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I. REGIONAL IRRIGATION IMPROVEMENT PROJECT

1.0 INTRODUCTION

Progress in the regional Irrigation Improvement Project (RIIP) is discussed in this section of the report. The structure of the report follows the Management and Operating Plan, dated 12 October, 1986. For the convenience of readers, the goals, objectives, and strategy outlined in the Plan are repeated below.

1.1 Goals

The main goals of the project are to:

1. Develop methods and procedures to rehabilitate and improve irrigation systems on old lands;
2. Develop capabilities of the RIIP staff to undertake a national program to rehabilitate and improve irrigation systems.

1.2 Major Objectives

The major objectives are to:

1. Implement a systematic approach to evaluate existing irrigation systems, identify their problems, and to plan their effective rehabilitation and improvement;
2. Develop staff capabilities of RIIP, through training, to undertake all phases of investigating, planning, and executing a rehabilitation project in the National Irrigation Improvement Program;
3. Procure state-of-the-art and technologically advanced equipment for data collection and analysis, design calculations and drawings, and construction supervision and inspection;
4. Produce effective operation and maintenance plans for water distribution systems, from the main canals through the mesqas; organize Water Users Associations and Irrigation Advisory Services.

1.3 Strategy

To accomplish the objectives above, the strategy in this project is to select pilot unit command areas (UCA) of the Serry canal command, analyze the problems in these UCA's, develop alternative solutions to these problems, and implement the selected rehabilitation and improvement plan. The main Serry canal will be improved along with the pilot UCAs.

A team of expatriate irrigation engineers, supported by subject matter specialists from inside and outside Egypt, will assist RIIP engineers throughout the project period to carry out the plan. Finally, an important part of the strategy is to monitor and evaluate the completed UDA's to determine the effectiveness of the improvement measures after they are implemented.

2.0 ORGANIZATION

Neither the central Cairo office nor the regional El Minya office are yet organized according to the structure described in the Plan. Staff in the central office has been increased by five engineers during the reporting period, but experience in irrigation system design is lacking, particularly for rehabilitation work. The present emphasis is to train both senior and junior personnel to fill the positions outlined in the Plan.

In the regional office at El Minya, all management responsibilities and technical decisions are being made by the General Director. There are as yet no sections nor Section Chiefs.

3.0 TRAINING

3.1 Invitational Tours

The Director of RIIP, Eng. Farouk Shahin, and the General Director, Eng. Abdel Raouf Salahi, toured the Southwest U.S. in June visiting irrigation systems. Their special interest was in canal lining projects. They also reviewed computer-assisted surveying equipment and were given demonstrations in computer-aided drafting and design in Laramie Wyoming and Fort Collins Colorado.

Senior Undersecretary Eng. Ali Abdel Rahman, and General Director Eng. Abdel Raouf Abu Noor attended a special conference on operation and management of irrigation systems in October. The conference included a tour of irrigation systems in the Southwest U.S.

3.2 Short courses

In June and July, the Deputy Director of RIIP, Eng. Hassan Shouman, and Eng. Aatif El Kadar, from a Regional RIIP office, attended a short course at CSU, titled "Social and Technical Aspects of Irrigation Organization". Two additional engineers from headquarters, Essam Barakat and Deputy Director Ramses Bahkoum attended a short course at CSU on the "Engineering, Management, and Economics of Irrigation Rehabilitation Projects" in August. This course was a complement to the short course above.

In July and August, two other engineers of the central RIIP office, Nadia Nelson and Hanaa Fahmy completed an 8-week training session, 6 weeks at the Salt River Project (SRP) in Phoenix, and 2 weeks at Colorado State University (CSU) in Fort collins. The primary purpose of their training program at SRP was to learn how to design control and other structures in main and branch canals. In Fort Collins they visited small irrigation systems and observed how they were operated and maintained.

3.3 In-Country

A two-month, introductory course on use of microcomputers was presented to engineers and support personnel of the central office as indicated in the schedule. Basic use and care of PCs was emphasized and the Word Perfect word processor, the 123 Lotus spreadsheet, and Symphony by Lotus, were featured in the applications aspect of the course. Several urgent "crash" projects, not related to RIIP, interrupted the computer course, which will be completed in the first quarter of 1987. A database program will be featured in the continuation.

3.4 On-The-Job

Training of both central and regional engineers was initiated in November through a step-by-step procedure on how to plan and execute rehabilitation and improvement projects. The standard approach in projects of this kind is (1) identify problems, (2) develop alternative solutions while considering their economic feasibility, (3) prepare detailed designs and specifications, (4) inspect and enforce quality construction, and (5) follow-up with a monitoring and evaluation program to determine the effectiveness of the project. All phases, except monitoring and evaluation, are underway in the Serry command in three unit command areas totalling about 15,000 feddans.

The process of designing the Serry canal is being used to train engineers at RIIP headquarters. A computer-based approach to both system and canal designs is being used.

4.0 SPECIALISTS

The following specialists arrived in Egypt during the reporting period:

1 Mr. Tim Martin, soil scientist and remote sensing specialist provided technical assistance and direction to the work of the remote Sensing Center (RSC). He served two periods, one in July-August, and the second in Nov-Dec.

2. Mr. Tom Flak, soil scientist, assisted in the field work of RSC, reviewed and improved field techniques for soil sampling using photo interpretations, and improved office techniques in aerial photo interpretations. His period of service was Nov-Dec.

3. Dr. Mel Skold, economist, outlined the baseline data needed to evaluate the benefits from improvement projects. His period of service was in October.

4. Dr. E.V. Richardson, project director for CID/CSU and campus coordinator, reviewed RIIP plans, and created work plans for the Water Research Center. He served two periods, one in October and a second in December.

4.1 Specialist Reports

The following reports were prepared during this time period.

1. Assessment of soil salinity and water table levels in the Serii command, Beni Mazar Area by T.c. Martin and T.E. Flack, copy in the appendix.
2. TDY Report by Dr. M. Schold on his Economics work.
3. Water Research Center Work Plan by E.V. Richardson, Dr. Abu-Zeid, and Water Research Center's Institute Directors.
4. TDY report by Dr. A. Barns giving recommendations on the Sorey needs of RIIP.
5. Dr. A.H. Barnes, surveying specialist, reviewed capabilities of the Survey Authority in Cairo and El Minya before making recommendations on the purchase of electronic survey equipment and computer-aided data reduction and drafting. His period of service was in December.

5.0 EQUIPMENT PROCUREMENT

5.1 Facilities

All of the furniture and equipment for the Central Office, except the large photocopier has been purchased and delivered. A blackboard, locally made, was not satisfactory and was rejected. A new one will be procured from the U.S.

For the regional office in El Minya, the office furniture and air conditioners have been procured and delivered. The drafting table, photo copier, and ammonia copier are in the process of being procured. The radio communications equipment must conform to GOE regulations and MOI selection. The type of equipment has not yet been selected.

5.2 Vehicles

The GOE has indicated that passenger carrier vehicles can no longer be brought into the country on project funds. It has therefore been decided by Director Farouk Shahin to add only working vehicles in the form of pickup trucks, and motorcycles to the project. The vehicles have not been selected, but they should be small and economical to operate.

5.3 Engineering Design

Calculators, computers, graphic plotters, and computer software have been ordered.

5.4 Instrumentation

All the instrumentation have been ordered excepting for those items can be constructed in Egypt. Those instruments are infiltrometers and measuring flumes.

5.5 Laboratory Equipment

None of the laboratory equipment will be purchased because they have been ordered on the nation-wide procurement program through Harza Engineering.

5.6 Construction Equipment

None of the construction equipment has yet been ordered.

5.7 Water System Equipment

The radial gates for the Boloktor canal, Herz-Nomaniya canals and distributors for El Gharak canal have been ordered and delivery is expected in the first quarter of 1987. The pumps have not yet been ordered.

5.8 Field Survey Equipment

Decisions on the type of field survey equipment to purchase are being made in accordance with the TDY visit of Dr. Barnes. None of the equipment has been ordered.

6.0 SERRY CANAL IMPROVEMENT

6.1 Identification of Problems

High ground water table is prevalent throughout and salinization of the Serry canal command is a serious problem in several areas, in the upstream sections (Herz-Nomaniya, Beni Ibeid, parts of Montout, and parts of Fuqai branch commands), and near the downstream third (Beni Mazar, and lower parts of Samalut). There are spots of serious salinization throughout the entire command .

The Serry canal is generally deficient in supply during the peak summer irrigation period by about 10 percent. In addition, poor water distribution generally exists throughout each branch command, but particularly for the longer branches such as Mantout, and Dier canals. The last branch canal, Bilhasa, is short of water for most of the peak summer periods. Water is being pumped into that branch canal from the Mohit drain to make up some of the deficiency, but not in sufficient quantities, so that distribution of water is still poor in the branch command.

While there is poor water distribution along the Serry canal and its branches, there is also an excessive amount of water flowing into the drains. The principal causes are lack of flow control and no night irrigation. There is no water measurement in any canal. Water delivery is set by prescribing water levels. In some canals there is a reasonable relationship of water level to discharge and crop water requirements, but in other canals, because of over-excavation, the discharge is frequently too large. Over-irrigation takes place at the head ends of branches with water flowing into drains from mesqas.

Poor mesqa maintenance is a particular problem where slopes are flat. Weeds reduce velocities, and prevent sufficient quantities of water to flow to farms at the tail sections. Lack of adequate maintenance of branch and main canals also causes similar problems. Weed growth in drainage canals causes high water levels which backs water into underground drains, so that tile drains become subsurface irrigation systems which raises the water table rather than drainage systems which lower water tables. High water levels in drainage channels also cause higher water tables in adjoining land.

Agricultural production is not as good as it can be in many areas of the Serry command because of salinity, and water delivery or distribution problems indicated above, and because many farmers continue poor farm management practices. Water is applied in successive small basins, or short rows, even when the land is suitable for long furrows. Plant bed preparation is poor, and because of labor shortage, or high cost of labor, cultivation of the land is inadequate.

6.2 Prioritizing UCAs

As part of a step-by-step process in training RIIP personnel in a planning procedure for rehabilitation and improvement, priorities for improving UCAs of the Serry command have been established as follows:

1. Herz-Nomaniya
2. Beni Ibeid
3. UCAs in the Beni Mazar region
4. UCAs in the Samalut region
5. Mantout, and subsequently Fuqai branch commands
6. UCAs in the Matai region
7. UCAs in the Maghagha region
8. UCAs in the Minya region

6.3 Designs

The designs of Unit Command Areas of the Serry canal continued. Of the selected UCAs, channel designs for the Herz-Nomaniya and Beni Ibeid branch canals have been completed. Designs for the hydraulic control structures have also been completed for the two UCAs. Alternative designs for mesqas in the Herz-Nomaniya area have not been completed. Mesqa improvements have not yet been proposed for the Beni Ibeid command. Nothing has been designed for other UCAs.

6.4 Construction

Construction on the Wasslet-Herz-Nomaniya canal has started. Four of five structures for the automatic radial gates have been competed, along with four bridges over the canals to improve access to farms from the main roads along the Nomaniya and Herz canals. Several attempts were made to begin lining the Nomaniya canal with precast blocks, but a successful technique has not yet been developed.

A plan developed in December has not yet been tried in the field. No construction has been started in the Beni-Ibeid command.

Contracts for construction of three cross regulators in the Serry canal have been awarded, with construction to begin with the closure of the canal in January. A contract for construction of three test wells have also been awarded, and drilling awaits a decision for the final location of the wells.

II. WATER RESEARCH CENTER

1.0 INTRODUCTION

Progress in the Water Research Center (WRC) is reported in accordance with the Work Plan of November, 1986. Although the overall goal for WRC is common to all institutes, the activities of the Chairman's office and the 11 institutes are described separately.

1.1 WRC GOAL

The goal of WRC is to determine the most effective and efficient methods for the development, control, and use of Egypt's water resources for its social and economic welfare.

1.2 OBJECTIVES

The objectives, within the framework of this project are to:

1. Conduct research to provide solutions to problems facing the Ministry of Irrigation (MOI) in its activities to meet its overall goal.
2. Conduct the research necessary to provide answers to key policy issues in the irrigation sector.
3. Develop the long-term capabilities of the WRC and its research institutes to provide the MOI and Egypt with solutions to their irrigation and water resources problems.

1.3 STRATEGY

The support, originally limited to the Chairman's office and a few institutes within this project, is being expanded to all 11 institutes. Support will also be continued to the Training and Manpower Development Department (TMDD). Support will be through:

1. Training of professional staff to further develop their abilities, and special training of other support staff while on-the-job, through short courses in the U.S.A., and formal degree and non-degree academic programs.
2. Procurement of equipment and commodities necessary to plan, manage, and conduct their research and training responsibilities.

3. Subject matter specialists to assist in the formulation and solution of special problems in management, research, or training.

2.0 ORGANIZATION

The Water Research Center is organized with the Central Office of the Chairman, and 11 Institutes. the function of the Chairman's Office is to coordinate the overall activities of the institutes within the framework of WRC goals and objectives. For purpose of reference the 11 research institutes are named below, with a brief description of their principal mission or interests.

1. Water Distribution and Irrigation Systems

This institute is concerned with all aspects that make up an irrigation system, including agronomic, sociologic, and economic disciplines as well as the physical, or engineering interests.

It is concerned with improving the water distribution network, modern irrigation methods, on-farm water management, assessment of plant water requirement, irrigation efficiency, water losses, and generally improving crop production.

2. Aquatic Weed control and Channel Maintenance

The major concern is to sorely, and economically, control the growth of harmful aquatic weeds in water channels, manually, mechanically, chemically, and biologically.

3. Drainage

Research on surface and subsurface drains, analysis of drainage water on a national scale, reuse of drainage water for irrigation, and salt balance for improvement of agricultural production are the chief interests of this institute.

4. Groundwater

This institute is responsible for making assessments of the capacity of the underground reservoir along the Nile valley and the delta, and its suitability for irrigation, largely through conjunctive use. It is also concerned with keeping up-to-date with the extent of salt water intrusion in coastal aquifers and along the Suez canal.

5. Water Resources Development

Interest is focused on possible water resources development projects on the upper tributaries of the Nile and in the Sinai.

6. High Aswan Dam Side Effects

Changes in the Nile resulting from the High Aswan Dam are the interests of this research institute, and includes such issues as channel degradation and its control, bank erosion and sedimentation.

7. Hydraulics and Sediment

Work in this institute is concentrated on the use of physical models to analyze and solve hydraulic and sedimentation problems of the Nile River, and canals, along with their hydraulic structures ranging in size from large river barrages and power stations to cross regulators and canal intakes.

8. Survey

This institute is concerned with problems which affect the determination of the geodetic surface in Egypt.

9. Mechanical and Electrical

The design, operation, and maintenance problems of control gates, pumps, and other electro-mechanical devices of interest to irrigation systems are of interest to this institute.

10. Coastal Protection

The principal interest is in problems involved in the protection of the shoreline. The institute also helps in the planning of coastal protection structures.

11. Soil Mechanics and Foundations

Problems relevant to foundations of hydraulic structures and canals, including seepage, is of principal interest to this institute.

In addition to the research institutions, the Chairman's office has responsibility over the Training and Manpower Development Department. This department is responsible for administering appropriate training programs for upgrading the practical knowledge and technical skills of personnel in the Ministry of Irrigfation.

3.0 TRAINING

Training activities during the reporting period are described in this section.

3.1 Academic

Three Ph.D. Candidates started their programs for study at Colorado State University in September. They were Farida El Hessy in Irrigation Engineering, Tarek Tawfic in Agronomy, and Mohammed Naguib in Sociology. Starting their Master's programs were Fatma Hassan in water Resources, and Ahmed El Attar in Education, both at CSU.

Abdel Fattah Metawie, in Engineering, and Ragy Darwish, in Economics, continued their Ph.D. studies. They are doing very well academically.

3.2 Invitational Tours

Eng. Abdel Hamid Fahim, Director of the Training and Manpower Development Institute, and Eng. Mohammed Ezzat Nasser, Director of the Project Preparation Department, visited the Salt River Project (SRP) in Phoenix for three weeks to discuss management and development of Human Resources.

Dr. Mohammed A. Helal of the Water Distribution and Irrigation Systems Research Institute presented a paper at the IECON '86 conference in Canada, in September, and visited Colorado State University to discuss plans for setting up a central computing

facility at WRC's new building at the Delta Barrage, as well as other special issues such as solar energy utilization for data collection stations, and pumping stations.

Dr. Awad El Meligui, Director of the Water Resources Research Institute visited the U.S. Geological Survey and the U.S. Bureau of Reclamation with special interest in design and construction of small dams for ponding water in ephemeral streams.

3.3 Short Courses

3.3.1 Chairman's Office

Dr. M. El Korani Gouda attended a course titled "Water Management and Runoff Farming" conducted by the University of Arizona, in August. Under the auspices of the Chairman's Office, three engineers from the Project Preparation Department)PPD) attended a short course titled "Engineering, Management, and Economics of Irrigation Systems" at Colorado State University, also in August. They were Loucy Boulos, Essam El Samanody, and Ghada Barakat.

Three engineers attended a course titled "Remote Sensing and Satellite Imaging Techniques" at the University of New Mexico. the three were Salwa Bakeer, Ahmed Khodier, and Sayed El Sayed.

3.3.2 Water Distribution and Irrigation Systems R.1

Sociologist Sohair Youssef attended a course titled "Training of Trainers for Agricultural and Rural Development" conducted by the University of Illinois, Urbana.

3.3.3 Aquatic Weed Control and Channel Maintenance

Participating in the Salt River Project (SRP) Exchange Program were two engineers, Ahmed El Raiys, and Shawki Habib, with particular interest in weed screening. Their stay at SRP was for a period of two weeks.

3.3.4 Training and Manpower Development Department

As a part of a short course for On-Farm Water Management conducted by TMDD, 27 people traveled to the Southwest U.S. to tour irrigation systems and to see some of the most up-to-date on-farm management

practices in the U.s. A report on the tour prepared by Mr. W. O. Ree is in the appendix. After the tour Engineer Ahmed H. Bayoumi attended a special short course on how to prepare video takes for teaching purposes at the Salt River Project in Phoenix, and the Audio Visual Department at Colorado State University.

3.4 Post-Doctoral

Dr. Mona El-Kady entered into a Post Doctoral training program at Colorado State University in September. She is working on the use of computers in engineering, irrigation water management and management and studying american management methods.

3.5 In-Country

The TMDD regularly conducts short courses to MOI engineers on subjects pertinent to improvement of irrigation systems. The on-farm management course was also conducted in July and August, culminating in a field trip to the U.S

3.6 On-The-Job

Training on the use of computers for solving technical problems continued for engineers assisting Dr. Gwinn with special problems of the WD&IS R. I. Work there resulted in the preparation of three reports, summaries of which are appended to this report.

4.0 SPECIALISTS

There were no subject matter specialists during the reporting period. Dr. Sunada and Dr. Layton finished their TDY at the beginning of the period for the Groundwater research Institute, and Dr. Warner started his TDY at the end of the period. There will be number of specialists called to Egypt during the next period.

5.0 PROCUREMENT

There were no equipment or commodities procurement during the reporting period, save for computer software and a few items of office furniture and supplies. The bulk of orders for equipment will be placed in the next period.

A P P E N D I X

ASSESSMENT OF SOIL SALINITY AND WATER TABLE LEVELS IN THE SERRI COMMAND

BENI MAZAR AREA

PRELIMINARY REPORT

REGIONAL IRRIGATION IMPROVEMENT PROJECT

T.C. Martin
T.E. Flack

Cairo, Egypt
December 14, 1986

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INTRODUCTION

This RIIP activity is a joint effort conducted by RIIP personnel, the Academy of Scientific Research and Technology, and Colorado State University. Priority was placed on assessment of the Beni Mazar area due to reports and concerns of officials and farmers that there were significant salinity and water table problems in the area.

This report is preliminary and will be superceeded by the final report for the work currently in progress for the entire Serri command. The reconnaissance map units described herein and the salinity and water table classes are being applied in this current study. These classes may be changed somewhat as the mapping progresses and should be also considered preliminary.

The field and office analysis was conducted by Dr. H. Younes and Dr. M. Abd El Rahim of the Academy of Science and by Mr. T.C. Martin and Mr. T.E. Flack of CSU. The field investigations were performed during the period November 20 to November 26, 1986.

OBJECTIVES

The primary objectives of this study of the Serri command are as follows:

1. Diagnose problems within the Serri command regarding soil salinity and depth and quality of subsurface water.

2. Locate and determine the areal extent of relative classes of soil salinity and water table levels.

3. Provide a more thorough understanding of the dynamics of soil salinity and encroachment of water table in the Serri command.

4. Provide the baseline information for monitoring long-term trends and for assessing the success of mitigation measures.

5. Provide the a land use map of the Serri command with associated acreages.

6. Establish a methodology which could be applied to other irrigation systems in the Nile River valley.

In addition to the above, other specific objectives for the Beni Mazar study:

a. Finalize the field methodology to be used for the remainder of the Serri command.

b. Test the reliability and applicability of the EM-38 electromagnetic inductance device for remote and rapid measurement of bulk soil electrical conductivity.

c. Observe, at a reconnaissance level, the effectiveness of subsurface drainage systems in the area.

METHODS

Reconnaissance Map

A reconnaissance photo interpretation of the Beni Mazar area was completed prior to field work. Areas which appeared affected by salinity and/or water table were delineated on 1:10,000 scale aerial photo mosaics. These delineations were then transferred to the individual aerial photo stereopairs and to 1:25,000 topographic maps for use in the field. This reconnaissance map provided a stratification of the area which assisted the field team in the selection and intensity of field sampling sites. Map units A, B, and C were used for the reconnaissance map and are described below:

Map Unit A Soils in this map unit are the least affected by salinity and water table. The majority of this map unit is only slightly affected by salinity. Significant sized areas of moderately affected soils occur within this map unit. These areas will be identified and separated during field investigations and interpretation of results of laboratory analyses. Severely affected soils are small and isolated, typically occurring adjacent to canals and mesqas. Anticipated composition of affected soils in this map unit are as follows:

65% slightly affected

30% moderately affected

5% severely affected

Field investigations will be required for verification of the map unit and for segregation of larger contiguous areas of moderate and severely affected soils. This map unit will require the least intensive sampling program.

Map Unit B This map unit represents areas moderately affected by soil salinity and water table. There is a wide

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range of soil and water table characteristics represented by this map unit. Field investigations and laboratory analyses are expected to reveal sizable areas of only slightly affected soils as well as areas of severely affected soils which are not separable by photo interpretation at a reconnaissance level. Anticipated composition of affected soils in this map unit are as follows:

25% slightly affected

50% moderately affected

25% severely affected

This map unit will generally require more detailed field investigations and sampling to separate the larger areas of severely affected and slightly affected soils. Within this map unit, it appears that certain complex areas will require more detailed field study than other, less complex areas

Map Unit C This map unit includes areas characterized as moderately to severely affected by soil salinity. These are the most obviously affected areas where salinity and/or water table is visibly imposing constraints to crop productivity. Also, salt accumulations on the soil surface can be detected by photo interpretation and are typically obvious in the field. Anticipated composition of affected soils in this map unit are as follows:

15% slightly affected

40% moderately affected

45% severely affected

A moderate level of detail in field investigations and sampling will be sufficient for apparently contiguous areas of severely affected soils in order to characterize the soils and water table levels. Complex areas where severely affected soils are intermixed with moderately (and slightly) affected soils will require more detailed investigations.

Field Investigations

Observations were made in the field at representative locations based on the reconnaissance mapping, on-site aerial photo interpretation, and visual assessment on the ground. Holes were augered into the water table or to a depth of 150 cm. The excavated soil was examined at varying depth increments and samples were collected for laboratory analysis. Visual assessments were made of crop and soil condition and farmer's

comments were noted where possible. Bulk soil conductivity was measured with the Geonics EM-38 electomagnetic inductance device for about one-half of the field sites. Electrical conductivity of subsurface water was measured with a digital conductivity meter. Water in irrigation supply channels and open drains was also measured for conductivity.

Soil Sampling and Laboratory Analysis

Approximately 140 soil samples representing 116 observations were collected for laboratory analysis. Samples were shipped to the soils laboratory in Cairo for routine analysis of electrical conductivity (1:5 dilution) and pH (1:2.5 suspension). In addition, 50 samples were analysed for electrical conductivity using the saturated paste extract method. This additional analysis provided information for assessing the reliability of the 1:5 dilution method and for correlating the EM-38 bulk soil conductivity readings.

RESULTS AND DISCUSSION

Influence of Salinity and Water Table on Crop Productivity

As a result of this study, areas of soil salinity and high water table have been identified. In general terms, as salinity levels increase, crop productivity and crop yields decrease. Similarly, as water table levels rise into the root zone, crop yields decline.

In the Serri irrigation command, there is generally a correlation between high water table and salinization of soils. Naturally occuring and introduced (fertilizer) salts in the soil will move downward with sufficient quantities of water. If subsurface drainage is inadequate, the water table will rise, redepositing salts in the root zone. Continued irrigation and inadequate drainage does not allow removal of salts and the system ultimately becomes "closed". If effective subsurface drainage is provided, the systems "opens" and salts can be leached below the root zone. Within the Beni Mazar area, the most significant problems of saline soils and high water table levels seem to occur under this "closed" system.

Salinity affects plants in varying degrees at different stages of development. Generally, most crops are as tolerent, if not more so, at germination than at later stages of development. Crops such as maize, barley and wheat are most sensitive at the seedling stage and become increasingly tolerent at later stages.

Most crops tolerate salinity up to a threshold level above which yields decrease approximately linearly with increasing

salinity. The data provided in Table 1 (Maas 1986) indicate this threshold salinity level and three levels of relative yield reduction as related to soil salinity for crops common to the Beni Mazar area. These data are presented in terms of the electrical conductivity of the saturated soil extract in dS/M (one dS/M equals one mmho/cm). Relative yield is defined as the maximum yield under nonsaline conditions independent of climate, soil, irrigation, and management factors. Thus, in a system such as the Serri command, the relative yield-salinity relationship should prove useful in assessing plant tolerance and production constraints.

Table 1. Salt Tolerance and Crop Response.

	Electrical Conductivity at Respective Reductions in Relative Yield, dS/M				
Crop	Threshold	10%	25%	50%	Rating(1)
Barley	8.0	10.0	13.0	18.0	T
Berseem	1.5	3.5	5.9	10.3	MS
Broadbean	1.6	2.5	4.3	6.9	MS
Cotton	7.7	9.7	12.5	17.3	T
Maize	1.7	2.5	3.8	5.8	MS
Onion	1.2	1.9	2.8	4.4	S
Pepper	1.5	2.2	3.3	5.1	MS
Sugarcane	1.7	3.2	6.0	10.2	MS
Tomato	2.5	3.5	5.1	7.6	MS
Wheat	6.0	7.5	9.5	13.0	MT

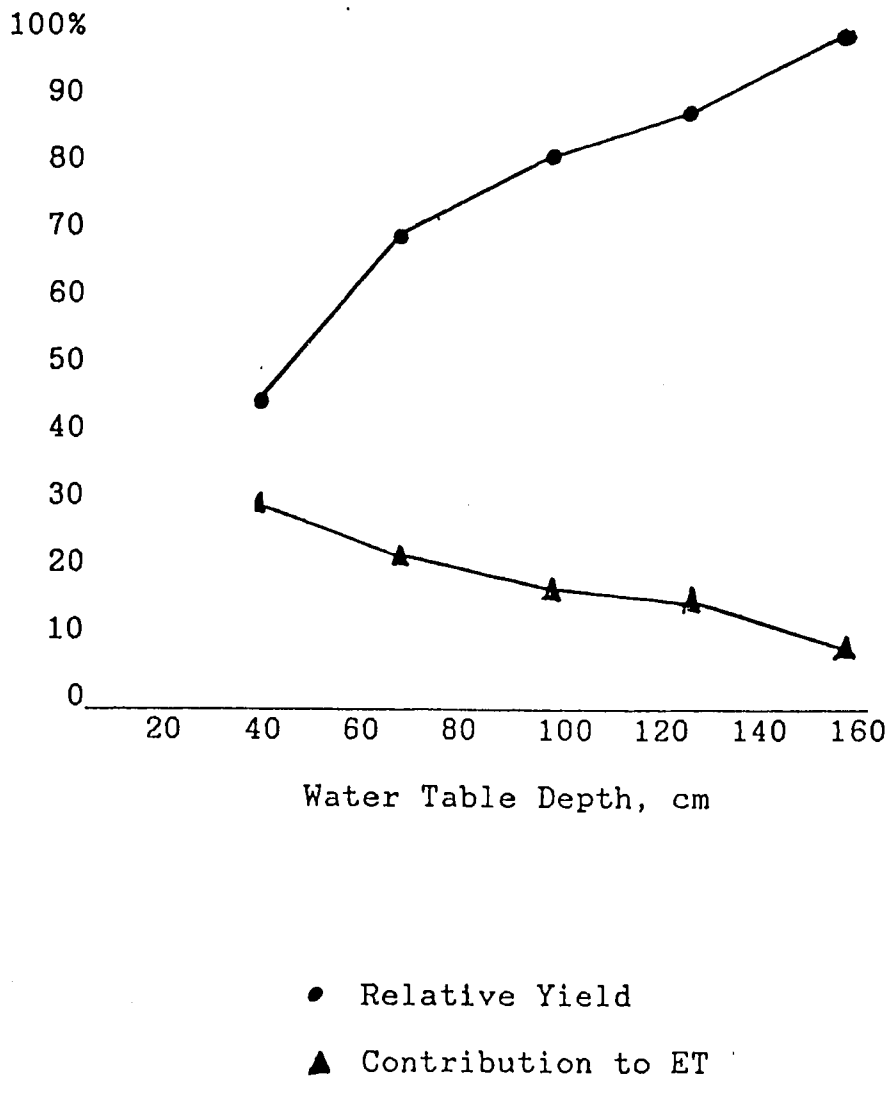
(1)Crop Sensitivity Rating
S=Sensitive
MS=Moderately Sensitive
MT=Moderately Tolerant
T=Tolerant

Development of high water table levels in the Beni Mazar area is mainly a consequence of poor subsurface drainage conditions and inefficient on-farm water management. High water tables result in reduced conditions within the root zone and are often associated with soil salinization. Research conducted in Egypt indicates that for water table depths of less than 130 cm, significant yield decreases occurred for maize (Moustafa et al. 1977). Similar experiments on cotton yielded a similar trend (Moustafa et al. 1975), as depicted in Figure 1.

Under certain conditions a shallow water table can be useful in supplying water for plant use. However, as the data indicate,

with a rising water table yields are generally reduced and, simultaneously, water table contributions to evapotranspiration is increased (Figure 1).

Figure 1. Reduction in cotton yield and contribution to evapotranspiration as related to water table depth.



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Salinity and Water Table Classes

Nine land classes were established for the mapping of soil salinity and water table levels. These land classes are based on conventional classification schemes and local information regarding impacts to crop production and represent the entire range of land conditions observed in the Serri command area. The land classes are described below:

Class 1A: Nonsaline; water table depth more than 150 cm.

- EC of the soil is generally less than 4 dS/M.
- Some localized areas of higher salinity, especially along mesqas.
- Water table has little or no detrimental influence on crop growth.
- Salt crusts may occur in areas and may affect germination, but conditions for successful production are otherwise good.
- Impacts on crop production are low and only the most sensitive crops (i.e., broad bean, onion and pepper) are affected.

Class 1B: Nonsaline; water table depth 100 to 150 cm.

- EC of the soil is generally less than 4 dS/M.
- Some localized areas of higher salinity, especially along mesqas.
- Salt crusts on the soil surface are more prevalent than in Class 1A and may affect germination, but salinity levels are otherwise good.
- Water table has some minor influence on deeper rooting crops such as cotton, maize and sugarcane; also influences movement of salts in capillary fringe to the soil surface.
- Impacts on crop production are low and only sensitive crops are affected.

Class 2A: Slightly saline; water table depth more than 150 cm.

- EC of the soil is generally 4 to 8 dS/M.
- Crop density is uneven and populations are below average; germination is moderately affected by prevalence of salts on soil surface.
- Water table has little or no effect on crop growth.
- Impacts on crop production are moderate; relative yield reduction up to 50 percent due to salinity can occur for broad bean, maize, onion, pepper and tomato; all other crops are affected to lesser degrees.

Class 2B: Slightly saline; water table depth 100 to 150 cm.

- EC of the soil is generally 4 to 8 dS/M.
- Crop density is uneven and populations are below average; germination is moderately affected by prevalence of salts on soil surface.
- Water table has influence on movement of salts to the soil surface and through the root zone; also has influence on root development of deeper rooting crops such as cotton, maize and sugar cane.
- Impacts on crop production are moderate; relative yield reduction up to 50 percent due to salinity can occur for broad bean, maize, onion, pepper and tomato; all other crops are affected to lesser degrees.

Class 2C: Slightly saline; water table depth less than 100 cm.

- EC of the soil is generally 4 to 8 dS/M.
- Crop density is uneven and populations are below average; germination is moderately affected by prevalence of salts on soil surface.
- Water table affects all but shallow rooted crops such as onion, berseem and possibly pepper; because of the lack of adequate drainage, salts are never leached from the root zone.
- Impacts on crop production are moderate to severe; relative yield reduction of 50 percent due to salinity and water table effects may occur for all crops.

Class 3A: Moderately saline; water table depth more than 150 cm.

- EC of the soil is generally 8 to 12 dS/M.
- Salt crusts are prevalent and severely affects germination; crop density is uneven and populations are low.
- Water table has little to no influence on growth.
- Impacts on crop production are severe; relative yields are below 50 percent for all crops except cotton and barley.

Class 3B: Moderately saline; water table depth 100 to 150 cm.

- EC of the soil is generally 8 to 12 dS/M.
- Salt crusts are prevalent and severely affect germination; crop density is uneven and populations are low.
- Water table influences salt movement in root zone and affects predominantly deep rooting crops such as cotton and maize.
- Impacts on crop production are severe; relative yields are below 50 percent for all crops except cotton and barley.

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Class 3C: Moderately saline; water table depth less than 100 cm.

- EC of the soil is generally 8 to 12 dS/M.
- Salt crusts are prevalent and severely affect germination; drop density is uneven and populations are low.
- Water table affects all but shallow rooted crops such as onion, berseem and possibly pepper; because of the lack of adequate drainage, salts are never leached from the root zone;salts are generally recycled.
- Impacts on crop production are severe; relative yields are below 50 percent for all crops except possibly cotton and barley.

Class 4: Strongly saline; water table less than 150 cm.

- EC of the soil is greater than 12 dS/M.
- Crop production is at a minimum; usually cotton, berseem or barley may be grown, but severely affected by the high salt level.
- Crop density is very thin and populations are very low.
- Water table is less of a factor in production than salinity; where near the soil surface, no crops are grown; at deeper levels, some production can be realized for only the most tolerant crops.
- White salt crusts are very apparent.
- This class may occur along mesqas or in depressions where water table levels remain high (less than 100 cm), drainage is inadequate and salts accumulate; this map unit has not been observed in extensive contiguous areas.

Soil Salinity and Water Table Classification Maps

The attached maps for the Beni Mazar area are at a scale of 1:10,000. These maps were created from aerial photo mosaics which are not cartegraphically correct and should be considered preliminary. The final classification maps will be transferred to the 1:25,000 scale survey maps upon completion of mapping of the entire Serri command.

Tile Drain Survey

Tile drain access wells were randomly observed throughout the Beni Mazar area. Of the 15 observations made, 12 contained standing water at depths less than one meter from the soil surface and one was filled dirt. Electrical conductivity of the standing water ranged from 0.6 to 4.4 dS/M. Only two of the systems were operating, and water was running at depths of 130 cm and 140 cm. Electrical conductivity of the water in these two systems was 0.8 and 2.7 dS/M.

In two of the locations where the access wells were in proximity to open drains, it was observed that the level of water in the open

drains was above the level of the tile drain outlets. For these sites, the water level in the open drain was measured relative to the soil surface using a pole and a hand-held clinometer. Water levels were found at 85 cm and 100 cm for these two sites. The water levels in the adjacent access well was found at approximately the same depths, respectively. Augered holes at the access wells revealed subsurface water table depths of 85 cm and 100 cm, respectively.

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ABSTRACTS OF REPORTS PREPARED DURING THE REPORTING PERIOD

FORECAST OF WATER SURFACE ELEVATION OF BIRKET QARUN, EL FAYOUM

EIIP Tech. Report No. 1

A method of forecasting water surface elevation of lake Qarun was developed using 1976-1985 data from Shakshouk Lake Evaporation Station in the El Fayoum Governorate. Total inflow to the area measured at Middle Lahoon, Hassan Wassif, Hawwaret Adlan, and Terat El Agooz regulators was used to develop prediction equations of the future lake elevation.

IRRIGATION SCHEDULING FOR EL-HAMMAMI PIPELINE

EIIP Tech. Report No. 2

Field data for the completed portion of the pipeline were added to the computer program. Also data on vegetables were included as one of the eight crops to be used by the program. The computer model uses field data of crop areas, crop consumptive use, ground water, application efficiency, conveyance efficiency, available moisture, and hydraulic characteristics to produce an operating schedule to satisfy irrigation demands for any time during the year.

MESQA DESIGN FOR WEED GROWTH IN UNLINED CHANNELS

EIIP Tech. Report No. 3

On large unlined canals, considerable quantities of water may be lost to the consumptive use of phreatophytes and hydrophytes where these water-loving plants are allowed to grow along the canal banks and berms in adjacent areas. The moisture requirements of these natural plants are usually satisfied before water becomes available for irrigation or other purposes.

Design criteria for small channels (mesqas) were prepared. Mesqa design considerations, limitations, specifications and equations are developed in the paper for a computer program.

A report on the
EGYPTIAN IRRIGATION IMPROVEMENT PROJECT
UNITED STATES IRRIGATION INSPECTION TOUR
AUGUST 25 TO SEPTEMBER 15, 1986

By William O. Ree

INTRODUCTION

The irrigation tour was a training mission for 27 members of the Egypt Irrigation Ministry. Most of the participants were irrigation engineers who had recently received related training in Egypt.

The tour was conducted in the Western United States where similarities with Egyptian irrigated agriculture are found. Thus the area visited is a good training ground for irrigation experts from Egypt and or similar lands. Also, the route of the tour was near the route of the Colorado River and some analogies between it and the Nile could be drawn.

At each point visited local experts would describe the facilities and the reasons why the particular system was used. The tour members would have the opportunity to ask questions which would lead to a better understanding of the facility. In addition to the instruction given at these stops learning was obtained by observations as the group traversed across the country. The bus is an excellent mode of travel for this type of mission. In no other way could as good a view of agricultural practices and land use be had.

The three-week duration of the tour was a bare miniumum to accomplish the training mission. There were places where some of the group would like to have had more time to discuss problems, especially those related to their job activities.

The group members were attentive throughout the tour and actively participated in the discussions.

THE PARTICIPANTS

The following table lists the participants and their positions:-

Farouk Abdel-Hameid Mansour	First Deputy Inspector,Sharkia
Mrs. Vinis Girgis Hanna	Inspector, East Qalubic
Gamal Mohamed Aly	Ag. Economic, PPD
Bahaa El-Deen Ibrahim Hassan	District Engineer, Banha
Ahmed Moustafa Abo El-Lail	Dir. of Works, Sohag
Ahmed Talat Mohamed Abdel-Aal	Ag. Eng., WRC
Ibrahim Abdel-Fattah Metawie	Engineer
Magdy Mohamed Abdel-Kader ElKashef	Dep of Irr. Dept,Kafr=El-Sheikh
Abdel-Baset Riad Hussien	Ass't Diir. of Works, Cairo
Aly Yehia Mohamed	Ass't Dir. of Works, Minya
Samir Fahim Shehata	First Dep. Inspector-E. Minya
Rafaat Seddick Abdalla	Eng. E. Minya Gen. Directorat
Hassan Aly Hassan Soliman	First Dep. Inspector
Hamza Abdel-Moeti El-Desouki	Ag. Engineer

Hosny Mousa El-Zaher Mousa	First Dep. Inspector
George Wadie Ibrahim	Inspector
Mohamed Ibrahim Abdou	Ass't Dir. of Works
Mohamed Fathy Ahmed Mohamed Hassan	First Dep. Inspector
Mohamed Abdel-Aal Sayed	Director of Works
Mahmoud Rashad Ahmed Nassif	Engineer
Ahmed Maher Ghiden	Dir. of Irr. Minister Office
Ahmed Hussien Bayoumi	Engineer
Mahmoud Seif Eisa	General Secretary- W. R. C.
Mohamed Mahmoud Ahmed El-Malkh	Director General
Gamal El-Deen Abbass Helmy	Director General
El-Sayed Mohamed Ahmed Hasan	Director General
Nay Selim Ghoriel	Under Sec. of State

Tour Guide

William O. Ree (accompanied by wife)

Interpreter

Ragy Darwish

The participants represent the organizational hierarchy from Engineer to Under Secretary of State. They all have responsibilities with respect to irrigation but still they have different interests. For example administrators are concerned with costs, alternative solutions, priorities, and the like, whereas the engineers are more directly involved in flow control and measurements. So, when it came to discussion sessions different kinds of questions would come from the group members depending upon their interests. At times it seemed that it would be better to have a more homogeneous group so that a particular subject could be discussed in greater depth, for example, design engineers could have gone into greater detail on say, flow measurement. However, it became evident that there were advantages in a mixed group. The young engineers could see first hand the problems of administrators and thus better qualify themselves to become administrators in time. In turn the administrators could obtain an understanding of the young engineers' problems leading to improved management skills. Three weeks of close contact experienced by the group certainly gave a greater opportunity to see the interests of the others than the normal contacts on the job.

A way to accomodate the various interests of a mixed group would be, for the discussion session following a presentation, to divide the group into several sub-groups for in-depth discussion of a subject with an expert. The engineers could sit at the table with the chief engineer and present their problems and consider solutions. The administrators could sit with management officials and talk of the things that concerned them. A third sub-group would be a general interest one to accomodate the unclassified.

TOUR SCHEDULE

A condensed schedule for the tour is:-

Aug 26 Ft. Collins - orientation

	27	Ft. Collins-Loveland area The Colorado-Big Thompson Project
	28	Travel - Ft. Collins, CO to Grand Junction, CO
	29	Grand Junction, CO Grand Valley Irrigation System, Colorado Agric. Expt. Sta., Fruita, CO
	30	Travel - Grand Junction,CO to Page,AZ
	31AM	Page, Arizona Glen Canyon Dam
	31PM	Travel - Page, AZ to Scottsdale, AZ
Sep	1	Free day - Labor Day holiday
	2	Phoenix, AZ - Salt River Project
	3	" " " "
	4	" " " "
	5	Phoenix, AZ USDA Water Conservation Laboratory
	6	Free day
	7	Travel to Yuma, Arizona
	8AM	Yuma, AZ Yuma County Water User Association
	8PM	Travel to El Centro, California
	9AM	El Centro, CA Imperial Valley Irrigation District
	9PM	Travel to Indio, California
	10	Indio, CA Coachella Valley Water District
	11AM	Travel from Indio, CA to Riverside, CA USDA Salinity Laboratory
	11PM	Travel - Riverside, CA to Anaheim, CA
	12	Anaheim, CA-- Free day
	13	Anaheim, CA --Disneyland
	14	Anaheim, CA -- Prepare for departure
	15	Travel - Anaheim, CA to Los Angeles,CA Airport Depart for Cairo, Egypt.

The program for each day will be discussed in detail.

Aug 26 - Orientation

The orientation was conducted by Martha Denney, Colorado State University, (CSU)

Welcomes to the group were given by:

Dr. Jim Meiman, Director of International Programs

Dr. Oxley

The mayor(?) of Ft. Collins, who presented certificates to each group member naming him or her Mayor for the Day. This gesture was much appreciated.

The presentation on irrigation in the Western United States was made by Dr. Ramchaud Oad, Agricultural Engineering Department, CSU

The presentation by Martha Denney on customs and mores of the

United States was candid and very good. Evidently it was effective because the group members adjusted well to life in the United States.

Aug 27 - Ft. Collins and Loveland, CO

The day started at the offices of the Northern Colorada Water Conservancy District. Mr. Jerry A Westbrook, Natural Resources Coordinator and Mr. Ken Whitmore, Chief of ROW Management were the hosts. The first order of business was the showing of a film on the Colorado-Big Thompson Project. Some impressions gained from the film were:-

1. The area served by the district was relatively barren land until water was brought in. Early day maps showed the area as part of the Great American Desert. Today it is productive agricultural land. A comparison can be made here with the Nile delta - what it would be like without irrigation water.

2. The lifting of the Colorado River water from the western slope of the mountains to the eastern slope was economically feasible. A main reason being the electric energy generated by the drop available on the east side is greater than the energy required to make the lift on the western side. This factor must be considered when comparing the lifting of Colorado River water with the lifting of Nile River water to the "new" lands being developed in Egypt.

3. The concept of a Conservancy District was difficult at first for the group to comprehend. The members were much interested in this type of organization. They learned that it is a non-profit organization chartered under the laws of Colorado, formed to receive and distribute the water from the Colorado-Big Thompson Project. The water is distributed to ditch companies and municipalities.

The showing of the film was followed by a tour through the district starting with a visit to the Big Thompson canyon. The tremendous flood caused by a very great rainfall was mentioned. However, of greatest interest to the group was the large pipe overhead which conveyed the water from the diversion tunnel to the canal on the east side.

A deer escape ramp on a canal bank could have some application to Egypt as a means for getting a gamoosa into or out of a lined canal. In this case the canal was concrete lined with bank slopes of about 1 1/2 to 1. No deer or similar hoofed animal could get out if it fell in. So on one side a short section of the canal had a bank of light slope, 4 to 1 or so, which had planks fastened to it. These would provide a "toe hold" for any animal trying to get out of the canal.

Mr. Bill Johnston, Superintendent, Larimer and Weld Irrigation Company led the group on a tour of the area served by his company. The canal delivery system appeared similar to systems in Egypt except that the water was delivered to the farm above field level. Since some effort has been made in Egypt to develop full gravity irrigation systems (eg, the Abueha Canal near El Minya) seeing one in operation was a good learning experience.

The tour terminated at an end user, a farm east of Ft. Collins. So

a good overview of the system was had. In all, a very good day.

One suggestion for improvement of an otherwise excellent tour would be at each stop to refer to a map showing the location of the stop and its function. In brief, get the big idea across at the outset.

Aug 28

The trip from Ft. Collins to Grand Junction with two rest stops and a lunch stop took most of the day. Some time was profitably spent discussing the previous days' program. Some mention had been made during the introductory session of the problems involved in getting the right to divert Colorado River water from its natural course to the other side of the mountain to serve the conservancy district. The group was not told that this was a controversial issue and that water users on the western slope were unhappy at the least. So after the tour reached the western slope of the mountains and the group could compare the rugged topography with the flat land on the eastern side they were asked if it was right to divert the water. At this point, this was a loaded question so the answer was an emphatic yes. But when it was pointed out that there was demand for more water on the west side to serve a proposed oil production facility the group was no longer as certain about the correctness of diverting the river flow. The suprising answer was "supply the needs of the oil industry. You need the oil. You have plenty of food" The point was made that water is a valuable and limited resource and great wisdom is required in deciding how to divide water among competing users - agricultural, municipal, and industrial. In time, if not already, Egypt will face similar problems in dividing the water of the Nile. So this consideration was a good exercise for the group.

The attempt to get Colorado River water for the oil industry in Colorado was made by the Federal Government. The states of the upper basin of the Colorado River argued against this request and won their case in court. The group could not understand how a state could prevail over the Federal Government. This led to a long discussion on the political structure of the United States- a question and answer session - with the tour guide doing the answering. It was a stimulating time. So the day was not spent in idle travel.

Aug 29 Grand Junction, Colorado

The tour included visits to The Grand Valley Irrigation Co., the Grand Valley Water Users Association and the Colorado State University Agricultural Experiment Station at Fruita, Colorado. The host and guide for this part of the tour was Dr. Dan Champion of the Agricultural Research Service, US Department of Agriculture, Grand Junction, Colorado. The guide for the Grand Valley Irrigation Co. was Mr. Phil Bertrand, Ass't Superintendent, CVI Co., Grand Junction.

The first stop was the Grand Valley Irrigation Co. diversion dam on the Colorado River. This is a low dam on a long diagonal across the river. The design was based on the need to pass flood flows over the dam at a relatively low head. This required a long weir. The device works satisfactorily in streams with small gradient and relatively low approach velocity. In a confined canyon with high approach velocity

during a flood a weir would not exercise control and lengthening the weir to reduce backwater would be of no avail. A floating boom was in place across the entrance to deflect or intercept floating trash. Rectangular sluice gates controlled the flow which was measured at a downstream gaging station, an arrangement used also in Egypt.

The next stop was the roller type diversion dam of the Grand Valley Water Users Association at the upper end of Grand Valley. The gate operator, Mr. Elmer Morris, explained its operation to the group. Gate openings would be adjusted in response to change in river level in order to maintain a predetermined water level at a downstream staff gage. This control system is also used in Egypt and has been criticized because as water withdrawal from the channel increases the level at the staff gage falls and the gates must be opened further to maintain the level at the staff gage. In other words - the more water you use the more water you can get. Upon discussing this possibility with the operator it was learned that the first withdrawal point is a few miles downstream and that the water surface profile at the gage is affected very little. Noticeable spalling of the concrete abutments and gate piers led to questions about the stability of the structure. The operator did not know about the foundations. But he surmised that the spalling was surface only and not a threat to the structure.

The visit to the Jim Fry farm was one of the most interesting of the tour. Mr. Fry is a vigorous farmer, 65 years young. enthusiastic and creative. The photograph shows Mr. Fry talking to the group. They were attentive as he explained the devices in use in his irrigation system. One of these is a canal sediment cleaner shown in the photograph. A head of water upstream of the gate will cause a high velocity jet to sluice under the gate and move sediment downstream. As the sediment is moved the gate will travel downstream ahead of it. When the lower end of the canal is reached the sediment is shoveled out by hand. Still much less labor is required than hand scraping and shoveling the full length of the canal.

Another simple, effective device was the sloping spile. The plastic spile through the concrete side slope of the canal slopes downward from inside to out at about a 20 degree angle. The spile can be moved in or out by sliding in a plastic pipe fixed in the canal side. Friction holds it in place at the desired position. When irrigating, the operator moves down the canal, setting the spile entrance to a selected level below the water surface in the canal. Thus equal flow rates can be obtained through all spiles. The need for precise setting of fixed spiles is eliminated. Also, any settling or shifting of the canal lining can be corrected for readily.

Rain made it impossible to get into the field at the CSU Agricultural Experiment Station. Still it was possible to view Dr. Champion's level irrigation plots from the roadside. One of the objectives of his experiment is to determine the minimum leaching requirement with the intent to reduce return flow. The Grand Valley is a big salt contributor to the Colorado River and means are sought to reduce the salt outflow without harming agriculture in the valley.

The alfalfa valves used for flow control from the pipe delivery system of the experiment station could not be reached because of mud. To

have seen their operation would have been helpful to the group because this type of valve is being used on the El Hamami pipe line at Beni Magdoul and is probably new to most.

The canal cleaner removes floating trash and debris thus passing clean water to the canal below. This is an elaborate, expensive structure so the group wondered about its value. When it was explained that state law requires control of noxious weeds and that irrigation water can quickly distribute the seeds from these weeds over the entire area the group understood the worth of the structure. However, some expressed doubt that such structures are needed in Egypt.

The automated skate gate and the automated cablegation system were viewed. It would have been helpful to have had brochures which described these systems.

Aug 30 - Travel from Grand Junction, CO to Page, AZ

During the trip from Grand Junction to Page the discussion on the visit to the Grand Valley was directed to the salt outflow problem and its solution. The Grand Valley contributes 780,000 tons of salt annually to the Colorado River. This adds 77 ppm to the salt concentration at the Imperial Valley Dam, about 9% of the total. This is a relatively large share since the Grand Valley is only about 0.2% of the area of the Colorado River Basin. It was clear to see why so much attention was being given to control of salt from the Grand Valley.

The route traversed an area of spectacular geology so attention was paid to the land forms. The tour guide had had some training in geomorphology and was able to offer some explanations for the land forms. Yet at the time he wished that he knew more. The group wondered about the potential usefulness of the area to meet the needs of a growing population, probably thinking of Egypt.

Aug 31 - Glen Canyon Dam

The Sunday morning visit to the Glen Canyon Dam was under the guidance of Mr. Harry Gilleland, a long time member of the project staff, but now retired. He was the Special Services Officer for the Glen Canyon and knew its history and many of the details concerning it.

The dam is a storage reservoir regulating the flow of the Colorado River below, thus increasing the dependability of irrigation water supply. In this role it is like the Aswan Dam and like the Aswan Dam is also an electric power producer. The Glen Canyon dam, with a full capacity of 27,000,000 acre feet is a key storage unit in the Colorado River Storage Project designed to control the erratic flow of the river.

The trip from Page to Scottsdale, Arizona that afternoon was also through spectacular scenery with fantastic land forms. The red sandstone eroded into fanciful form, the basalt intrusions, and the volcanic outflows all held the attention of the group. The north rim of the Grand Canyon could be seen in the valley in the distance.

Sep 1 - Free day

Sep 2 - The Salt River Project, Phoenix, Arizona

The essential information on the project is given in the seminar program and outline "Water Operations and Management, Seminar SRP/MOI/CSU, Sep 2 - 4, 1986" and the brochure "A Valley Reborn" by the Salt River Project and will not be repeated here. Instead a commentary will be offered on the program items.

The welcomes were given by Mr. R. W. Teeples, Associate General Manager and Mr. E. Kirdar, Manager of the office of International Affairs. Mr. Dick Etter was the chairman of the sessions.

The orientation film elicited some questions. The questions will be reported because they are an indication of the interests of the group. An abbreviated answer will also be given.

Q - Why is it called the Salt River? Is it salty?
A - No, there are some salt springs in the watershed.

Q - Why diversified power sources?
A - Not enough hydro power available. Now 10% hydro,80% coal, 10% oil and gas. Future power source will be nuclear.

Q - When do you maintain canals?
A - North side - November, 1 month, South side - December, 1 mo.

Q - What is the maintenance cost for one square meter of canal.
A - Deferred, to be covered in later session.

Irrigation Scheduling, Operations and Management
Sid Friar

Mr. Friar briefly described the system including the watershed, the dams, the project area, the canals and the telemetry system and controls to lay the basis for his presentation. This part of the presentation will not be repeated beause it is covered in the brochures previously mentioned. Questions were answered during his talk and the answers provide a a good description of the subject. So the questions will be cited here along with brief answers.

Q - Why do you pump water back up into the reservoir?
A - During the times when customer demand for electric energy is low the energy from other power plants is used to supply the hydro plants to pump water back into the reservoir above. Then during times of peak demand for electric energy the water is run back down through the turbines. This is an economically feasible operation.

Q - What is the source of ground water?
A - Percolation from precipitation.

Q - Do wells work all the time?
A - On city contracts, yes. The rest depends on the need.

Q - What is the salinity of the well water?

A - 1000 ppm total dissolved solids. This compares with 300 ppm for the Verde River and 500-600 for the Salt River.

Q - Do you mix water from wells with reservoir water?
A - No. not intensionally.

Q - What kind of irrigation system do you have?
A - All gravity flow - except for 1 pump.

Q - Do you have weed problems with concrete lined canals?
A - Yes, moss and algae.

Q - Is there any sprinkler irrigation?
A - Very little.

The question and answer presentation will be interrupted here for a description of the scheduling process.

A farmer places his order for water by telephone. A clerk receives the order and places it in the computer. The Zanjero (ditch rider) gets the information for his section and schedules deliveries for each 24 hour period - midnight to midnight. The urban dweller signs up for delivery on a 14 or 28 day cycle. Sid Friar said he gets 18 irrigations for $34 a year. The zanjeros work ten 8 hour days and then have 2 days off.

The questions are resumed;

Q - Is groundwater being overpumped?
A - (Mr. Ed. Kirdar fielded this one) Yes, we are presently using 5,000,000 acre feet. Only 3,000,000 are renewable so 2.000,000 are being mined. The remedy is to bring in 1,500,000 from the outside and save the remainder, 500,000 by conservation. In time no water will be taken from the ground.

Q - Is there a drainage problem?
A - Return flows are picked up and used downwtream. In 1928 there was a high water table. Pumps were used to lower it.

In the afternoon the field trip included visits to the ADC/Water Command Control Center (Bob Whitmarch, operator), The Granite Reef diversion dam (a dredge was operating in the pool to remove sediment), and the Stewart Mountain dam, Bill Rainey, operator.

Sep 3 - Salt River Project continued

Conjunctive Use of Surface and Groundwater
Charley Ester

This presentation was scheduled to be given by S. Wilson. The talk started with a review of the salient features of the Salt River Project.

A major purpose of the Salt River Project is to meet the water demand of the valley. Early day practice was to supply surface water to the holders of water rights. But drouths made the use of groundwater

necessary. Today the PROP committee projects future water needs starting with the assumption that the current year is the first year of a seven year drouth. It is forecast that agriculture in the valley will decline to zero by the year 2028. Total water demand is expected to decline until the year 2000 and then start to increase as population increases. The Central Arizona Project will deliver some Colorado River water to supplement the present supply. Questions asked following the talk were:-

Q - Does the salinity of the ground water increase with time?
A - No, it may vary with depth.

Q - Any plan for using sewage effluent?
A - Yes, for urban irrigation, golf courses.

Q - Is the ground water salty?
A - There are some very salty wells in the western part, but as a whole the well water is very good - 300 ppm

Q - What is the source of ground water?
A - The aquifer is in an alluvial fill and much of the water is of glacial origin. So ground water is being mined.

Q - Will new lands be found to replace agricultural land being lost to urbanization?
A - No. We can not move water out of the district'

Q - What is the evaporation rate?
A - 120 inches per year, or 3000 mm

Q - How do you protect water from evaporation?
A - We do not. Monomolecular films not practical.

Q - Do you reuse the water delivered?
A - No, but we must pick up tailwater.

Q - What are the effects of ground water level decline?
A - Some land subsidence.

Q - What are the reasons for error in estimates of water supply?
A - Answer deferred.

A film was shown of water supply. Questions asked were:-

Q - Is there any effort to restrict growth and not reduce agriculture?
A - No, the people have free choice.

Q - What is the cost of ground water?
A - $25 per acre foot. Surface water costs $8.50 per acre foot.

Q - Are snow surveys made every year?
A - Yes, during the season surveys are made every two weeks.

Q - Is stream flow manipulated?
A - No.

Maintenance of an Irrigation System
R. Merkley

Maintenance problems change as water use changes from agricultural to urban, and a big change is taking place in the Salt River Valley. In 1934 there were 218,000 acres of irrigation agriculture. In 1984 there were only 89,000 acres.

There are 1200 miles of canals and ditches in the project area. There are 131 miles of canals, 60% of which are lined with concrete, 4 inches thick on the bottom and 1 1/2 inches on the sides, wire mesh reinforced.

In addition to the canals many structures are needed, including 171 radial gates and a number of pumps. Pipe lines have replaced some canals. Urbanization has crowded structures. In some places there is no room for the zanjero to park his vehicle when he must service a control valve in the city.

Canal maintenance has always been required. In the early years horse drawn disc harrows were used to clear the canals. Today gang harrows or huge chains are drawn by tractor through the canal. A "gradeall" is also used. Its' limitation is reach - 32 feet. Cost figures were given:-

Tractor and chain demossing - $3,000 per mile.
Gradeall - $1020 per mile.
Chemical control - $750 per mile for 500 cfs canal.
_ $2500 per mile for hydrothal 191 above filter plants.
Spraying weed seeds - $50 a mile per side. At 12 sprayings per year the cost is $1.2 million for terrestial weeds.

Fish can be used for weed control but first the Fish and Commission must be satisfied that they will not become a pest. Fish mentioned were the white amur and the telapia.

Burning can control weeds, but it can be done only at certain times and also it is not economic.

Bridge piers collect trash during floods and must be cleaned. Today bridge piers in canals are not permitted on new installations. People tend to dump trash in the canal and this aggravates the problem.

The building of freeways has caused access problems. The movement of large equipment down the canal has become impossible in some places and it is then necessary to go around the bridge. Portland cement paving is needed at the site of the crossing. Asphaltic pavement could not withstand the the impact of tracked vehicles.

There are 5 canal trash intercepting structures. For a 300 cfs canal the cost of the structure was $80,000.

This was a fact packed session so not too many questions were raised. They were answered as the talk progressed.

Water Measurement
J. McDade

Measurement of the irrigation water is necessary to assure equitable delivery and to reduce waste. Before water measuring was begun the loss to the Salt River Project was 35% of the water. This rate stayed the same no matter what was done. So measuring was started to learn where the water was going. The first step was to teach the zanjeros how to measure water. It took 10 years to develop the program to where it is today. As a result the loss today is only 10%.

One of the achievements of the measurement program has been the preparation of a manual intended for the instruction of the zanjeros:- "Measurement of Irrigation and Storm Water" a Reference Manual prepared by J. McDade of the Salt River Project. Each tour participant received a copy. An addendum was provided which gives the rating equations in metric and also rating tables in metric units. This greatly increases the uselfulness of the manual to those who use the metric system.

The principles of flow measurement which are the bases for the manual were described. These are given in the manual and will not be repeated here. Suffice it to say that the manual was written in simple terms because it is intended for use by zanjeros (gate guards, ditch riders). Demonstrations of flow measuring were a part of the afternoon field trip.

In the afternoon the field was conducted by J. McDade and Herb Mattingly. Flow measurement of free flow and submerged flow under sluice gates was done. Heads were measured , rating tables referred to and the discharge estimate was determined immediately.

Chemical treatment sites were visited. Secure storage for the chemicals was needed to prevent their falling into wrong hands. Vandalism is a problem.

A gradeall equipped with the SRP telescoop was observed cleaning a small canal. This machine moves along the canal with its boom extending over the canal. It does a very good job of removing sediment from the canal bottom. The machine requires a 5 meter wide roadway along the canal. This space would not be available along mesqas in Egypt.

Sep 4 - Salt River Project continued

The review of the day 2 program brought out some questions:-

Q - Have you studied the side effects of magnicide H for weed control?
A - We are careful. We use it only for agricultural purposes but not where it could enter drinking water.

Q _ What about the effect of the chemical on crops.
A - The dilution is so great that there is no effect.

Q - How do you determine water need?
A - Kirdar answered this one. He said that water rights and not water duty determine the flow. This 5 acre feet per acre per

year.

Q - Why not use more efficient irrigation and irrigate more land?
A - Again, water rights are the determining factor.

Q - How can you minimize evapo-transpiration?
A - Maybe the answer will be provided at the Water Conservation Laboratory.

Water Engineering
T. Neal

Mr. Neal's presentation covered canal transmission lines, canal lining, canal check structures, canal to lateral head structures,lateral distribution items, pipe lines, slip formed lined ditches, and measurement structures. The foregoing are related to the Salt River Project. In addition the Civil Engineering Department has other projects. (listed in the seminar outline). The questions which followed were:-

Q - Is canal lining put in manually or mechanically, any precast?
A - Most manually. None precast.

Q - Why not use another kind of lining?
A - We tried plastic, but without protection the sun would deteriorate it.

Q - Is Cost-Benefit analysis used?
A - This type of analysis is not formalized.
We are in a service business. For example if we have a request for a pipe line we try for the most economical. Cost-benefit comes in when we evaluate maintenance. If too costly we advize the customer to seek an alternative. Or if we are building something new we use Cost-Benefit analysis.

Q - What is the thickness of concrete linings?
A - Large canals - 6" bottom, 3" sides
Small canals - 1 1/2 " bottom and sides.

Q - Where canal intersects a road do you design the bridge?
A - We do not design, but advise and oversee. Where we own the land we establish the criteria.

Q - Is the canal lining reinforced? Are expansion joints used?
A - Bottom not reinforced, sides have wire mesh. We do not use expansion joints. We cut a groove in the partially set concrete.

Q - How is it grooved?
A - Press in a metal blade half inch or more. In hot weather the canals are filled with water so there is very little expansion.

Q - Do you have seismic investigations of dam sites?
A - (by Kirdar) Following the Teton Dam failure the congress passed a law requiring inspection of dams to assure safety both hydrologically and for earth quake resistance. We found

that our dams do not meet present safety criteria. If the Federal Government owns the dam it will pay the cost of upgrading. If we benefit from the change we will have to pay our part. In our case the cost to SRP will be $300 million and to the Federal $800 million.

Computer Applications at the Salt River Project
L. Agan

See the seminar manual for outlines of this presentation. They will not be repeated here. Some additional information is that the main frame computer is maintained in operation 7 days a week, 24 hours a day. The computer department writes programs and trains the users. This is a big operation with a budget of $30,800,000 for O & M, and $21,200,000 for capital improvements and aquisitions. Compare this with the total budget for SRP of $785.000,000 a year. Of the total of 5600 employees in SRP 277 are in the information section.Another indicator of growth of computer usage is that there are 840 PCs on the project today. There were only 30 in 1983. Questions following this talk were:

Q - What would happen if wrong information is fed to the computer?
A - This possibility is of major concern. Data quality determination is built into the programs to help guard against this happening.

Q - Do you share programs?
A - Yes.

Q - Do you have special programs for land leveling?
A - Yes.

Q - What is hardware? software?
A - Hardware is the machine. Software is the set of instructions.

Planning and Goal Setting
N. Bennett

There is considerable material on this subject in the seminar manual. So it is possible that some of these notes will duplicate material already in the manual. Hopefully they will help amplify and explain.

At the outset the group was asked:-
How many set goals. All answered yes.
Are goals set for you? Again all answered yes
It was evident that goal setting was not new to the group.

Why set goals?
Determine the work process. To communicate with employees. To save time. To provide and challenge
How do you set goals?
See the FY 86/87 Performance plan form in the seminar manual.

See the Work Plan in the manual.
Know what you want to accomplish. Develop an action plan. What resources do you need to accomplish the plan. How is performance going to be measured. Set a deadline.

A check list :-

Specific; Pertinent; Attainable; Measureable; Objective

By being objective say what needs to be done. Stay away from adjectives - e.g. "better", "more"

One step further:-

What is more than expected. Expectations are exceeded.

Failure to attain objective can be:-

Goal set too high.
Might have a conflict.
The worker gets no feedback.

The emphasis in this session was on employee management. This is one of the most important aspects of a managers job and should receive great attention.

One question asked was "Do need to consider the tools required to accomplish the job?" The answer was "yes" e.g. this overhead projector was needed to accomplish this presentaion.

Weed Control
Mike Francis

A manual on weed control had been given to the group members. This provides information on all aspects of weed control. Mr. Francis was brought in to answer questions. These were:-

Q - How much time must be allowed before chemically treated water can be turned into the field?
A - 72 hours.

Q - How does magnicide affect fish? How does it kill vegetation?
A - Kills all fish. Kills weeds by literally blowing them apart.

Q - At what concentration is it harmful to people.
A - You can swim in a concentration of 10 to 15 ppm but you may get a rash.

Q - How long will a chemical in a container remain active.
A - 25 containers with 53 gallons each have remained OK for over a year.

Q - What kinds of weeds do you have?
A - Sago Pond weed, floating algae.

Q - Have weed types changed?
A - No.

Q - Have you done any studies on the effects of chemicals?
A - We studied effect on crops with age or stage of development of the crop a variable.

Q - Has there been any study of chemical in the water after 72

hours?
A - Yes, no chemical in the water after 72 hours.

The afternoon's program was a visit to the offices of the Central Arizona Project. The system has 330 miles of canal and inverted siphons to convey Colorado River water pumped from Lake Havasu to points of use in Arizona. The water must be lifted about 2900 feet in elevation as it flows east and south across Arizona. The project will not be completed until the year 2000, but the first part is complete and in operation. The Salt River Project will receive 30,000 a year from this source. The control room for the system is indeed impressive.

Sep 5 - US Water Conservation Laboratory

There are 4 groups in the laboratory :-

Air-Plant-Water-Soil relations --Dr. Reginato

Arid Land Crops -- Dr. Nakiyama

Ground Water Hydrology and Pollutants --Dr. Bouwer
and Reclamation of Sewage.

Irrigation Hydraulics, Sediment Measurement --D. Replogle

Dr. Bouwer is director of the laboratory but he was not in Phoenix at the time. Dr. Replogle was our host.

Dr. Dedrick discussed surface irrigation. He said that 2/3 of the irrigated areas are under surface irrigation. The ratio may increase. With leveled fields there are advantages to surface irrigation. They are uniformity of application, no tail water, little erosion, and low management requirements. The basic equation for surface irrigation is:-

$qt = ad$ where q = the flow rate
t = the time or duration of application
a = the surface area of the field
d = the depth of application

Dr. Dale A. Bucks talked on consumptive use. The publication "Consumptive Use of Water by Major Crops in the Southwestern United States" Conservation Research Report No. 29, Agricultural Research Service, US Department of Agriculture, May 1982. was distributed. An earlier version of the report found much use in Egypt so the group was interested in the update.

Dr. Replogle discussed flow measurement in canals. The broad crested weir received considerable attention. One of the chief advantages of this device for flow measurement is its simplicity. However, under some conditions it might not have the required sensitivity for measuring a range of flows. Models of the weir were demonstrated in the laboratory.

A list of the laboratory publications was available for examination and the group participants were encouraged to study it and select those of interest to them. They were then given copies from the laboratory

stock. This was an unusual opportunity and all took advantage of it.

Sep 6 - Free day

Sep 7 - Travel from Scottsdale, AZ to Yuma,AZ

The tour was to have included an inspection of a drip irrigation system, but this type of irrigation had been discontinued and the stop was eliminated from the tour. Along the way considerable land leveling activity was observed.

Sep 8 - Yuma, Arizona

The tour host at Yuma was Mr. Donald Pope. Thr project was prepared for the group and had printed material descriptive of the project available for them.

The Yuma County Water User's Association was organized in 1903 to deal with the Bureau of Reclamation to obtain water for the association.

The first stop on the field trip was the Imperial Dam, the furthermost dam downstream on the Colorado River. Mr. Bill Montana met us at the dam site and explained the facility to the group. The outstanding feature of the dam is the desilting works to keep sediment from entering the All-American canal.

The siphon drop discharging water from the All-American canal into the Yuma canal is being replaced with a new structure under construction. A hydro power plant is incorporated into the drop structure to take advantage of the power producing potential of the site. A lesson learned here as well as at other projects visited is that whatever the situation encountered the engineer has an answer or a solution. Creativity is the key ingredient.

The tour continued through the irrigation association's area and terminated at the headquarters. The shops were inspected and then the group assembled in the office to meet the staff and the supervisors of the association.

In the afternoon the group travelled to El Centro, California.

Sep 9 - El Centro, California

The tour guide for the visit to the Imperial Irrigation District was Linda Sanchez.

The Imperial Irrigation District was formed in 1911 and in time took over 13 water companies in the area. Today the district services about 5,500 water users over an area of 500,000 acres. It also operates 9 hydro power plants, a steam plant, 8 gas plants, and a diesel power plant for a total power generation of 453 megawatts. 60,000 electric power accounts are serviced.

The Imperial district is ranked as one of the most productive farm lands in the world. The crops grown include garden crops, field crops,

and permanent crops. The great variety of crops grown means that there is planting and harvesting going on all year long. Irrigation water demand is present every month of the year. The average annual rainfall is only 2.93 inches per year so irrigation is essential.

A practice, not observed elsewhere, was the use of holding ponds to capture and store excess canal flow. The pond viewed had a relatively large surface area so evaporation loss could be considerable, but the water saved more than offset this loss.

The afternoon was spent in travelling to Indio, California.

Sep 10 - Indio, California.

The visit here was to the Coachella Valley Water District. The tour guide was Mr. Dennis Mahr.

The Coachella District is served by the 122 mile long Coachella Canal, a branch of the All-American Canal. The canal ends at Lake Cahuilla, a storage lake with a capacity of 1500 acre feet. It provides a reserve supply of water for emergency use, necessary because it takes 3 days for the water to flow from the All-American Canal to the district.

The first step in developing the land for irrigation, after grading and leveling, was to install the underground drainage system. The underground pipe delivery system was installed and water applied to the land for leaching. Today , because of the efficient drainage system, the land is less salty than it was when irrigation was started. This seemed to be a sharp contrast to the Grand Valley project in Colorado where subsurface outflow is held to a minimum.

Control of canal weeds with fish is being tried on the project. The grass carp is very good for weed control because of its great appetite for canal vegetation, but the Fish and Game Commission will allow the use only of sterile fish. The problem has been to effectively sterilize the fish. Surgical sterilization, which was the best method, failed because in time the fish regained potency.

A 90 hole golf course is being built in the area on good agricultural land. This trend toward urbanization is a real threat to the agricultural productivity of the nation.

Sep 11 - Riverside, California

The early morning was spent in travel from Indio to Riverside California to visit the US Salinity Laboratory. There our guide was Mr. Jack Goertzen.

The laboratory was established in 1938 at the request of 11 western states where salinity was a problem. It is organized into three subject matter areas:-

Soil-Water Chemistry
Plant Physiology
Physics-Engineering

The staff includes 12 to 14 scientists.

The four probe salinity sensor was described. Four energized rings are the electrodes. Three ranges are available on the meter. They are - 0 to 1, 0 to 10, and 0 to 100 millimhos. It is temperature corrected to 25 degrees C. The cell is 6 inches (15cm) long and thus the minimum sampling depth is 6 inches. Another probe is being developed for smaller depths.

Dr. Gene Maas, Research Leader for the Plant Sciences group discussed salt and boron tolerance in plants. He started with these concepts:-

The production function, the relationship between the crop yield and the amount of evapo-transpiration. Yield increases with ET up to a point

Root zone salinity-yield function, the relationship between crop yield and root zone salinity. Yield remains constant at a maximum level with increasing root zone salinity until a level of salinity is reached where yield starts to drop off sharply with further increase in salinity

Root Salinity and how to calculate it.

He then showed the interdependence of the Water-Production Function, the Root Zone Model, and Salt Tolerance. This work provides the analytical basis for learning how to use waters of impaired quality for irrigation and how stage of growth of the plant enters in.

Dr. Frank Dalton discussed the physics of the soil-water system and of the plant-water system. He described the instrument which gives water content of the soil and its salinity in one read out.

Dr. Lee Francois discussed agronomic aspects of the salinity problem.

Mr. Goertzen showed and described the plots where the studies on crop yield is affected by salinity at various stages of growth. This study could yield information which would help decide if and when drainage water could be used with canal water to irrigate - the conjunctive use question.

At the conclusion of the Riverside visit the group travelled to Anaheim, California for the termination of the tour.

Some thoughts by the tour guide

The objectives of the training mission of the tour were achieved by:-

Viewing many different irrigation projects the participants gained new ideas for application back home.

Meeting experts on various aspects of irrigation the participants obtained answers to questions they had - witness the kind and number of

questions they asked.

Learning where information can be obtained and how to obtain it.

Learning that irrigation projects are willing to share information e.g. the Salt River Project is willing to share computer programs.

Having the opportunity to purchase a needed text or reference on irrigation practices or engineering

Above all, by learning of the difficulties faced by the projects at the start and seeing the problems brought about by change- urbanization for example-and how these problems were faced and solved by engineers should be a real inspiration to any irrigation engineer and therein lies the greatest value of this tour.

Tour Guide Bill Ree

Linda Sanchez, Imperial Irrigation District, and Ragy Darwish, Interpreter. (What's Ragy doing?)

Mr. Jim Fry, farmer near Fruita, Colorado, speaking to the Egyptian Irrigation tour group.

A canal sediment cleaner on the farm of Mr. Jim Fry. The Egyptian Engineer is Ibrahim Abdel Fattah-Metawi.