Health has always resisted any proposal that a larger and more effective project staff be superimposed upon the general infrastructure of health services in the Governorates, and believes that overall evaluation must be obtained through the available system. As described, limited evaluation teams are now operating in the Governorate centres, but more direct supervision of these is necessary.

31. While the overall achievements of the bilharzia control programme to date can be regarded as very satisfactory, their further improvement, consolidation and maintenance pose formidable problems.

Lessons which have been learned

i. Overall management control by the Ministry of Health has been inadequate and more direct supervision of field operations is necessary.

ii. The infra-structure of health units and centres has enabled the chemotherapy delivery system to operate, but it is very variable in quality and could be improved by the creation of special case-finding treatment teams.

iii. The multiple dose drug regimen required for metrifonate imposes a ponderous treatment schedule, but more direct supervision of medical personnel would ensure higher compliance rates and improved results. The cost-effectiveness of chemo-therapy per se may be increased by using a 'single' dose drug, but this is not a panacea and should not be adopted without careful consideration of the cost implications and examination of the weaknesses inherent in the infrastructure of the health units, which I believe are largely responsible for the apparent failure to achieve better and more consistent progress.

iv. The results to date show that overall prevalence in the project area is greater than 11%, and that difficulty is being experienced in reducing it, although intensity of infection has apparently dropped. In my opinion, the adoption of snail surveillance and focal molluscicide during the summer phases of operations, at the beginning of the consolidation phase, played a significant role in the partial breakdown of transmission control. This is now compounded by other technical difficulties, e.g. fish farming, resulting in failure to achieve adequate coverage of the irrigation and drainage areas during the spring and autumn operational periods.

v. As already indicated, there should be much greater motivation and involvement of senior personnel in project activities within the respective Governorates. Far too many technical procedures, data collection, recording etc. are performed by subordinate personnel with only cursory professional supervision.

vi. The enormous volume of raw data are now proving extremely difficult to handle in the absence of automated data banking and computer analysis which has been constantly urged during the past six years.

vii. The proposed extension of control activities in Giza and east Delta, Beheira, etc. will pose many problems for the meagre Cairo based headquarters staff, since there is a shortfall of adequately trained technical staff and support personnel. The inconsistent payment of adequate incentives for special duties, is a contributory factor at Governorate level.

viii. The presently applied strategy may be regarded as cost-effective in terms of an annual per-capita cost at circa U.S.$1.0 compared with other programmes, because of the high population density in the area under control, although relatively expensive if the total health expenditure of about U.S.$4.50 per capita is considered.

ix. Control strategies involving continuation of molluscicide activity must represent a significant drain on Ministry of Health resources, since both foreign and locally procured molluscicides involve relatively large foreign exchange outlays. I have no confidence that snail surveillance and focal molluscicide can ever be effectively carried out in large-scale irrigation systems with high population density and almost universal human water contact. In the absence of much more efficient organization, however, it is most unlikely that a control programme, based upon chemotherapy only, would be more cost-effective than an integrated approach involving molluscicides.

x. The periodic I.B.R.D. supervision missions have been extremely valuable in stimulating the necessary organization of control inputs, data collection and evaluation. Indeed it is most unlikely that the present level of control would have been achieved without them. Consideration should however be given to greater direct involvement of I.B.R.D. personnel for extended mission periods in any future programme of this kind and scale.

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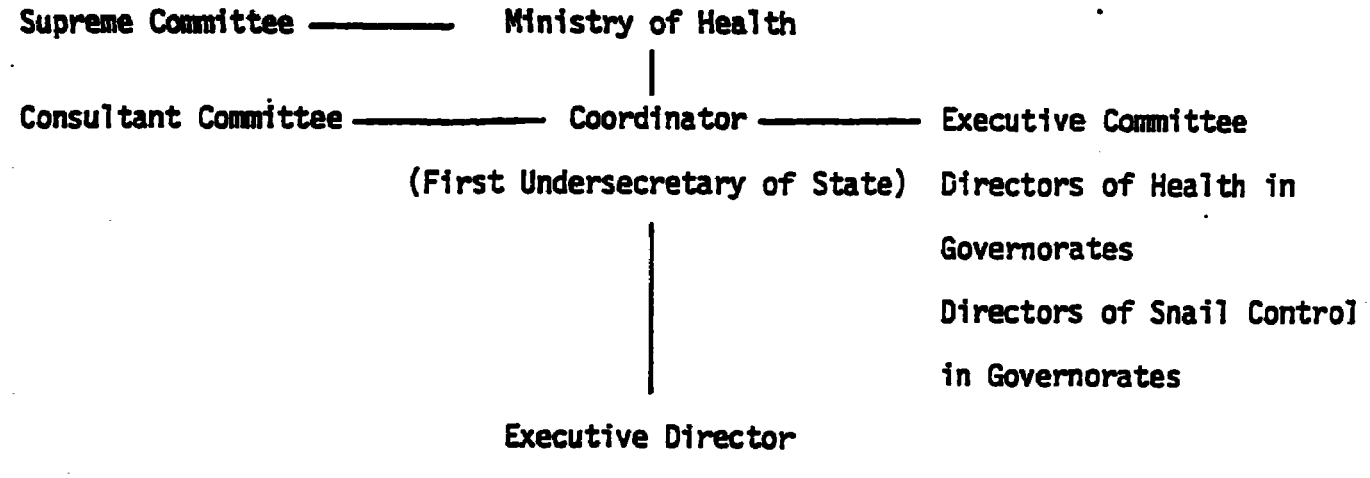
## Organization




| | | | | |
|---|---|---|---|---|
| Rural H. units and centres | 427 | 347 | 113 | 4 |
| End. Dis. Hosp. | 28 | 20 | 6 | 1 |
| **Snail Control** | | | | |
| Gov. Inspectorate | 3 | 3 | 1 | 1 |
| District " | 28 | 20 | 7 | |
| Snail Control Centres | 59 | 45 | 9 | 2 |
| " " Units | 236 | 170 | 37 | 18 |

UPPER EGYPT DRAINAGE PROJECTS I & II: Prevalence of S. haematobium estimated by sample surveys in 58 villages covering all districts 1977 - 1982.

| Year | Beni Suef | | Minya | | Assiut (North) | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Examined | % | Examined | % | Examined | % | Examined | % |
| 1977 | 822,422 | 27.7 | 1,458,763 | 33.6 | 537,977 | 19.3 | 2,819,102 | 29.4 |
| 1979 | 32,972 | 17.3 | 111,247 | 17.4 | 20,949 | 11.8 | 165,168 | 16.6 |
| 1980 | 24,980 | 14.8 | 169,213 | 17.3 | 17,437 | 9.9 | 211,630 | 16.4 |
| 1981 | 30,980 | 15.5 | 296,390 | 14.7 | 69,031 | 10.4 | 396,401 | 14.0 |
| 1982 | 179,436 | 15.2 | 505,260 | 14.0 | 45,593 | 7.6 | 730,289 | 13.4 |

UPPER EGYPT DRAINAGE PROJECTS I & II: Periodic Examination of the Fixed Samples "COHORTS" in Villages Assigned for Evaluation. 1977-82.

| Governorate | 1977 | | July 1979 | | July 1980 | | July 1981 | | July 1982 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Exam. | +ve | Exam. | +ve | Exam. | +ve | Exam. | +ve | Exam. | +ve |
| Beni Suef | 6,226 | 1,720 (27.6%) | 7,115 | 1,204 (16.9%) | 6,930 | 902 (13.0%) | 7,724 | 983 (12.7%) | 7,338 | 1,106 (15.1%) |
| Minya | 15.645 | 5,256 (33.6%) | 11,072 | 1,973 (17.8%) | 13,450 | 1,403 (10.4%) | 11,576 | 1,439 (12.4%) | 13,035 | 1,550 (11.9) |
| Assiut (North) | 5,534 | 1,073 (19.4%) | 3,799 | 334 (8.8%) | 2,460 | 201 (8.2%) | 2,883 | 160 (5.5%) | 3,013 | 128 (4.2%) |
| TOTAL | 27,405 | 8,049 (29.4%) | 21,986 | 3,511 (16.0%) | 22,840 | 2,506 (11.0%) | 22,183 | 2,582 (11.6%) | 23,386 | 2,784 (11.9%) |

UPPER EGYPT DRAINAGE PROJECTS I & II: Examination of School Children in School Years 1978 - 1982.

| School Year | Beni Suef | | Minya | | Assiut (North) | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Examined | % Infected | Examined | % Infected | Examined | % Infected | Examined | % Infected |
| 1978-79 | 44,528 | 20.4 | 94,269 | 22.1 | 74,382 | 16.3 | 213,179 | 19.7 |
| 1979-80 | 64,562 | 16.3 | 121,569 | 26.3 | 33,481 | 14.1 | 219,612 | 21.5 |
| Re-exam. in summer | 44,782 | 12.3 | 86,809 | 18.6 | - | - | 131,591 | 16.5 |
| 1980-81 | 61,935 | 16.3 | 116,167 | 31.3 | 34,023 | 15.8 | 212,125 | 24.4 |
| 1981-82 | 74,645 | 15.7 | 156,440 | 25.2 | 46,756 | 14.5 | 277,841 | 20.9 |
| Re-exam. in March 1982 | 68,981 | 12.8 | 133,779 | 16.1 | 32,416 | 14.2 | 235,176 | 15.0 |
| 1982-83 | 78,321 | 14.1 | 157,896 | 26.0 | 44,895 | 16.7 | 281,112 | 21.2 |

UPPER EGYPT DRAINAGE PROJECTS I & II: Intensity: Geom. mean ova count/10ml urine assessed in a subsample of primary school children, October, 1981, February 1982 and October 1982 (compared).

| Governorate | October 1981 | | February 1982 | | October 1982 | |
|---|---|---|---|---|---|---|
| | Number Examined | Ova Count | Number Examined | Ova Count | Number Examined | Ova Count |
| Beni Suef | 970 | 24.6 | 795 | 23.1 | 984 | 19.1 |
| Minya | 2,111 | 57.5 | 1,486 | 108.9 | 1,848 | 77.4 |
| Assiut (North) | 404 | 14.1 | 113 | 7.8 | - | - |
| TOTAL | 3,485 | 43.3 | 2,394 | 75.6 | | |

UPPER EGYPT DRAINAGE PROJECTS I & II: Incidence: Assessed in a subsample of primary school children, "Confirmed" negatives in 1980-81 and 1981-82, with follow-up examination in the next school year.

| Governorate | October 1980 - October 1981 | | | October 1981 - October 1982 | | |
|---|---|---|---|---|---|---|
| | Negative 1980-81 | Positive 1981-82 | Conversion Rate | Negative 1981-82 | Positive 1982-83 | Conversion Rate |
| Beni Suef | 1,333 | 292 | 21.9% | 1,375 | 256 | 18.6% |
| Minya | 1,080 | 103 | 18.0% | 1,614 | 370 | 22.9% |
| Assiut (North) | 1,084 | 35 | 3.2 % | 1,614 | 196 | 12.2% |
| TOTAL | 3,497 | 530 | 15.2% | 4,603 | 822 | 17.9% |

UPPER EGYPT DRAINAGE PROJECTS I & II:

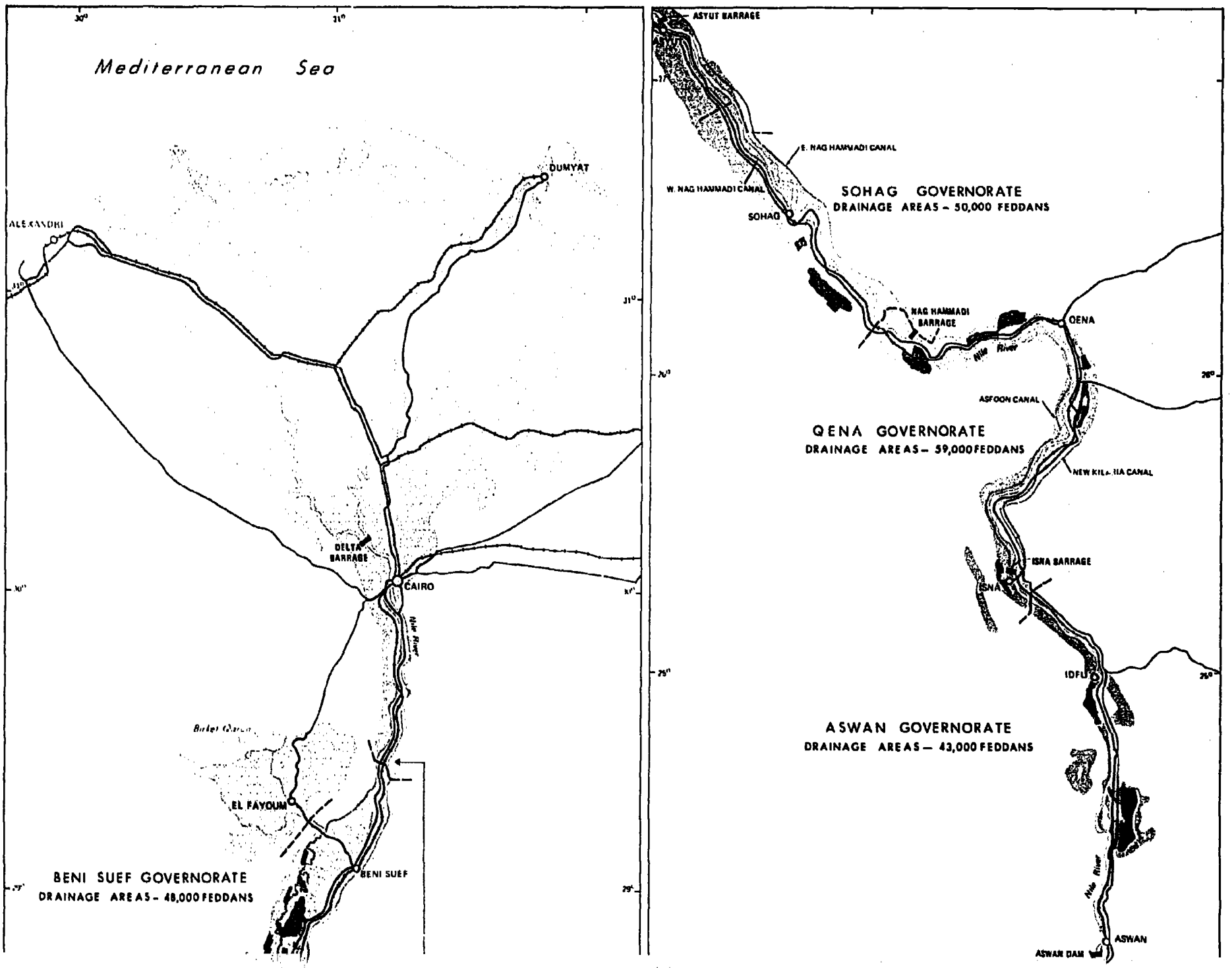
Distribution of villages according to overall prevalence in the primary examination and in the July-August survey, 1979.

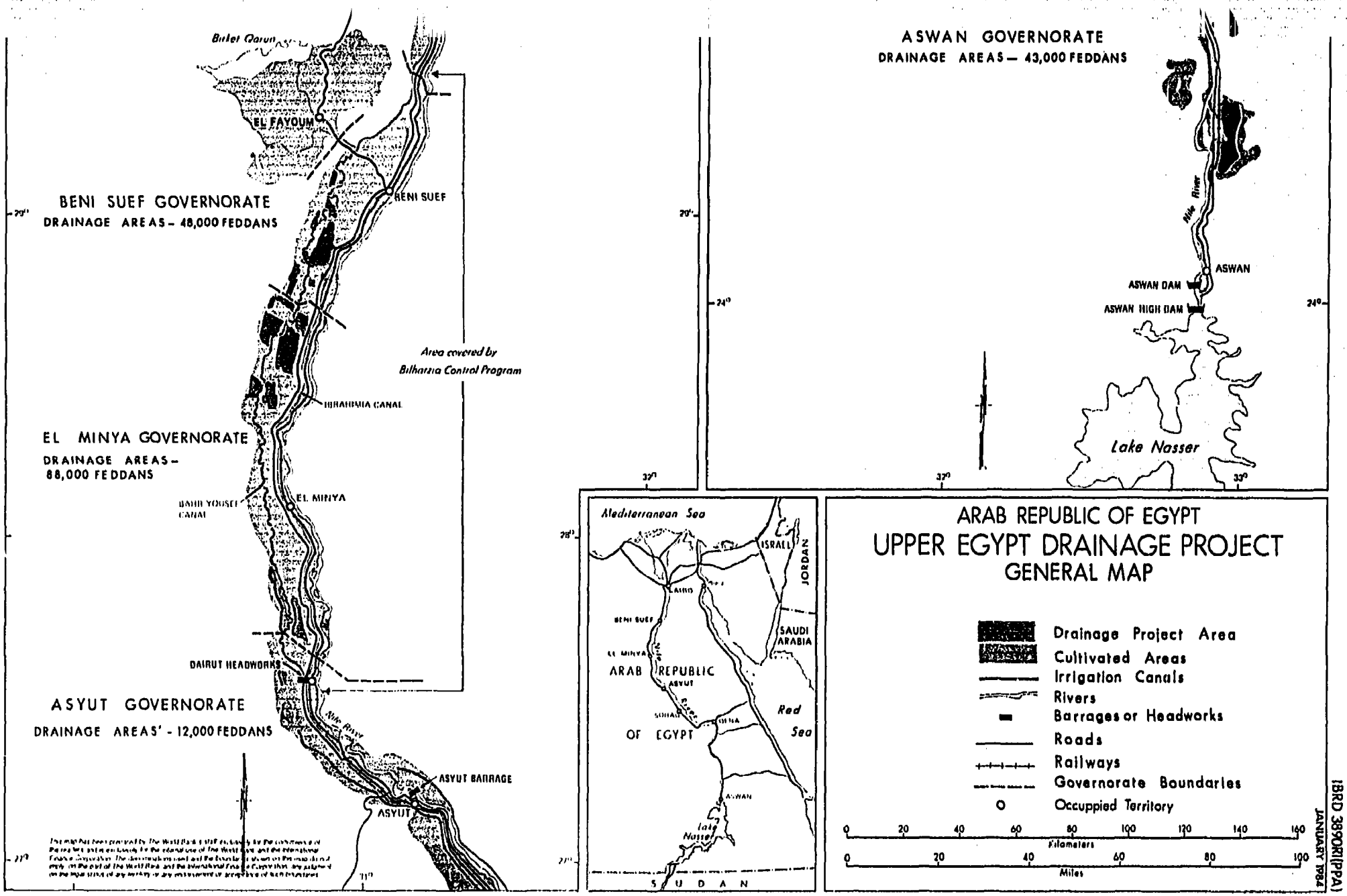
| Overall Prevalence % | Number of Villages | | Percentage of Villages | |
|---|---|---|---|---|
| | 1st exam. 1977 | July Survey 1979 | 1st exam. | July Survey |
| 0 - 9 | 25 | 83 | 7.8% | 25.9% |
| 10 - 19 | 62 | 126 | 19.4% | 39.4% |
| 20 - 29 | 87 | 59 | 27.2% | 18.4% |
| 30 - 39 | 71 | 36 | 22.2% | 11.3% |
| 40 - 49 | 43 | 11 | 13.4% | 3.4% |
| 50 - 59 | 20 | 3 | 6.3% | 0.9% |
| 60 - 69 | 9 | 1 | 2.8% | 0.3% |
| 70 + | 3 | 1 | 0.9% | 0.3% |
| TOTAL | 320 | 320 | | |

UPPER EGYPT DRAINAGE PROJECTS I & II:

Special surveys made in Beni Suef for S. mansoni infections in 1982.

| District and Village | No. examined | Positive (lat. spine) | | |
|---|---|---|---|---|
| | | Urine | Stools | Both |
| El Wasta: | | | | |
| Maydoum | 2,720 | - | 149 | - |
| Abweet | 1,028 | - | 77 | - |
| Kom Abu Radi | 2,750 | 6 | 61 | - |
| Nassir: | | | | |
| El Zytoon | 379 | 3 | - | - |
| Bahbasheen | 18 | - | - | - |
| Beni Suef: | | | | |
| Bayad | 7,486 | 130 | 123 | 56 |
| Beni Soliman | 1,856 | 60 | 12 | 7 |
| Naiim | 987 | 1 | - | - |


Mediterranean Sea
DUMYAT
ALEXANDRIA
DELTA BARRAGE
CAIRO
Nile River
EL FAYOUM
BENI SUEF
BENI SUEF GOVERNORATE
DRAINAGE AREAS - 48,000 FEDDANS
ASYUT BARRAGE
E. NAG HAMMADI CANAL
W. NAG HAMMADI CANAL
SOHAG
SOHAG GOVERNORATE
DRAINAGE AREAS - 50,000 FEDDANS
NAG HAMMADI BARRAGE
QENA
Nile River
ASFOON CANAL
QENA GOVERNORATE
DRAINAGE AREAS - 59,000 FEDDANS
NEW KILA-IIA CANAL
ISNA BARRAGE
ISNA
IDFU
ASWAN GOVERNORATE
DRAINAGE AREAS - 43,000 FEDDANS
Nile River
ASWAN
ASWAN DAM


Birket Qarun
EL FAYOUM
BENI SUEF GOVERNORATE
DRAINAGE AREAS – 48,000 FEDDANS
BENI SUEF
Area covered by
Bilharzia Control Program
IBRAHIMIA CANAL
EL MINYA GOVERNORATE
DRAINAGE AREAS –
88,000 FEDDANS
BAHR YOUSEF CANAL
EL MINYA
DAIRUT HEADWORKS
ASYUT GOVERNORATE
DRAINAGE AREAS' - 12,000 FEDDANS
Nile River
ASYUT BARRAGE
ASYUT
ASWAN GOVERNORATE
DRAINAGE AREAS – 43,000 FEDDANS
Nile River
ASWAN
ASWAN DAM
ASWAN HIGH DAM
Lake Nasser
Mediterranean Sea
ISRAEL
JORDAN
SAUDI ARABIA
ARAB REPUBLIC OF EGYPT
Red Sea
SUDAN
ARAB REPUBLIC OF EGYPT
UPPER EGYPT DRAINAGE PROJECT
GENERAL MAP
Drainage Project Area
Cultivated Areas
Irrigation Canals
Rivers
Barrages or Headworks
Roads
Railways
Governorate Boundaries
Occuppied Territory
Kilometers
Miles
IBRD 3890R(PPA)
JANUARY 1984