WATER AND SANITATION FOR HEALTH PROJECT

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A STUDY OF THE PROBLEMS OF HIGH GROUNDWATER LEVELS IN NILE DELTA VILLAGES

WASH FIELD REPORT NO. 133

OCTOBER 1984

Prepared for:
USAID/Mission to the
Arab Republic of Egypt
Order of Technical Direction No. 186

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October 9, 1984

Michael Stone
USAID Mission
Cairo, Egypt

Attention: Fred Pollock

Dear Mr. Stone:

On behalf of the WASH Project I am pleased to provide you with ten copies of a report on the problems of high groundwater levels in Nile delta villages.

This is the final report by Joseph Haratani and is based on his trip to Egypt from August 16 to 19, 1984.

This assistance is the result of a request by the Mission on July 16, 1984. The work was undertaken by the WASH Project on August 16, 1984 by means of Order of Technical Direction No. 186, authorized by the USAID Office of Health in Washington.

If you have any questions or comments regarding the findings or recommendations contained in this report we will be happy to discuss them.

Sincerely,

Dennis B. Warner

Dennis B. Warner
Director
WASH Project

cc: Dr. John H. Austin
S&T/H/WS

DBW:kk

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Prepared by:

Joseph Haratani

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ACKNOWLEDGEMENTS

This report could not have been written without the dedicated assistance of the LAD/BVS staff. Special thanks go to Fred Pollock and Mervat Salem who gave up a whole weekend of relaxation in order to guide and accompany me on my three-day field trip. The visits to the six villages were made possible and productive by the ORDEV staffs of Menoufia and Beheira Governorates. I am grateful to Mohamed Kabala, ORDEV representative of Menoufia Governorate, Yousri Abdel Aleem, ORDEV representative of Beheira Governorate and their respective staffs for their kindness and for guiding me to and through the villages.

As is always the case, I am most deeply indebted to the villagers themselves for accepting my intrusion into their private lives with dignity and good humor. To these long-suffering brothers and sisters, I owe a debt of gratitude which, unfortunately, I shall never be able to repay.

To all of you, "Thank You."

EXECUTIVE SUMMARY

High groundwater levels in the villages of the Nile Delta, attributable in part to the construction of the Aswan High Dam, have contributed to (1) a serious sanitation and public health problem and (2) the undermining of house foundations. The high groundwater saturates mud-brick house foundations by capillary action; in time, the foundations begin to crumble.

The AID-funded Basic Village Services (BVS) project, designed "to improve and expand a continuing capacity in local units to plan, organize, finance, implement and maintain locally chosen infrastructure projects, characterized by physical improvements in roads, water systems, and drainage structures," has provided resources to address this critical problem, among others. However, since some BVS-funded efforts to reduce groundwater levels actually contributed to the sanitation problem, a moratorium was declared on all sewerage and drainage subjects.

Before initiating new projects or implementing a proposed, and rather expensive, overall solution to the problem, AID asked a WASH consultant to review the situation and to recommend approaches to solving the problem. The consultant visited six sites in the project area, documented the extent of the problem, and concluded that "it is not possible to develop a single solution which can be applied throughout the Nile Delta... A set of varied solutions that address the specific manifestations of the problem is needed." Therefore, the consultant recommended to USAID a specific plan of action which included three approaches to solving the problem of high groundwater levels by evaluating the effects of: raising the level of homes, lowering the level of groundwater, and remedying the effects of high groundwater. It was also recommended that AID add one U.S. direct-hire field engineer/specialist to its BVS staff.

Chapter 1

INTRODUCTION

1.1 Purpose of Technical Assistance

The DRPS/LAD office (Development Resources and Program Support/Local Administration and Development) of USAID/Cairo asked the Water and Sanitation for Health (WASH) Project to provide technical assistance in studying the groundwater/drainage problem in Nile delta villages covered by the Basic Village Services (BVS) project. The problem of high groundwater levels has existed for many years but is reported to be increasing since the construction of the Aswan High Dam. Some attempts have been made under the BVS project to solve the problem in certain villages. However, these subprojects have had only limited success and have caused additional sources of pollution to the local environment.

The purpose of the technical assistance provided by WASH was to study the groundwater/drainage problem and its effects in delta villages and to develop recommendations to address the problem within the scope of the BVS project.

1.2 Study Methodology

The study began with a review of a limited number of relevant project documents provided by the DRPS/LAD staff. Following this review of documents, the consultant was briefed by the DRPS/LAD staff on the purpose, operational process, and history of the BVS project. Then the consultant went on a three-day field trip in the Nile delta. During this trip meetings were held with governorate and village officials and visits were made to six villages. In Menoufia Governorate, the villages of Kafr Tablouha and Kom el Khdar were visited. In Beheira Governorate, the consultant visited the villages of Edfina, Mahlet el Ameer, Maneah, and El Tod. In each village specific problems related to high groundwater levels were observed and noted. Information regarding these problems was obtained from the villagers. The information gathered from these field visits, the briefing, and the document review provided the basis for the analysis and recommendations made in this report.

1.3 Project Background

The BVS project paper describes the project purpose as follows: "The immediate purpose of the project is to improve and expand a continuing capacity in local units to plan, organize, finance, implement and maintain locally chosen infrastructure projects. While this purpose is necessarily limited to a capacity building effort with outputs characterized by physical improvements -- roads, water systems, drainage structures -- the infusion of a capacity for infrastructure becomes a stepping-off point by which other problems can be tackled and other solutions explored...."

The strategy for achieving the project purpose was to utilize the existing organizational structure and staff resources of the Organization for the

Reconstruction and Development of the Egyptian Village (ORDEV) at the national and governorate levels to implement the project. Specific infrastructure subprojects were to be requested by villages and designed by district or governorate engineers. These subprojects were then submitted to ORDEV's Interagency Committee (IAC) for review and approval or disapproval. Approved infrastructure subprojects were built through contracts with local construction firms under the supervision of the ORDEV engineering staff.

An evaluation of this BVS project, conducted in February and March of 1984, identified wastewater in areas of high groundwater levels as a critical problem to be solved. It concluded that the proposed systems designed to solve this problem were too expensive and inappropriate for rural conditions in Egypt.

Meanwhile, the IAC declared a moratorium on the review and approval of all sewerage and drainage subprojects submitted by villages because some BVS-funded "groundwater lowering" subprojects had illegally discharged raw sewage into irrigation drains. In effect, this freeze deprives the villages of their main source of development assistance for solving their sewerage and drainage problems and also negates the basic purpose of the BVS project.

Chapter 2

FINDINGS AND ANALYSIS

2.1 General

The subject of rising groundwater levels in the Nile delta has received more attention each passing year since the construction of the Aswan High Dam. At the academic level, scientists and others continue their debate regarding the role played by the Aswan High Dam in raising the groundwater levels in the Nile delta. At the national development program level, government functionaries and technical experts view the problem in regional or delta-wide terms and attempt to formulate regional plans of action to address this general phenomenon. Until now, attention has been focussed largely on the effects rising groundwater levels have had on farmlands.

At the local level, the Nile delta villager is unaware of the academic debate and unimpressed with bureaucratic efforts toward long-range, regional solutions. To the villager, the problem is immediate and requires immediate attention and solutions. He does not have the luxury of time to wait until the debate is settled and the regional solutions are developed and put into place. He sees the rising groundwater levels destroying his home and causing sanitation and public health problems. He feels that he needs help now -- not some time in the future.

In the past few years, as more and more houses have collapsed, attention has begun to focus on the plight of the delta villager living in his mud-brick home. So far, it has been the villager rather than the government that has taken the lead in solving the problems caused by rising groundwater levels. In the "worst case" situation, i.e., where the house has collapsed, those who can afford to are rebuilding their homes with fired brick and often on foundations elevated above the natural ground level. Those who cannot afford to rebuild are forced to live under desperate conditions in the partially restored or salvaged areas of the home.

While it is widely accepted that both the regulated year-round flow of the Nile River and the practice of irrigating year-round have been the basic causes of rising groundwater levels in the Nile delta, there are other additional and, perhaps, more immediate conditions of a local nature which exacerbate the problem in individual villages. Some villages are at or below the elevation of the surrounding farmlands. Often there is underground seepage from adjacent irrigation canals and drains. More water is being used. And poorly graded streets and paths do not provide adequate drainage of surface water.

Taking these localized contributors to high groundwater levels into consideration, it is apparent that there are both regional and local manifestations of the overall problem. The regional problem of high groundwater levels is beyond the scope of the BVS project and will require resources of a scale not provided in the project. However, the local manifestations of the problem in individual villages are within the scope of the BVS project and need to be addressed. Interim actions can and should be taken to provide relief to the residents of Nile delta villages affected by rising groundwater levels.

The factors contributing to the problem of rising groundwater levels are distinct and different in each village. It will not be possible to develop a single solution which can be applied throughout the Nile delta. The relative importance of each causal factor (e.g., irrigation water seepage, low village elevation, increased potable water use, uneven topography, rainfall, etc.) must be weighed and addressed in each village. What is then needed is a set of varied solutions that address the specific manifestations of the problem rather than a single solution that attempts to address the overall problem of high groundwater levels. This report describes some of the problems caused by high groundwater levels and recommends actions that can be taken within the scope of the BVS project.

2.2 Field Observations

Six Nile delta villages were visited from August 16 to 18, 1984. The size, settlement pattern, ground elevation relative to surrounding lands, proximity of major irrigation canals and drains, and the drainage patterns of streets and pathways varied considerably from village to village. There were also significant variations in the visual manifestations of high groundwater levels. In Maneah, where a considerable number of houses have collapsed during the past two years, there is a large stagnant pond covering about a hectare of land skirting the lower edge of the village (see Illustrations 1 and 2). On the other hand, while there was no evidence of standing water in the village of Kafr Tablouha, there was considerable evidence of capillary action on the walls of the homes (see Illustrations 3 and 4).

At Kom el Khdar, standing pools of water were seen covering the entrance to one home and also in the foundation excavation of a home under construction (see Illustrations 5 and 6). Some home owners had dismantled the second floor of their homes in an effort to halt the collapse of the first floor walls (see Illustrations 7 and 8). One family had recently built a new home of fired brick on a foundation built up some 1.5 meters above street level (see Illustration 9).

Kom el Khdar is surrounded on two sides by an irrigation canal and drain with water levels higher than the ground levels in the lower sections of the village. It is therefore suspected that in Kom el Khdar the major cause of the groundwater problem may be seepage from the irrigation canal and drain. The problem is more serious in Maneah where most of the village appears to be below the level of the nearby irrigation canal and the surrounding farmland.

Three of the villages visited had installed "groundwater lowering" or drainage systems. The systems in Edfina and Mahlet el Ameer are simple sewer systems which receive the overflow from household sewage vaults (cesspits). These two systems are partially blocked by solid wastes (see Illustrations 10 and 11). The system at El Tod was reportedly designed to drain off high groundwater through openings in the manholes. However, the sewer lines are installed at too shallow a depth to have any effect on the groundwater level.

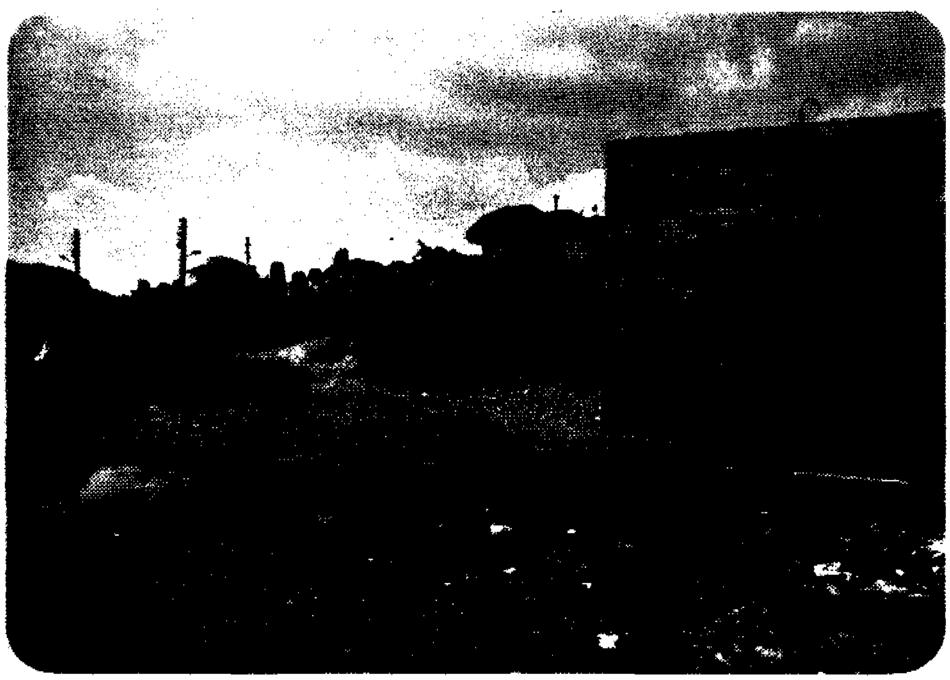
At Edfina raw sewage was flowing directly into an irrigation drain running along one side of the village. Less than a block below this raw sewage discharge, young girls were washing cooking utensils in the drain (see Illustrations 12 and 13). There also were pools of raw sewage in some of the unsewered sections of the village where sewage vaults were overflowing into the alleys (see Illustrations 14, 15, 16 and 17). In one case the raw sewage was flowing across the street and into the Rashed branch of the Nile River. Wastewater from public water taps was also a source of problems by producing mud holes (see Illustrations 18 and 19). Most of the village is above the water level in the river, and even the lowest sections are above the water level in the irrigation drain. Therefore, it seems that the problem of standing water stems from overflows from sewage vaults and wastewater from public water taps rather than from the river or irrigation drain. The treatment and disposal of sewage is a difficult problem here because the village is almost totally surrounded by the river, irrigation drain, and active farms. The lack of available land makes it impossible to install oxidation ditches or lagoons for sewage treatment near the villages. Sewage would have to be pumped to an area away from the village for treatment. At El Tod sewage is collected by gravity in a holding tank and is then pumped through a force main to a natural drainage channel at the edge of the village. At present, no formal treatment is provided; however, it would be possible to modify the channel and to operate it as an oxidation ditch or sewage lagoon.

In all six villages visited there was evidence of problems related to high groundwater levels. Since the visits were made at the height of the dry season, the problem was not at its peak. Walls saturated by capillary action, floors buckled by sub-floor swelling, cracked and crumbling walls, and the remains of collapsed homes were still in evidence (see Illustrations 20, 21, 22, 23, 24 and 25). However, the problem of artesian water flowing up through the floors of homes was seen only as damp spots, and most of the pools of standing water had disappeared either as the result of installed sewer systems or of natural drainage and evaporation. It can be assumed that the problems of collapsing homes and standing pools of wastewater are more intense during the wet season from November to March. It may also be that the successes attributed to the recently installed sewer systems in solving problems related to high groundwater levels are partly due to the natural effects of the dry season.

It is evident from a visual inspection of some homes and buildings that the Nile delta villager has lived with the problem of high groundwater levels for more than a few years and probably for some decades. For example, cemeteries are built on high ground to avoid the problem of high groundwater. The physical evidence leads one to believe that the decay of homes in the Nile delta (especially those built of sun-dried mud bricks) is not a recent phenomenon. It is a serious long-standing problem and solutions for it are going to be neither simple nor inexpensive.

While it is the responsibility of both the government of Egypt (GOE) and donor agencies involved in building basic village infrastructures to develop appropriate solutions to the problem, we should recognize that villagers have been developing solutions of their own over the years. They are switching from mud brick to fired brick. They are building their homes above the groundwater level by raising the foundation. More recently they are stopping the flow of capillary action by installing a plastic sheet between the foundation and the wall (see Illustrations 26 and 27). Finally, as a group, the villagers have borrowed the concept of the underground drainage system from the agriculture sector and applied it to the village in attempting to lower the groundwater level. In view of the solutions already developed by the villager, what may be needed are not totally new approaches but rather the modification and improvement of existing solutions.

Illustrations 1 and 2
Two views of stagnant pond at edge of Maneah



Illustrations 3 and 4
Capillary action on walls in homes in Kafr Tablouha

Kom el Khdar

Illustration 5
Standing water at entrance of home

Illustration 6
Standing water in foundation excavation

Illustration 7
Second floor dismantled to halt collapse of first floor walls

Illustration 8
Failure of wall at door jamb

Illustration 9
New home built on foundation 1.5 meters above street level

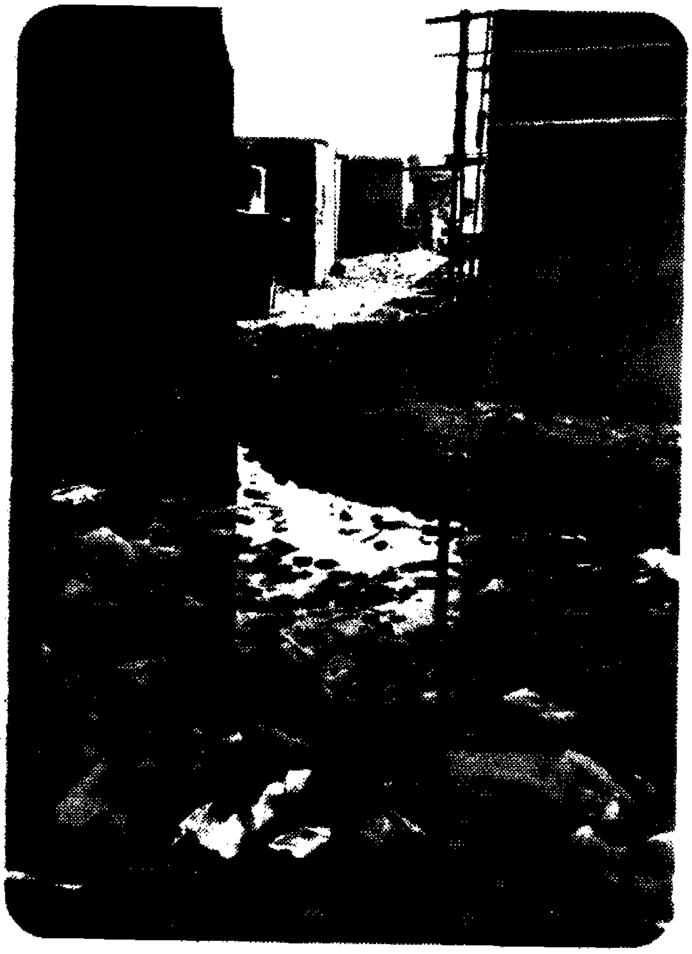
Illustrations 10 and 11
Sewers blocked with solid wastes in Edfina

Illustration 12
Raw sewage discharge into irrigation drain

Illustration 13
Girls washing cooking utensils downstream from sewage discharge

Illustration 14 and 15
Sewage vault overflowing in Edfina

Illustrations 16 and 17
Raw sewage pool from vault overflow in Edfina



Illustrations 18 and 19
Wastewater problem around public water tap in Edfina

Illustrations 20 and 21
Collapsed homes in Maneah

Illustrations 22 and 23
Collapsed homes in Maneah

Illustrations 24 and 25
Distorted floors in houses in Maneah

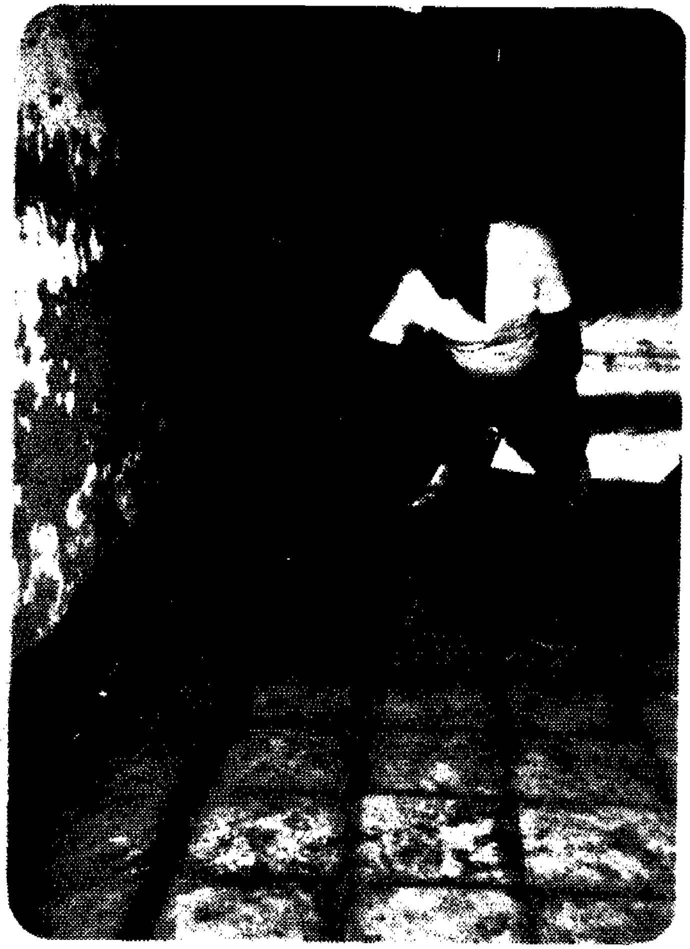


Illustration 26
New construction using fired brick and raised floor level

Illustration 27
New construction using fired brick and plastic sheet to halt capillary action

Chapter 3

RECOMMENDATIONS

3.1 General

Past efforts to solve the problem of high groundwater levels have been directed toward finding one or two technical solutions to the various manifestations of the problem. To date this approach has produced no major engineering breakthroughs. Rather than concentrating solely on treating the effects of high groundwater it might be useful to focus as well on the specific causes.

A significant contributing cause is the provision or expansion of potable water supplies. The installation, improvement, and/or expansion of potable water systems result in increased water use. Since the bulk of domestic water consumption is returned to the ground as wastewater, increased water use adds to the problem of rising levels of groundwater.

As long as BVS continues to support the installation of water supply systems without simultaneously providing for the disposal of wastewater, the project contributes to the general problem of rising groundwater levels. The moratorium on all sewerage and drainage projects forces USAID to take the necessary actions to solve the problem or to avoid contributing to it by not installing water supply or sewerage and drainage systems in those villages where the problem is the most serious and the destruction of homes the most widespread.

3.2 Recommended Plan of Action for USAID

It is recommended that USAID form an interagency task force charged with planning, implementing, monitoring, and evaluating a series of demonstration subprojects that test solutions to the problem of the effects of high groundwater levels on the living environment of Nile delta villages. As recommended in the February-March 1984 evaluation, USAID should marshall the resources of its own considerable technical staff to focus on this issue and, where necessary, draw upon AID/Washington staff and contractor resources, working with and through the interagency task force.

This task force should include representatives from ORDEV and the key GOE agencies responsible for the design, installation, and operation of water supply, sewerage and drainage systems (e.g., NOPWASD*, GOSSD**, etc.). It should also include representatives from the GOE regulatory agencies which are responsible for controlling and monitoring discharges to irrigation drains, namely, the Ministry of Health, the Ministry of Irrigation, and USAID.

* NOPWASD = National Organization for Potable Water and Sanitary Drainage
** GOSSD = Cairo General Organization for Sewerage and Sanitary Drainage

This task force should plan subprojects which directly address the several distinct problems of high groundwater levels in specific villages (i.e., malfunctioning cesspits and sewers, standing wastewater and rainwater, capillary action on walls, distortion of floors, etc.). It should evaluate among other alternatives, the following problem-solving approaches:

1. Raising the level of homes by:

   a. Importing fill material from nearby unuseable land or from the desert.

   b. Systematically using cut and fill within the village or using borrow pits adjacent to the village.

   c. Using reinforced concrete frame construction instead of the traditional brick bearing-wall construction and installing the first floor above ground level.

2. Lowering the level of groundwater by:

   a. Installing a drainage system similar to that used to drain excess irrigation water. Installation costs may be lowered by using so-called "French-drains" instead of perforated pipes.

   b. Installing large diameter, hand-dug, Ranney-type infiltration wells in soils demonstrating higher permeabilities.

   Note: The above drainage systems will require the installation and continued operation and maintenance of pumping equipment similar to that installed at El Tod or that used by farmers for irrigation.

3. Remedying the current effects of high groundwater by:

   a. Improving the collection, treatment, and disposal of sewage -- an approach having limited success in El Tod. Both the design and the quality of construction of the El Tod system need to be improved as well as the operation and maintenance of the system. In addition, the natural discharge channel should be improved and operated as a sewage lagoon or oxidation ditch before final discharge to an irrigation drain. The biochemical oxygen demand (BOD) and suspended solids content of the treated sewage should be monitored to determine if it can meet the standards set by the GOE regulatory agencies.

   b. Improving the current practice of installing an impermeable plastic sheet between the foundation and wall in new construction. The practicality of sealing off the whole foundation and sub-floor areas with a continuous plastic sheet should be explored.

   c. Installing a cut-off wall to intercept canal seepage, or lining the canal section near the village, and/or installing "French drains."

Each of the above suggested approaches has its advantages and disadvantages. Some approaches (e.g., the cut-and-fill), create new environmental problems while solving others. The cost of installing (and operating) each system is the key determinant of the approach's practicality and suitability.

One overall disadvantage of these suggested approaches is that not one, with the exception of the groundwater lowering scheme, addresses the problem of saving the existing mud-brick housing stock. The eventual loss of these mud-brick structures may finally have to be carried by the nation as a cost associated with the building of the Aswan High Dam.

3.3 Recommended Staffing

Under present USAID staffing and technical assistance contract arrangements, USAID/Cairo appears to be receiving fairly complete reporting on project activities on a regular basis. However, USAID/Cairo has not been able to place an engineer or specialist in the field on a long-term basis who can address or resolve the fundamental problems resulting from high groundwater levels. The history of the BVS project indicates that these problems cannot be adequately addressed by occasional visits by experts from Cairo. The attention of a full-time USAID direct-hire project engineer or specialist residing and working in the Nile delta is needed.

This project engineer/specialist is to be a member of the interagency task force and act as its technical representative in the field. He will participate in the planning the test/demonstration activities and work directly with governorate, district, and village officials to supervise the construction and operation of the test/demonstration activities planned by the interagency task force and approved by the IAC. A brief description of the qualifications for the project engineer/specialist is given in Appendix A.

APPENDIX A

Draft Qualifications for Project Engineer/Specialist

DRAFT

Qualifications for Project Engineer/Specialist

Education/Experience:

B.S. in engineering (civil, sanitary, agricultural, or related) or equivalent education and experience in engineering work. Direct working experience with problems resulting from high groundwater levels in deltaic formations is highly desirable. Must have work experience in the design, construction and operation of irrigation drainage or land dewatering systems or similar experience. Should have a basic knowledge of simple water supply and sewerage system design, construction, and operation.

Language/Cultural:

Speaking knowledge of Arabic highly desirable. Previous overseas working experience of at least two years. Ability to adapt to basic rural living and working conditions in a developing nation for extended periods of time.