# WORKSHOP ON WASTEWATER TREATMENT FOR SMALL COMMUNITIES IN THE MIDDLE EAST

WASH Field Report No. 435
December 1993

# WATER AND SANITATION for HEALTH PROJECT

Sponsored by the U.S. Agency for International Development
Operated by CDM and Associates

WASH Field Report No. 435

# WORKSHOP ON WASTEWATER TREATMENT FOR SMALL COMMUNITIES IN THE MIDDLE EAST

Prepared for the Near East Bureau
of the U.S. Agency for International Development
under WASH Task No. 458

by

Robert A. Gearheart
Brad A. Finney
Lee Jennings
Mac McKee
and
Philip Roark

December 1993

Water and Sanitation for Health Project
Contract No. 5973-Z-00-8081-00, Project No. 936-5973
is sponsored by the Bureau for Global Programs, Field Support, and Research
Office of Health, Population, and Nutrition
U.S. Agency for International Development
Washington, DC 20523

# RELATED WASH REPORTS

*Guidelines for Improving Wastewater and Solid Waste Management.* WASH Technical Report No. 88. August 1993. Prepared by Richard N. Andrews, William B. Lord, Laurence J. O'Toole, and L. Fernando Requena, with assistance from E. Brantly, P. Roark, and F. Rosensweig.

*Guidelines for Water Reuse.* WASH Technical Report No. 81. September 1992. Prepared by James Crook, David K. Ammerman, and Daniel Okun.

*Central American Regional Workshop on Wastewater Management: San Salvador, El Salvador, July 12-16, 1993.* WASH Field Report No. 419. August 1993. Prepared by Armando F. Balloffet and Alan Hurwitz.

*Andean Regional Workshop on Alte: .ve Approaches to Wastewater: Santiago, Chile; September 28-October 2, 1992.* WASH Field Report No. 394. March 1993. Prepared by J. Ellis Turner and Alan Hurwitz.

# CONTENTS

# ABOUT THE AUTHORS

Robert A. Gearheart is a Professor of Environmental Engineering at Humboldt State University, Arcata, California, where he teaches courses in Waste Supply/Wastewater Treatment and International Development. He has worked for WASH for 10 years in the areas of technical evaluation, sanitation and hygiene education, project design, and planning.

Brad A. Finney is a Professor in the Department of Environmental Resources Engineering at Humboldt State University in Arcata, California, specializing in water resources, hydrology, environmental engineering, and water quality. He holds M.S. and Ph.D. degrees in Civil/Environmental Engineering from Utah State University. He has completed numerous research and consulting assignments, including work in the United States, Jordan, Chile, Indonesia, and Taiwan.

Lee Jennings is a Senior Trainer with Training Resources Group and has completed more than 30 missions for the ISPAN and WASH Projects since 1983. His development work began in Tunisia as a Peace Corps Volunteer in 1962-64. Subsequently, he has worked in more than 40 countries in Africa, the Americas, Asia, and the Caribbean. Mr. Jennings is an experienced and accomplished training specialist, skilled at designing and delivering training of trainers workshops and management training programs, conducting team planning and project start-up workshops, developing curricula, and providing technical assistance to organizations, training units, and teams as they analyze their improvement needs and develop programs in response.

Mac McKee is a Professor in the Department of Environmental Resources Engineering at Humboldt State University in Arcata, California, specializing in computer simulation of hydraulic, hydrologic, and economic systems. He has been principal and co-principal investigator for approximately 20 university research projects, and has significant domestic and international consulting experience. He holds M.S. and Ph.D. degrees from Utah State University.

Philip Roark is WASH Associate Director for Environmental Sciences and Management. In that capacity he has led many interdisciplinary teams on assignments primarily related to evaluations of water and sanitation projects. He has 25 years experience in international development and natural resource management with many years residing overseas as a project manager or staff hydrologist in Africa, the Middle East, and the Caribbean. Mr. Roark has an M.S. in hydrology and watershed sciences and is fluent in French.

# ACRONYMS

| | |
|---|---|
| A.I.D. | U.S. Agency for International Development |
| CDM | Camp Dresser and McKee |
| EMWD | Eastern Municipal Water District |
| EPA | U.S. Environmental Protection Agency |
| HSU | Humboldt State University |
| IRWD | Irvine Ranch Water District |
| O&M | operations and maintenance |
| USDA | U.S. Department of Agriculture |
| WASH | Water and Sanitation for Health Project |
| WAWTTAR | Water and Wastewater Treatment Technologies Appropriate for Reuse |

# EXECUTIVE SUMMARY

The purpose of this workshop, held July 21 through August 4, 1993, was to provide a forum for the presentation and discussion of appropriate technologies and approaches for water/wastewater treatment and wastewater reuse/reclamation for arid and semi-arid regions of the world. Low-cost technologies appropriate for smaller communities in the Middle East received heavy emphasis throughout the proceedings.

Participating in the workshop were 16 senior-level technicians from areas participating in the Middle East Peace Talks; all had significant experience in wastewater management as engineers, scientists, and/or government officials. The workshop, which began in eastern Maryland, moved to southern California for its final 11 days. The U.S. Environmental Protection Agency (EPA) had prime responsibility for the Maryland portion of the workshop, and WASH/A.I.D. was responsible for the California portion.

During the first segment of the workshop, participants visited several wastewater collection and treatment facilities. Leaving eastern Maryland the morning of July 25th, they arrived that evening in California. There they began the second leg of the workshop. The workshop site, the Hyatt Newporter Resort in Newport Beach, was located near several examples of wastewater treatment and reuse facilities that served as field visit sites.

Designed to be participatory in nature, the workshop featured an extensive exchange of experience between delegates in an open, interactive setting. These interchanges enriched the workshop mix of technical presentations, field trips, computer simulations, practical design sessions, and information sharing. Participants made five field trips to innovative water and wastewater treatment facilities in southern California, visiting Irvine Ranch Water District, Orange County Wastewater District, Water Factory 21, U.S. Department of Agriculture (USDA) Salinity Laboratory, Eastern Municipal Water District, and Disneyland. Each site demonstrated one or more technologies and institutional arrangements for wastewater treatment and reuse.

Among the experienced and renowned wastewater experts involved in the workshop were Daniel Okun of the University of North Carolina, James Crook of Camp Dresser and McKee (CDM), and Jim Kriessel of EPA. Technical experts from the Bureau of Reclamation, Soil Conservation Service, U.S. Fish and Wildlife Service, and Arizona Department of Environmental Quality presented appropriate technologies for wastewater treatment and reuse. In addition, each participant received a copy of the computer software package specially designed for this workshop by Humboldt State University staff.

Co-sponsoring the workshop were several U.S. government agencies and two state agencies:

- Department of State
- Agency for International Development

- Environmental Protection Agency
- National Oceanic and Atmospheric Administration
- Department of Agriculture/Soil Conservation Service
- Department of the Interior/Bureau of Reclamation
- California Water Resources Control Board
- Fish and Wildlife Service
- Arizona Department of Environmental Quality

The participants enthusiastically joined group discussions concerning the wide range of factors affecting technology selection. All of them shared some of their own experiences and suggested technical and institutional approaches for dealing with this critical environmental problem.

By the end of the workshop all participants could use the computer model to select appropriate wastewater reuse technologies. Everyone took home a copy of the program, a user's manual, and a compendium of technical data on water and wastewater treatment processes.

In the formal workshop evaluation, the participants indicated that all objectives had been achieved. They also gave the organizers high marks for the planning, logistics, and implementation of the workshop. The computer decision model was judged to be highly useful for work in Middle East settings. Participants suggested a follow-up newsletter sharing user experience with the model. They also suggested a follow-up workshop in about a year to compare experiences and discuss full implementation of the program.

**Chapter 1**

# INTRODUCTION

## 1.1 Background

For most cities in the Middle East, removing and safely disposing of excreta and wastewater are critical environmental health needs. Improper disposal and inadequate drainage of sewage and wastewater lead to pools of polluted water—often used for drinking—that spread diarrhea, dysentery, and intestinal parasites, and also provide breeding grounds for mosquitoes that carry filariasis, malaria, and other diseases. Another danger in water-short areas is the reuse of wastewater, a practice that threatens both farmer and consumer. Cholera remains a constant hazard in such circumstances.

Pollution control for surface and groundwater sources becomes vitally important wherever clean water is in short supply. One way to extend these supplies is to reuse water wherever possible. However, efficient treatment is needed to return this wastewater to a state acceptable for certain purposes.

In North Africa and the Middle East, most residents of large urban centers have access to adequate sanitation, although the extent varies from country to country. Typically, large cities have several sanitation systems in use, with many residents in the affluent and commercial sections connected to sewers and others to individual septic tanks. In peri-urban zones, however, many residents lack acceptable sanitation facilities of any kind. Within the region, wastewater treatment facilities and approaches generally follow conventional designs, although they vary considerably in extent of treatment.

A breed apart from the capital cities are the hundreds of small urban centers whose residents number fewer than 10,000. Each of these towns has its own set of environmental problems influenced by such factors as population size and density and scale and nature of the production base, and also by climate, topography, water resources, and type and distribution of flora and fauna in and around the town. What appears as a particularly pressing problem in one town may represent a very minor difficulty in others of the same area, while towns of other regions may have an entirely different set of problems.

Smaller towns take a more ad hoc approach to sanitation, one that often results in inadequate coverage and utilization of inappropriate methods. But conventional treatment approaches are costly and difficult to sustain in small towns. Recognizing this problem in the mid 1970's, A.I.D. published *Appropriate Methods of Treating Water and Wastewater in Developing Countries*. This manual considered technical, economic, and institutional issues that affect choosing appropriate methods. However, the advancing state of the art in recent years, coupled with changing economic and social conditions, suggests a need for reevaluation. Also to be considered are the advances in nontechnical approaches that emphasize pollution prevention through economic and policy changes.

A range of potential wastewater treatment methods exist, each with a set of technical, economic, and institutional conditions that must be evaluated. The analysis and decision-making process would be aided by a reiterative approach that compares the various possibilities. Until lately, no computer software for this purpose existed. However, recently developed software can draw upon current technical and economic data to help improve the selection process and expand sanitation coverage to many marginal towns.

## 1.2 Workshop Purpose and Objectives

A forum in which professionals from North Africa, the Middle East, and the United States could review and exchange information on this process was clearly needed. Such an exchange of information would highlight successful approaches that could benefit all concerned. The forum would serve as a first step toward lessening water scarcity and avoiding the massive expenditure for water cleanup programs now facing the United States and other industrialized countries. The purpose of this workshop was to provide such a forum, as part of the Middle East Peace Talks. Here, appropriate technologies and approaches for water/wastewater treatment and wastewater reuse/reclamation for arid and semi-arid regions could be presented and discussed. These were the specific participant objectives:

- Learn to use a computer model—Water and Wastewater Treatment Technologies Appropriate for Reuse (WAWTTAR)—to confidently and quickly evaluate large numbers of water treatment, wastewater treatment, and water reuse approaches.
- Suggest ways the computer model can be improved to best meet regional needs of North Africa and the Middle East.
- Observe water reuse/reclamation alternatives and discuss ways to adapt them to specific country or regional situations.
- Discuss wastewater reuse/reclamation guidelines and standards as well as standards and guidelines for the treatment and reuse of biosolids.
- Observe and discuss potential uses of low-cost land application technologies.
- Identify the role community members should play in the conception, implementation, and management of water treatment, wastewater treatment, and water reuse systems.

## 1.3 Scope of Work

For this workshop, the WASH Project was charged with the following tasks:

1. Develop a computerized reiterative selection methodology for appropriate technologies targeted to small communities in arid/semi-arid regions of the Middle East.

2. Characterize a range of wastewater treatment approaches as to their efficacy in construction, cost, energy consumption, chemical use, operator skills, maintenance, and legal requirements.

3. Develop configurations of wastewater treatment technologies and wastewater reuse/reclamation technologies that in combination can supply water and nutrients to locally grown crops and animals.

4. Prepare a user's manual for participants describing technologies, design criteria, and operation and maintenance requirements, and identifying the role community technicians can play in their implementation.

5. Design and conduct a two-week participatory workshop for 20-30 participants to demonstrate a range of appropriate technologies and enable participants to attempt a hands-on application to their own country conditions.

As subcontractors to the WASH Project, Humboldt State University (HSU) staff developed the computer model, identified the field sites, and selected the guest speakers. These six lecturers provided an overview of low-cost and appropriate technologies for reusing treated effluent in semi-arid areas: Daniel B. Okun, of the University of North Carolina (wastewater reuse and economics/cost recovery of reclamation systems); James Crook, of CDM-WASH (reuse guidelines/standards/implementation/public health issues); Herman Bouwer, of the Soil Conservation Service (soil-aquifer, soil mantle treatment system); Nick Parker, of the National Fish and Wildlife Service (role of treated wastewater in meeting future food, water, and wildlife needs); Ron Frey, of the State of Arizona (biosolids as a resource); and Robert A. Gearheart, of Humboldt State University (wetlands, role of natural systems in water reuse systems).

## Chapter 2

# WORKSHOP PLANNING AND PREPARATION

## 2.1 Planning

This workshop was organized by the Asia and Near East Bureau of the State Department as a part of the Middle East Peace Process. A.I.D.'s Near East Bureau was responsible for the workshop implementation, which was based on needs identified by the Environmental Working Group of the Middle East Peace Process. In December 1992, the Near East Bureau requested that WASH develop a design for this workshop, implement the California segment, and handle logistics and travel. The workshop was to involve participants from North Africa and the Middle East in the selection of appropriate wastewater technologies for water reuse in small to mid-size communities. As part of the contract, a subcontractor (Humboldt State University) would develop a user-friendly computer program that could be used to select alternative wastewater treatment systems based on a specific community's ability to construct, operate, and maintain the system. Although an earlier model had been developed for A.I.D. in 1972, an updated version was needed to account for more recent advances within the sector.

The workshop was to involve field trips, guest presentations, participant presentations, and work sessions with the computer model. Initially scheduled for April 1993, the workshop took place from July 23 to August 4, 1993—a modification that provided a longer period to identify participants via Middle East Peace conferees. In the early planning stages, HSU was asked to coordinate with the Environmental Protection Agency (EPA) on wastewater treatment/reuse technical data. For example, HSU and EPA staff met in mid-June to review the computer model and the technical information in the data base. A.I.D. and the State Department also joined WASH in the planning process.

## 2.2 Roles and Responsibilities

Following is a breakdown of tasks carried out by several workshop co-sponsors.

### *A.I.D.*

A.I.D.'s Bureau for Near East had the primary responsibility for workshop implementation for the State Department. Near East Bureau staff worked directly with both State Department and WASH staff on timing, direction, and logistics. In May 1993, Near East personnel presented the workshop concept, along with an example of the computer model, to the meeting of the Environmental Working Group of the Middle East Peace Talks in Tokyo. At that time, each participating delegation received an official invitation to the workshop. Early in the planning process, A.I.D. conducted meetings at which WASH, EPA, the National Oceanic and Atmospheric Administration, and the U.S. Geological Survey contributed to workshop

planning. At the workshop itself were two A.I.D. staff members, who collaborated on changes and enhancements to the program.

### *EPA*

The EPA had primary responsibility for the workshop's first three days, held on Maryland's Eastern Shore. Agency staff identified field examples of small community collection and treatment systems and presented information on low-cost treatment technology based on U.S. experience. These presentations and site visits were supplemented by a wide range of EPA technical publications, which participants received while in Maryland. After serving as both technical director and logistical and social coordinator in Maryland, a member of the Cincinnati EPA office accompanied participants to California. There he stayed for one day, helping to create a smooth and logical transition to the workshop's California portion.

### *WASH*

Contracted to implement the workshop, the WASH Project coordinated planning, implementation, and participant and workshop logistics. WASH coordinated with the HSU team's work on the workshop design and schedule, the computer program, and technical support documents. As well, WASH supplied computer hardware and software both during the development of the computer model and during the workshop. For the Maryland segment of the workshop, WASH had few responsibilities other than arranging for the keynote speakers, Daniel Okun and Robert Gearheart, and the opening session facilitator, Kathy Alison.

### *NOAA*

NOAA's role was to pass on lessons learned from the Middle East Peace Talks workshop "Oil Spill Detection and Clean-up," held in March 1993 in Santa Barbara, California. The agency was also responsible for designing the workshop logo.

## 2.3 Workshop Design

During both segments, the workshop employed a hands-on, interactive learning process in which participants were encouraged to share experiences and to contribute to the overall learning experience. Activities were more-or-less equally divided among computer model work, field trips, presentations by identified experts and workshop participants, and discussions involving both large and small groups. The following activities shaped the workshop design.

- Participants share their own experiences with wastewater treatment approaches and technologies.

- Participants express their concerns and needs regarding selection of appropriate technologies for water treatment/wastewater treatment/water reuse and reclamation technologies.
- Participants discuss local health guidelines and agricultural use standards for wastewater reuse/reclamation in each country.
- HSU staff and other presenters review the range of technologies available for water treatment and water reuse/reclamation in small communities in arid environments.
- HSU staff demonstrate a regional decision model (developed for the workshop) to select approaches that can meet water-quality goals and reuse/reclamation objectives.
- The full group discusses irrigation requirements for crops in arid regions of the Middle East that can benefit from treated wastewater.
- Randomly selected teams plan and design a wastewater treatment/reuse reclamation scheme typifying Middle East conditions, then report on the design to the entire group.
- Participants describe how they will use their workshop learnings and tools in the coming year to implement wastewater treatment programs in their areas.

## 2.4 Participants

In May 1993, members of the Environmental Working Group of the Middle East Peace Talks received a formal announcement of the workshop. This announcement requested that two technical-level wastewater/water reuse specialists be selected for the workshop from each participating delegation. These representatives were to be drawn from the ranks of—

- Government officials dealing with the identification and treatment of domestic/agricultural water supplies for small to mid-size communities.
- Government officials dealing with the planning, design, and construction of wastewater treatment processes for small to mid-size communities.
- Government officials and scientists dealing with technology transfer relating to water, wastewater, and reclamation alternatives for small to mid-size communities.

## Chapter 3

# WORKSHOP PROCESS

## 3.1 Participants

Included among the 16 workshop participants were wastewater policymakers and technicians from Algeria, Egypt, Israel, Jordan, Morocco, Oman, Tunisia, Yemen, Gaza, and the West Bank. An official observer/participant also came from the Russian Republic, a co-sponsor with the United States of the Middle East Peace Talks. All were highly qualified, participating actively in the workshop and demonstrating a high level of professionalism in their involvement with the workshop material and with fellow participants. (See Appendix A for addresses of all participants and workshop staff and guest speakers.)

## 3.2 Workshop Description

The following sections describe the workshop process, providing each day's agenda and the activities associated with each agenda item. Key aspects of the workshop were the development of specific objectives for each session and frequent reviews of the key "learnings"/points retained by participants from all sessions. Lee Jennings served as workshop facilitator.

Soon after their arrival (July 21) in Washington, D.C., where they were greeted by workshop organizers, the participants traveled to Easton, Maryland. There they were housed in the Tidewater Inn, which would be the headquarters of the East Coast portion of the workshop.

### 3.2.1 Maryland Activities

***Day One—July 22***

The first day began with a formal opening ceremony followed by a "get acquainted" session in which participants introduced themselves and noted their expectations for the workshop. This interchange set the stage for the participatory and informal atmosphere that characterized this workshop.

For the first technical session, Daniel Okun, Jim Kreissel, and Robert Gearheart presented an overview of water resources, waste minimization, water and wastewater technology, and water reclamation. Criteria for selecting appropriate wastewater technology were then developed and put into the context of the workshop objectives. That afternoon participants visited the Easton wastewater treatment facility, and later heard a presentation by Tim Journey on duckweed aquaculture.

***Day Two—July 23***

During the morning session participants traveled to Stevensville to visit the Queen Annes County sludge composting plant. A trip to the EPA office in Annapolis followed, for a presentation on small community wastewater collection systems. That afternoon the group visited the Mayo wastewater facility.

***Day Three—July 24***

Morning activities included a trip to Henlopen State Park in Delaware to tour its wastewater treatment system (rapid infiltration). In the afternoon the group visited the wastewater facility of Lewes, Delaware and the Inland Bays Regional Water Facility.

***Day Four—July 25***

Participants spent their fourth day traveling from Maryland to California via Washington, D.C. Arriving at the Orange County airport, they traveled to the Hyatt Newporter in Newport Beach for the second portion of the workshop.

### 3.2.2 California Activities

***Day Five—July 26***

After being welcomed to the West Coast session, participants met the WASH team and shared their learnings from the East Coast phase, comparing expectations with the proposed agenda and clarifying logistical issues. This introduction served also as a get-acquainted exercise to reinforce the informal working atmosphere that prevailed throughout both segments of the workshop. The first technical session provided an overview of water resources, waste minimization, water and wastewater technology, and water reclamation.

The specific objectives for this session called for the participants to—

- Discuss and develop criteria for selecting appropriate wastewater treatment technologies.
- Discuss the importance of considering water-reuse opportunities when deciding on wastewater treatment technologies.

Following small-group brainstorming and plenary discussion, participants arrived at these criteria: available resources, environmental considerations, planning/management issues, economic/social ramifications, design issues, technological implications, site/regional issues, local conditions/constraints, institutional issues, and plant performance/requirements.

In the afternoon, participants looked at the support documents that serve as the database for the computer model WAWTTAR. This database contains most of the known water, wastewater, reuse, and solids handling processes used to manage water quality. After a clarifying session on the purpose and use of WAWTTAR, participants had their first hands-on

practice with data entry as they completed a hypothetical community database. This community profile data was then used to introduce the participants to the "expert computer model" based upon existing environmental, social, cultural, and economic conditions.

Besides providing an introduction to WAWTTAR and hands-on experience, this session required participants to familiarize themselves with the Tech Sheets and to describe treatment processes and trains and review the database in an interactive way. They were also expected to describe how the program can help them during the prefeasibility phase of planning water, wastewater, and/or water reuse systems.

***Day Six—July 27***

The second day of the California segment began with an overview of wastewater treatment processes, linking the most commonly used processes with the most commonly used wastewater treatment systems. Participants were introduced to the technical database for wastewater treatment processes and systems that would be used throughout the remainder of the workshop. They also got their first look at the upgraded EPA support documents serving as the database for the computer model.

On Tuesday afternoon, participants visited Irvine Ranch Water District (IRWD) and the planned city of Irvine, which reuses highly treated wastewater for home irrigation, crop irrigation, commercial building dual water systems, etc. The IRWD has established an extensive institutional and management system to cost-effectively reuse wastewater for a wide variety of users. Session objectives for that afternoon called for the participants to—

- Cite key aspects of the progress and accomplishments of the IRWD.
- Describe the water reuse and reclamation alternatives seen at the IRWD.
- Identify key institutional aspects required for a total quality management water program.
- Identify and discuss strategies for building public acceptance of wastewater reuse practices.

Following their field visit, participants identified several points that struck them as important.

- Seeing wastewater as another resource.
- Internal institutional self-monitoring of water quality.
- Elected governing body—a local government agency.
- Use of wastewater with ascending price structure helps conserve and make money.
- Learning how to convince people to accept wastewater.
- Using two budgets: operating and capital.
- Recognizing the relation between money raised and the cost of water.
- Learning how cross connections can be avoided by things like color coding all wastewater

pipes and equipment in a purple color.

- Management by local neighborhood associations.
- Discharge standards very severe from the beginning.
- Mix of agricultural and in-city use of treated wastewater.
- Use of both drinking water and treated wastewater in very close proximity.

### *Day Seven—July 28*

On Wednesday participants visited several southern California wastewater reuse and reclamation sites. One of these—the Eastern Municipal Water District (EMWD) in Hemet/San Jacinto, California—is an excellent example of water recycling in an arid environment. This community has found a way to use treated effluent for a wide variety of water, wastewater, and reclamation technologies. Participants viewed groundwater recharge via a low-cost rapid infiltration system that recharges both drinking water and irrigation groundwater sources. (This project receives support from by the U.S. Bureau of Reclamation on the basis of experimentation with low-cost appropriate wastewater treatment technologies.) This site demonstrates the use of constructed free surface wetlands to polish effluent from an activated sludge treatment plant. The site also afforded participants an opportunity to observe saline water conversion and water conservation. The field trip was supported by an orientation session, handouts, and small-group guides for the field exercises. Bureau of Reclamation representatives were on hand to present their agency's experience in wastewater reuse and their policies relating to water reclamation and reuse.

### *Day Eight—July 29*

The first session on Day Eight reviewed the previous day's field trip to Eastern Municipal Water District. Participants cited a number of key points relating to wetlands, water recharge, decentralization, and forward/long-term planning. Many saw potential applications in their home countries for certain measures taken by this particular water district.

- Wetlands can be an approach to consider.
    - Potential disadvantage is water loss
    - Offers opportunity to improve effluent
- There is a need for water recharge in arid urban areas.
- The way the Bureau of Reclamation is working with local districts represents a change of approach by a federal agency.
- Reverse osmosis is very expensive—involving capital and O&M cost and spare parts problems plus the need for energy and qualified technicians for O&M.
- Wetlands need large area.

- Don't reduce dissolved solids.
- Might create good environment for mosquitoes.
- Evaporation rate high.

- Groundwater recharge is good and feasible, but requires a large area.
- Wetlands depend on cheap available land.
- The idea of saline water wetlands is transferable for some situations in the Middle East.
- What are the design criteria for wetlands—i.e. minimum land area for amount of water.
- A main reason for wetlands is to help overcome psychological barriers—also to promote nature conservation.
- Can see use of wetlands along streams before discharge—also might use wetlands adjacent to industrial zones.
- Influent in wetlands is an effluent of a secondary treatment process.
- Importance of forward/long-term planning.

Following the review discussion, Nick Parker of the U.S. Fish and Wildlife Service made a short presentation on the "Global Vision of Reuse." Dr. Parker expanded upon the need to think ahead in terms of both food production to meet world demand and water preservation to maintain a healthy population. The objective for this discussion was that participants be able to explain the need for wastewater recycling as it relates to world food supply, aquaculture, forage crops, and wildlife needs. They were also asked to describe how such recycling would relate to a project for food dehydration and water reuse. For an ensuing discussion of wastewater reuse and reclamation guidelines and standards, led by Jim Crook of CDM, objectives called for participants to explain the background on microbiological aspects of reclaimed water and on World Health Organization and EPA water reuse guidelines, and to demonstrate familiarity with current EPA Wastewater Reuse and Reclamation Guidelines.

Theory yielded to practices as participants learned about the use of computers to select appropriate technologies for their hypothetical examples. (The technical profiles for these communities had already been added to the computer database.) The rest of the day was spent in small groups working on the computers, with each participant selecting several examples of water treatment, wastewater treatment, and water reclamation on the computer. This session was designed to bring participants to a point where they could identify reasons why the inclusion of reuse will yield a different optimal wastewater treatment train, and demonstrate with the model the trade-offs implied by the inclusion of reuse as part of the planning process. By the end of the day, all participants could use the computer model. That evening, several participants presented a brief summary of the wastewater/reuse situation in their respective areas.

The following participants made brief presentations on the status of wastewater treatment and reuse in their areas:

| | | |
|---|---|---|
| Tunisia | - | Akica El Bahri |
| Israel | - | Gideon Oron |
| Jordan | - | Muwaffaq Saqqar |
| Israel | - | Yeshaya Bar-or |
| West Bank | - | Nader Khatib |
| Algeria | - | Slimane Zaouche |
| Yemen | - | Ali Abdulah al-Zubairy |
| Oman | - | Ahmed Al-Sabahi |
| Morocco | - | Lahoussaine Echihabi |
| Tunisia | - | Khalil Attia |
| Russia | - | Yuri Maksimenko |

***Day Nine—July 30***

Friday offered a variety of activities exposing participants to various types of wastewater treatment processes. In the morning Herman Bouwer of the Phoenix office of the U.S. Department of Agriculture described "The Bouwer Process," a process of rapid infiltration/soil mantle treatment for treating wastewater to use in recharging groundwater aquifers. Dr. Bouwer was followed by Robert Gearheart of Humboldt State University, who discussed the use of constructed wetlands for tertiary treatment, as well as for water reuse and reclamation for small communities. From this presentation participants gained a clear view of the wetlands treatment process and of the role wetlands can play in reuse and reclamation. Dr. Gearheart also touched upon the value of wetlands as a habitat for wildlife.

Friday's computer session featured an introduction of biosolids management and disposal processes in computer databases. Participants learned to access these processes in the database, describe their limitations, and use the output. They also spent some time on editing water quality and reuse standards.

That afternoon participants visited the Orange County Sanitation District and Water Factory 21, a total water-reuse demonstration project in which drinking water quality is the final objective. After visiting these two sites, the participants went to Disneyland to see its approach to energy conservation, recycling, and the effective reuse of water.

### *Day Ten—July 31*

The first session of the day focused on the previous afternoon's field trips, helping to clarify questions and identify major learnings from these visits. It was followed by a presentation on the reuse of biosolids by Ron Frey of the State of Arizona's Department of Environmental Quality. Mr. Frey discussed treatment processes, plant nutrient value, water holding value, and standards and guidelines.

Participants spent the remainder of the morning on the computers, using them to select appropriate technologies for their individual country examples. (The community profiles for these communities had already been added to the computer database.) The participants selected several examples of water treatment, wastewater treatment, and water reclamation, and by the end of the day could meet all the objectives of that session:

- Explain how standards are used as constraints in the program.
- Demonstrate how to edit collection systems and standards data.
- Explain opportunities for applying WAWTTAR.
- Identify critical assumptions.
- Describe the program's sensitivity to alternative reuse processes.
- Explain the implications of community support and its impact on reuse alternatives.

### *Day Eleven—August 1*

Day eleven, Sunday, was set aside for fun and relaxation in southern California.

### *Day Twelve—August 2*

In the morning, participants used the computer model to select appropriate water treatment, wastewater treatment, and reclamation systems for the hypothetical examples from their areas. They also used it to do a sensitivity analysis of the effects/impacts of any given technology upon a given environmental/sociocultural setting. The objective of this session was to be able to use the model not only for decision-making but also for framing critical questions concerning technology selection.

During the afternoon the participants visited the USDA's Salinity Laboratory, located on the campus of the University of California in Riverside. This facility offered them an opportunity to see examples of the reuse of high-saline water, low-cost land application technologies, and operation and maintenance considerations for land application processes. Time was made available in the evening to practice using the computer and to test each participant's unique community data against the processes selected to treat wastewater for reuse. Later, during a plenary discussion of key points from the first week in California, participants developed the following list covering such areas as cost, long-range planning, dual distribution systems,

appropriate methodology, system safeguards, and a new vision of wastewater (i.e., as a potentially valuable resource).

- Dual distribution systems of potable water and reused water are feasible.
- $1 billion cost makes it not applicable for most countries.
- Factory 21 is good as a vision for the future—important to think ahead.
- Factory 21 is a good example of learning about new technologies.
- Demonstrations can help change attitudes.
- Many technologies seen are not suited for poor rural areas.
- Use of reverse osmosis can be used for wastewater treatment.
- Need for advanced research to find simpler technologies that can be applied—example of solar energy.
- Reuse of wastewater in urban settings.
- What is expensive today may be less expensive and feasible tomorrow.
- Sludge needs more research for agricultural use.
- Saw conditions similar to own countries—example of use of wetlands to treat wastewater and groundwater recharge.
- 80 percent of wastewater treated by Orange Co. is wasted in the ocean.
- Water transfer, reclamation, and recharge are appropriate non-conventional approaches.
- Comparing the different approaches—example of use of treated wastewater for golf courses in United States and Tunisia.
- Use of wetlands is very interesting—especially research aspect.
- Good example of producing electricity from biogas.
- Examples of seeing treated wastewater as a valuable commodity.
- Encourage use of appropriate local materials and wetlands.

The objectives for the field trip to the USDA Salinity Lab in Riverside were that the participants be able to:

- Describe how high saline water can be reused,
- Explain low-cost land application technologies, and
- List O&M considerations for land application processes.

***Day Thirteen—August 3***

The first session of the day featured a review of the field trip to the salinity lab. Then, participants prepared a set of feasibility plans (computer model output) for a water treatment and wastewater reclamation system for hypothetical case studies. The objectives of this session were to demonstrate participants' proficiency and confidence in using the computer model and also to show them how the model can be adapted to local conditions and how new technologies can be added to the database. This session evolved into an informal evaluation session, since several participants spoke to the group about the value of the workshop to them personally and also to their constituents.

The objectives for the computer case study presentations called for participants to—open files; edit files and add to them; calculate a solution; examine print and interpret output; and perform a sensitivity analysis. These were their hypothetical case studies:

***Case 1:*** a rural community, in an inland semi-arid region, that relied on subsistence agriculture

***Case 2:*** a mid-size coastal community, in a semi-arid area, that relied on fishing

***Case 3:*** a mid-size inland community, in a semi-arid area, that relied on export agricultural crops requiring irrigation

***Case 4:*** a mid-size, but fast-growing, community located between two larger cities on a scenic coast (tourist/environmentally sensitive area)

***Day Fourteen—August 4***

Much of the morning was set aside for presentations: participants from Egypt, Israel, and Gaza spoke on water and wastewater conditions in their countries; Phil Roark of WASH discussed lessons on sustainability issues that WASH had learned during the International Clean Drinking Water and Sanitation Decade; and four participants made brief presentations on the status of wastewater treatment and reuse in their areas. Afterward, participants made suggestions for follow-up activities and completed the final evaluation. The workshop adjourned at noon.

That evening participants attended a closing dinner and received their certificates. Gil Jackson of A.I.D.'s Near East Bureau, Charles Lawson of the Department of State, and Yuri Muksimenko, representing Russia as an observer to the workshop, gave closing comments on the workshop activities and the role the participants had played in making it successful. Participants also commented on the value of the workshop and the friendships they had developed with staff and other participants.

***Day Fifteen—August 5***

Participants returned to their homes.

## Chapter 4

# WORKSHOP EVALUATION AND POTENTIAL FOLLOW-UP

## 4.1 Summary of Results

The workshop was well implemented according to participants, who scored the Maryland and California segments high both in logistical matters and in meeting the stated workshop goals. Most evaluation questions received a rating between four and five on a one-to-five scale, with five being the most satisfactory. The lowest ratings were given to certain guest presentations and one field trip. (A complete summary of the ratings for all items on the Final Evaluation can be found in Appendix B.)

Full implementation of the computer model, combined with the experience of the participants, should result in water and wastewater treatment systems that are both more appropriate and more sustainable. However, the participants believe follow-up activities to be a necessary next step in such implementation.

## 4.2 Summary of Primary Comments

Following are representative comments from participants:

- Follow-up activities are necessary to achieve ultimate goals.
- A central organizing group is needed to continue developing the computer model.
- There was not enough time to practice the computer program. A follow-up program is needed.
- The package is a first step in the right direction, but continuous support from A.I.D. and the Department of State is necessary to upgrade and modify the package so that it remains a highly effective tool.
- A very good training program.
- Several excellent trips, but some fell short of their goals.
    - Some of the plants were too sophisticated and much too expensive to operate in my country.
    - There was not always enough time to see more of the wastewater treatment plant.
- Treatment and reuse of biosolids should have been more developed and presented in the same way as Jim Crook did for wastewater reuse.

## 4.3 Participant Suggestions for Follow-Up

At the end of the workshop, participants made a number of suggestions relating to follow-up activities that would be useful to them upon their return home:

- Training needs assessment; local or regional training workshops—including training of trainers workshops.
- A central focal point (perhaps in the United States) to enable exchange of information from this workshop.
- One institution to be responsible for updating and continuing to develop the computer program.
- A workshop on treatment of industrial wastewater that includes clean, low-cost, and appropriate technology.
- A workshop on solid waste management—including biosolids treatment and reuse.
- Support for upgrading and modifying the computer package. (Participants considered this a very important matter.)
- A focal point in each country to follow up modifications and exchange information in order to provide the technical support needed for the package. The focal point would act as the link between the country and the U.S. institutions.
- Wastewater research (relative to both small and large communities) within the region. Emphasis should be on common regional issues in this field.
- Pilot projects in the Middle East countries within the framework of this workshop. These should be jointly supervised by a local agency and a U.S. entity (university, research institute, EPA, A.I.D., consultant). This would also enhance the application of the computer package, using sound local data.
- A continuation of the workshop framework and expansion to include other related countries.
- A meeting of the workshop group every six months or so. The group should meet in one of the associated countries to receive updates and exchange ideas.
- A constant communication network among all participants.
- An organizing committee (three delegates, at least one from the United States) that would be elected for further treatment of this professional activity.
- Gradual replacement, every five years, of country representatives.

## Chapter 5

# CONCLUSIONS OF WORKSHOP STAFF

## 5.1 General Outcome

The participants were exposed to a wide variety of wastewater treatment technologies and reuse methods in both Maryland and California; in all, there were 10 presentations on low-cost wastewater treatment and reuse technologies considered appropriate for the Middle East and North Africa. Participants also were able to discuss design, construction, and operational issues with staff from wastewater treatment facilities and from several national, state and local organizations. In addition, they had many opportunities while traveling to and from workshop activities to discuss their observations and concerns informally with other participants and workshop staff.

In addition to the U.S.-based presentations, participants had the opportunity to share their own experiences and research in the area of low-cost treatment and reuse methods. These experiences proved extremely beneficial to all workshop staff and participants.

By the end of the workshop, all participants were able to use the computer model despite their widely varying computer skills. Approximately 15 hours was dedicated to using the model to select appropriate treatment trains for wastewater treatment and reuse. Participants learned to enter community data, edit standards, edit treatment processes, build treatment trains, and use the outcome of the computer model to plan a system. An exercise on the next-to-last day allowed participants to go through the entire process on their own, first working in groups and then individually applying the process on computers.

During the workshop, participants developed close personal and professional relationships with each other. Many of these new ties could aid technical progress in solving the region's water and wastewater problems.

## 5.2 Computer Model Outcome

WAWTTAR, the software package/database developed for use in the workshop, provides a framework for an initial feasibility analysis program. Using this tool, engineers, planners, economists, and local decision makers can examine a wide range of water and wastewater treatment processes on the basis of potential to produce an effluent that can be used as a resource. This decision-making framework enables the user to describe the technical, economic, and demographic characteristics of a community, a profile that is then used to determine those treatment processes the community can support.

The database includes design criteria, removal efficiencies, construction costs, operation and maintenance (O&M) costs, land requirements, and so on for over 150 water and wastewater treatment processes. The database also includes water, wastewater, and reuse

standards/guidelines from numerous sources. With this program, the user can construct treatment trains that can then be tested for their ability to meet reuse guidelines and for their appropriateness for a particular community. If the reuse guidelines can be met by certain treatment trains, the program then provides an economic analysis of the feasible solutions. This analysis orders the treatment trains by capital cost, O&M cost, or total cost depending on the user's preference. The program also provides land requirements, upgrade abilities, and adaptability of feasible alternatives. A secondary criteria of effluent values for the feasible solution is also given to allow the user to select those trains that might meet all guidelines but have different effluent biochemical oxygen demand, total suspended solids, nitrogen, phosphorus, and fecal coliform levels.

Infeasible treatment trains are also listed, with reasons given for the determination. These trains could be deemed inappropriate for many reasons; for example, the community might lack the resources to construct and/or to operate and maintain the system. Or, perhaps the trains could not produce an effluent that would meet a quality requirement for disposal or reuse. The program is designed to allow users to test a wide range of conditions and assumptions so that they can better help small to mid-size communities select wastewater reuse options that are economically viable and ecologically sound, and that enhance the communities' health and welfare.

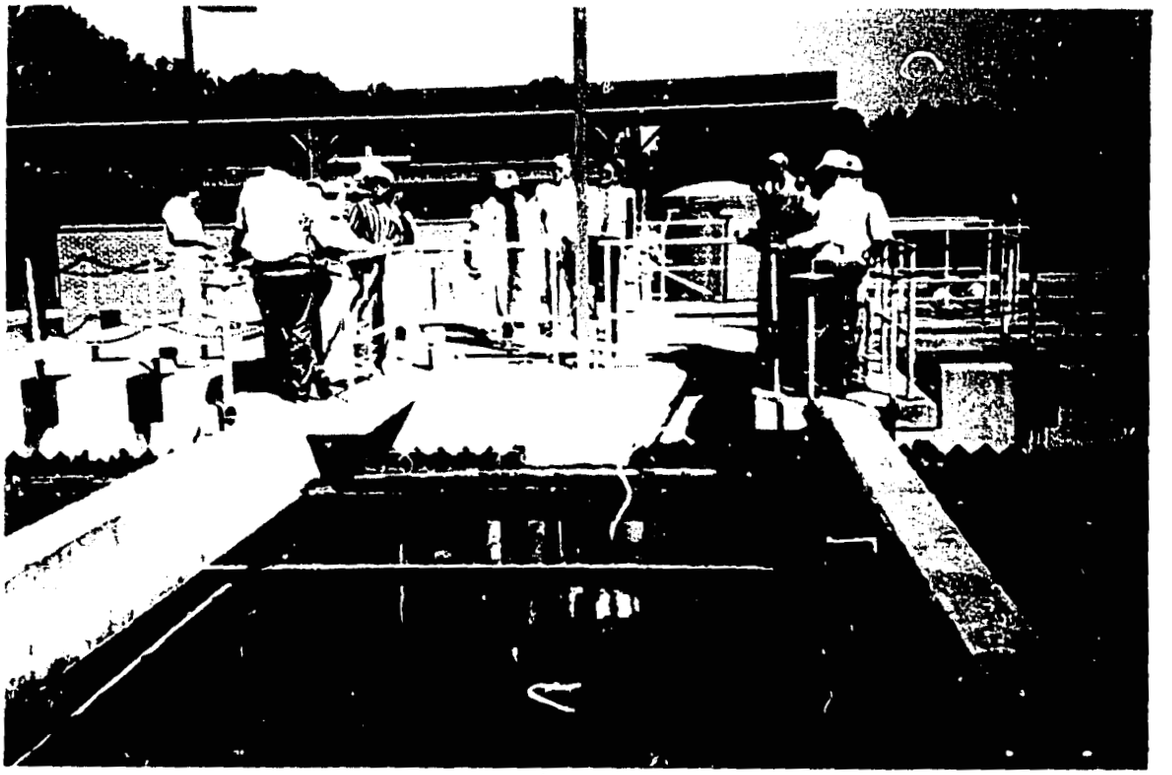
The program allows all databases to be edited: for example, the user can add and delete processes, build trains, describe communities, add new standards and guidelines, revise these, etc. Essentially, users can develop their own unique databases for planning purposes.

WAWTTAR should have its greatest utility during the project prefeasibility phases, when technology selection is a major issue. When combined with user experience and vision, this program can help improve the quality of community life by insuring the implementation of appropriate and sustainable treatment approaches.

## 5.3 Recommendations

- The State Department and A.I.D. should build on the positive outcomes of this workshop by organizing others that enable the original participants to upgrade their applications of the computer program, and that also draw in additional participants as a way to increase the number of Middle Eastern technical experts on wastewater treatment approaches.
- The Humboldt State University staff should keep WASH and the Near East Bureau informed of new developments regarding the computer model, as participants use it and as the university staff adds or refines elements.
- A quarterly newsletter for participants and other interested organizations would be a good way to disseminate model related news and also information on wastewater applications in the Middle East.

No. 1 Participants visited various wastewater treatment facilities while on field trips to the Eastern Shore of Maryland.



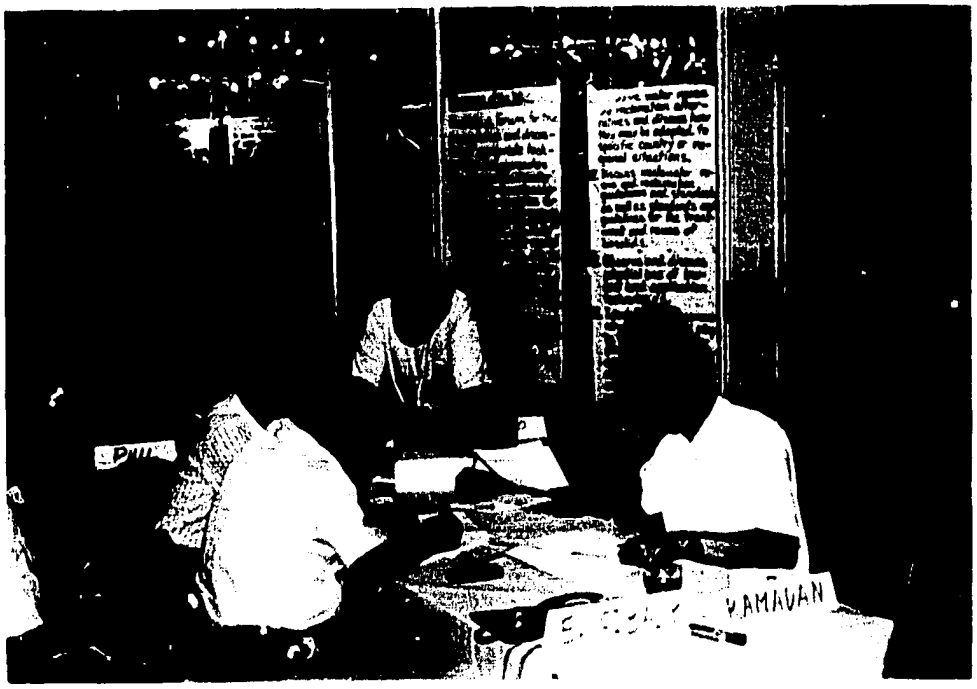
No. 2. Laboratory facilities for monitoring treatment effectiveness were viewed at Easton, Maryland.

No. 3 Workshop participants learned about the use of salt-tolerant plant species while on a field trip to a constructed wetland site at a U.S. Bureau of Reclamation piiot project near San Jacinto, California.

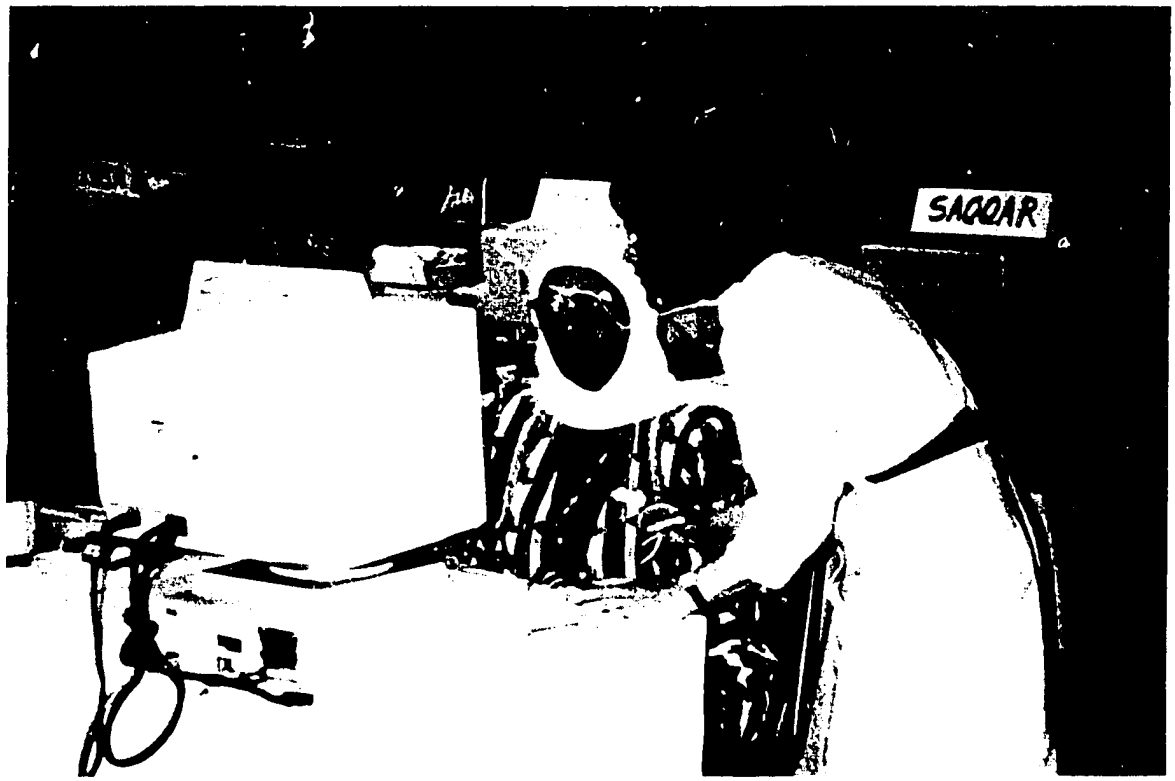
No. 4 During a field trip to the U.S. Bureau of Reclamation facilities at Hemet, California, participants discussed vegetation types used in wetlands wastewater treatment.

No. 5 At Anaheim, California, participants viewed cactus species irrigated with reclaimed wastewater.

No. 6 Small group sessions were held to discuss the applications and limitations of the computer model on selecting appropriate treatment alternatives.



No. 7 One-on-one instruction was provided to give participants a working knowledge of the computer model.




No. 8 Each participant ran tests of case studies to further develop an understanding of the computer model.

No. 9 Certificates were awarded to each participant during workshop closing ceremonies.

No. 10 Participants and staff at workshop site in Newport Beach, California.

**Appendix A**

# PARTICIPANT AND STAFF ADDRESSES

***ALGERIA***

Slimane Zaouche
Sous Directeur
Secretariat D'Etat A La Recherche Scientifique
Direction de L'Environment
6 Placette d'Hydra
16035 Alger, Algerie
Tel: 59-27-73
FAX: 65-33-60 TX: 65303

***EGYPT***

Alla El Gibaly
Director, Design Department
National Potable Water and
Sewage Authority (NOPWASD)
96, Orabi Street
El Mohanseen
Cairo, Egypt
Tel: 344-5486
FAX: 302-3045

El Sayed Fouad Moussa Ramadan
Head Administrator, Planning Sector
Ministry of Public Works and Water Resources
Imbaba
Cairo, Egypt
Tel: 312-9258

***ISRAEL***

Yeshaya Bar-Or
Head, Division of Water Quality
Ministry of the Environment
POB 6234
Jerusalem 91061 Israel
Tel: 972-2-251936
FAX: 972-2-251830

Gideon Oron
The Jacob Blaustein Institute for Desert Research
Industrial Engineering & Management Department
Ben Gurion University of the Negev
Kiryat Sde-Boker, Israel 84993
Tel: 972-57-565070
FAX: 972-57-555058; 972-57-280776
E-Mail: gidi@bgumail.bgu.ac.il

***JORDAN***

Issam M. Miqdadi
Water Authority of Jordan
Ministry of Water and Irrigation
P.O. Box 20692
Amman, Jordan
Tel: (6)695757

Muwaffaq M. Saqqar
Water Authority
Ministry of Water and Irrigation
P.O. Box 540116
Amman, Jordan
Tel: (6)680100
FAX: (6)679143

***MOROCCO***

Lahoussaine Echihabi
Chef du Department de l'Eau
Adjoint du Directeur du
Laboratoire de la Qualite des Eau
Office National de l'Eau Potable
B.P. Rabat - Chellah
Rabat, Maroc
Tel: (7)75-96-00; 242(7)758892
FAX: (7)75-23-77

***OMAN***

Ahmed Mohammed Al-Sabahi
Head of Water Pollution Section
Directorate General for Environmental Affairs
Ministry of Regional Municipalities and Environment
P.O. Box 323, Postal Code 112
Muscat, Sultanate Of Oman

Tel: 696-444
FAX: 602-320

***WEST BANK***

Nadir Khatib
Bethlehem Water Supply and Sewerage Authority
P.O. Box 844
Bethlehem, West Bank
Tel: (02)743-602
FAX: (02)743-606

***GAZA STRIP***

Samir Shaath
Consultant (Hydrogeologist)
c/o Orient House, Jerusalem
OR
P.O. Box 1110, Gaza (Via Israel)
Tel: (07)851-304

***TUNISIA***

Khalil Attia
Chef du Department du Centre
Office National de l'Assainissement
Rue 18 Janvier 1952
4000 Sousse, Tunisie
Tel: (03)28690
FAX: (03)29300

Akica El Bahri
Ingenieur Agronome
Rural Engineering Research Center
CRGR
BP 10 - Arlana 2080
Tunisia
Tel: (1) 717801; (1) 798055
FAX: (1) 789573

***YEMEN***

Mohammed Ali Al-Thamary
Director General of Irrigation and Hydraulic Structures Dept.
Ministry of Agriculture and Water Resources
P.O. Box 11008
Sana'a, Yemen
Tel: 976-1-239-379
FAX: 976-1-230-103

Ali Abdulah Al-Zubairy
Project Director, Water and Sanitation in Provincial Towns
National Water and Sanitation Authority
P.O. Box 10462
Sana'a, Yemen
Tel: 967-1231-264; Home: 967-1-2737760
FAX: 967-1-233-933

***RUSSIA***

Yuri L. Maksimenko
Director of Environmental Legislation and Regulations
Russian Federation Ministry on Environmental
Protection and Natural Resources
Bolshay Gruzinskay str., 4/6
Moscow Russian Federation 123812

---

***A.I.D.***

Gilbert Jackson
Bureau Environmental Coordinator
U.S. Agency for International Development
NE/DR/ENR, SA2
Washington, D.C. 20523-0223 USA
Tel: (202)663-2489
FAX: (202)663-2494

Anne E. Patterson
Environmental Scientist
U.S. Agency for International Development
NE/DR/ENR, SA2
Washington, D.C. 20523-0223 USA
Tel: (202)663-2458
FAX: (202)663-2494

***U.S. DEPARTMENT OF STATE***

Charles A. Lawson
Special Assistant for Science and Technology
Bureau of Near Eastern Affairs
NEA/RA, Room 5252A
U.S. Department of State
Washington, D.C. 20520 USA
Tel: (202)647-1139 (Dir.)
(202)736-7369 (Sec.)
FAX: (202)647-7837

***WASH***

Lee Jennings
Senior Trainer
Training Resources Group
909 N. Washington St.
Alexandria, Virginia 22314 USA
Tel: (703)548-3535
FAX: (703)836-2415

Philip Roark
WASH Project
1611 N. Kent St.
Suite 1001
Arlington, Virginia 22209 USA
Tel: (703)243-8200
FAX: (703)243-9004

John Yanulis
WASH Project
1611 N. Kent St., Suite 1001
Arlington, Virginia 22209 USA
Tel: (703)243-8200
FAX: (703)243-9004

**HUMBOLDT STATE UNIVERSITY**
Robert A. Gearheart
Mac McKee
Brad A. Finney
Barbara Smith
Judy Wartella
Environmental Resources Engineering
House 18
Arcata, California 95521 USA
Tel: (707)826-3619
FAX: (707)826-3616

***SPEAKERS***

Herman Bouwer
Chief Engineer
U.S. Water Conservation Laboratory
4331 East Broadway
Phoenix, Arizona 85040 USA
Tel: (602)379-4356
FAX: (602)379-4355

James Crook
Camp Dresser & McKee Inc.
Ten Cambridge Center
Cambridge, Massachusetts 02142
Tel: 617-252-8497
FAX: 617-621-2565

Ron Frey
Arizona Department of Environmental Quality
Room 201
Phoenix, Arizona 85001
Tel: (602)207-4616
FAX: (602)207-4634

Daniel B. Okun
900 Linden Road
Chapel Hill, North Carolina 27514
Tel: 919-966-4898
Fax: 919-966-7646

Nick Parker
Cooperative Fish & Wildlife Research Unit
Texas Tech University
Lubbock, Texas 79409-225 USA
Tel: (806)742-2851
Home: (806)794-5324

**Appendix B**

# FINAL EVALUATION FORM

Workshop on
Wastewater Treatment Systems for Small
Communities in the Middle East

July 22-24, 1993: Eastern Shore of Maryland
July 25-August 4, 1993: Newport Beach, California

*Thank you for taking the time to complete this questionnaire. Your feedback and suggestions will help us implement similar activities.*

## A. Evaluation of Overall Purpose, Goals, and Segments

Please circle on a scale of 1 (not achieved) to 5 (achieved very well) the number that reflects how well you believe each item was accomplished. [Scores received appear in parentheses in the second line.]

1. Overall purpose was to provide a forum, as part of the Middle East Peace Process, for the presentation and discussion of sustainable approaches for water/wastewater treatment and wastewater reuse/reclamation for arid and semi-arid regions.

   Purpose not met 1 2 3 4 5 Purpose met successfully
   Scores: (2) (5) (9)

   *Average*: 4.4

   Comments:

   - Follow-up activities are necessary to achieve ultimate goals.
   - Reservoir water management was not adequately shown or discussed.
   - It is a good plan. The follow-up is the most important thing.

2. Overall eductional and technical aspects of the East Coast (Maryland) segment of the workshop organized by EPA.

   Not well organized 1 2 3 4 5 Very well organized
   (1) (5)(10)

   *Average*: 4.4

Comments:

- This was the best system I have ever seen.
- The in-class training was not as good as the field trips.

3. Overall educational and technical aspects of the West Coast (California) segment of the workshop organized by WASH.

Not well organized 1 2 3 4 5 Very well organized
(4) (12)

*Average*: 4.7

Comments:

- There was too little opportunity to discuss industrial reuse of treated urban wastewater.
- The salinity lab presentation was not stimulating enough.

4. Overall goals of the California segment

a. Use of computer model (WAWTTAR) to be able to evaluate large numbers of water treatment, wastewater treatment, and water reuse approaches for prefeasibility planning purposes.

Goal not met 1 2 3 4 5 Goal met successfully
(2) (6) (8)

*Average*: 4.37

Comments:

- A central organizing group is needed.
- Not enough time to practice the program. Need follow-up program.
- The package is a first step in the right direction, but continued support from A.I.D. and the Department of State is necessary to upgrade and modify the package so that it becomes a highly effective tool.
- Did not practice on water treatment evaluation.
- Very good training program.

b. Organize field trips to representative facilities to observe water reuse and reclamation alternatives and discuss how these might be adapted to specific area or regional situations.

Goal not met 1 2 3 4 5 Goal met successfully
(1) (2) (9) (4)

*Average*: 4.0

Comments:

- Several excellent trips; some fell short of their goals.
  - Some of the plants were much too sophisticated and expensive to operate.
  - Time was not always sufficient to see more of the wastewater treatment plant.
- Lack of discussion of reservoir management.

c. Discuss wastewater reuse and reclamation guidelines and standards as well as standards and guidelines for the treatment and reuse of biosolids.

Goal not met 1 2 3 4 5 Goal met successfully
(5) (7) (4)

*Average*: 3.4

Comments:

- Time allocated was not enough; only one presentation.
- Treatment and reuse of biosolids should have been more developed and presented in the same way as Jim Crook did for wastewater reuse.

d. Present and discuss low-cost, land-based wastewater treatment and reuse processess.

Goal not met 1 2 3 4 5 Goal met successfully
(3) (5) (8)

*Average*: 4.3

Comments: none

## B. Evaluation of Other Aspects

1. Tidewater Inn in Easton, Maryland, as site for first phase.

Not satisfactory 1 2 3 4 5 Quite satisfactory
(1) (4) (4) (7)

*Average*: 4.0

Comments:

- Poor facility; difficult to get around and deceptive in its lack of water proximity.
- The arrangement for covering all meals was less good than the per diem arrangement done in California.

2. Hyatt Newporter Hotel in Newport Beach, California, as site for second phase.

Not satisfactory 1 2 3 4 5 Quite Satisfactory
(7) (9)

*Average*: 4.5

Comments:

- Good as a resort.
- Closer to Humboldt University would have been much better.
- Excellent setting.

3. a. EPA training team for first phase.

Not effective 1 2 3 4 5 Quite effective
(1) (3) (12)

*Average*: 4.7

Comments:

- Excellent.

b. EPA logistics team for first phase.

Not effective 1 2 3 4 5 Quite effective
(1) (3) (12)

*Average*: 4.7

Comments: none

4. a. WASH training team for second phase.

Not effective 1 2 3 4 5 Quite effective
(5) (11)

*Average*: 4.7

Comments: none

b. WASH logistics team for second phase.

Not effective 1 2 3 4 5 Quite effective
(1) (7) (8)

*Average*: 4.4

Comments:

- Ticketing was very bad. Logistics in California were good.

5. Workshop materials, exercises, field trips, and practice in first phase (East Coast).

Not useful 1 2 3 4 5 Quite useful
(1) (3) (12)

*Average*: 4.6

Comments:

- Poor planning.

6. Workshop materials, exercises, field trips, and practice in second phase (West Coast).

Not useful 1 2 3 4 5 Quite useful
(4)(11)

*Average*: 4.7

Comments:

- Good trips—relevant to the training.
- Some field trips were too long for the specific reason.

7. Any other comments or suggestions.

- Everything was successful.
- A follow-up is clearly needed.
- The workshop overall was excellent—in all aspects. Everyone who participated was about perfect—U.S. and others.
- Keep us updated about any scientific reports published by any organization in this team.
- Provide a small lamp to every participant during slide presentations. Many thanks.
- It may be more useful if it were done in one phase in California, in order to concentrate more on using the model and other features which are similar to cases in the Middle East.
- The workshop was well organized and very useful. Follow-up activities are very important to achieve the ultimate goals.

## Appendix C

# WORKSHOP AGENDA

***Wednesday, July 21***

Arrive Easton, Maryland.

***Thursday, July 22***

9:00 Introduction by U.S. Department of State and Agency for International Development.

9:20 Participant introductions.

10:45 Coffee break.

11:00 Panel presentation by wastewater experts (Daniel Okun, Jim Kreissel, and Robert Gearheart). Introduction of computer software and overview of the California section of the workshop.

12:30 Lunch.

2:00 Overview of small community technologies.

3:15 Tour Easton wastewater treatment facility. [Technology: Overland flow system]

4:45 Return to Tidewater Inn.

5:15 Augmented wetlands: Duckweed aquaculture for saline environments. (Tim Journey)

6:00 Free time.

7:00 Dinner.

***Friday, July 23***

9:30 Tour sludge composting plant; Queen Annes Facility.

10:30 Visit EPA office in Annapolis, Maryland.

12:00 Lunch.

1:30 Tour Mayo wastewater facility. [Technologies: community septage systems, recycling sand filter, emergent wetland system]

4:00 Travel to Mayo System outfall for half-hour visit.

6:30 Dinner in Annapolis.

***Saturday, July 24***

10:30 Tour Henlopen water treatment system. [Technology: rapid infiltration system]

11:30 Travel to Lewes, Delaware.

12:00 Lunch in Lewes.

1:00 Visit Lewes wastewater treatment facilities. [Technologies: total barrier oxidation ditch, fine bubble diffusers, teacup grit separators, sand filtration systems, sludge applications]

3:30 Travel to Long Neck, Delaware.

4:00 Tour Inland Bays regional water facility. [Technologies: slow-rate infiltration system, aerated lagoons, and wastewater irrigation system]

5:00 Return to Easton.

7:30 Dinner.

***Sunday, July 25***

9:30 Depart hotel for Washington.

2:00 Depart for Orange County Airport, California.

5:00 Arrive Newporter Hotel, Newport Beach, California.

***Monday, July 26***

9:00 Introductions and icebreaker.

10:00 Review learnings from Maryland and expectations for California. Clarify objectives and agenda.

10:45 Discussion of working norms and logistic issues.

11:00 Coffee break.

11:15 Criteria for selecting appropriate wastewater treatment technologies.

12:30 Lunch.

2:30 Introduction of computer model WAWTTAR (Water and Wastewater Technologies Appropriate for Reuse).

3:15 Hands-on introduction to hypothetical community profile database.

4:30 Coffee break.

4:45 Hands-on practice with data entry/finalization of hypothetical community database.

5:30 Review day; pass out brochure on Irvine Ranch Water District.

7:00 Reception by AWWA Research Foundation/Newport Beach Harbor.

***Tuesday, July 27***

8:30 Introduction to wastewater treatment technologies: "Choosing the cars to assemble the train."

10:00 Coffee break.

10:30 Introduction to treatment trains: "Building the train to take you to your destination."

12:00 Lunch.

2:30 Depart for Irvine Ranch Water District.

3:15 Introduction to water reuse and reclamation alternatives. (Ron Young, Irvine Ranch District)

4:00 Field visits with staff of Irvine Ranch Water District.

5:30 Review of day at Irvine Ranch Water District.

6:00 Depart IRWD.

***Wednesday, July 28***

8:30 Preparation for field trip to Hemet-San Jacinto, Eastern Municipal Water District, Bureau of Reclamation, Department of Interior. [collection and treatment facilities, saline water conversion, ground water recharge, water conservation, wildlife habitat]

9:00 Leave for Hemet-Jacinto.

11:00 Arrive Hemet-San Jacinto; welcome by Board of EMWD with overview of activities of total water management program. [wetlands, environmental program including wildlife habitat, water conservation program]

Overview of U.S. Bureau of Reclamation efforts in Southern California. [national policy for reclamation, collaborative efforts with EMWD for wetlands research]

12:00 Lunch.

1:00 Field visits with EMWD Staff (agenda to follow).

4:00 Leave EMWD for Newport Beach.

***Thursday, July 29***

8:30 Review Hemet Field Trip

9:30 "Global Vision of Reuse." (Nick Parker, U.S. Fish and Wildlife Service) [wastewater aquaculture, horticulture, and habitat/recreation]

10:15 Coffee break.

10:45 Wastewater Reuse and Reclamation Guidelines and Standards. (Jim Crook, WASH) [public health standards (WHO), plant tolerance guidelines, recreation and wildlife guidelines, industrial guidelines]

12:30 Lunch.

2:30 Introduction of reuse/reclamation processes in the computer database: "Hook the caboose to the train."

5:00 Review and end of day.

***Friday, July 30***

8:30 Rapid Infiltration/Soil Mantle Treatment. (Herman Bouwer, USDA Water Reclamation/Phoenix)

10:00 Coffee break.

10:30 Constructed wetlands for tertiary treatment and water reuse. (Robert Gearheart) [wetland treatment processes and habitat values, wetland application in reuse and reclamation]

11:30 Introduction of biosolids management and disposal processes in computer database. (Brad Finney)

12:30 Lunch.

1:30 Briefing for field trips to Orange County Sanitation District's Water Factory 21.

2:30 Visit Water Factory 21.

4:00 Clarify questions and identify learnings from field visits.

5:00 Departure from Factory 21 for Disneyland.

6:00 Visit Disneyland, with tour of grounds from the Environmental Director.

10:00 Depart for Hyatt Newporter.

***Saturday, July 31***

9:00 Treatment and Reuse of Biosolids. (Ron Frey of the State of Arizona) [treatment processes, plant nutrient value, water holding value, standards and guidelines]

9:45 Coffee break.

10:30 Editing collection systems and standards. (Mac McKee)

12:30 Lunch.

1:30 Presentations by State of California/Metropolitan Water District.

3:00 End of day.

PM Free time.

***Sunday, August 1***

Free day for relaxation. Arrangement made to visit various spots in southern California by the Metropolitan Water District. (Marjorie Shovlin)

***Monday, August 2***

8:30 Review of last week's learnings and plans for upcoming week.

9:00 Return to computer model for sensitivity analysis: "Is the train ready to run?" [identification of critical assumptions, sensitivity to alternative reuse processes, implications for community support levels/impact identification]

10:30 Coffee break.

10:45 Continued computer practice.

12:00 Plenary discussion of work on sensitivity analysis.

1:00 Departure for USDA salinity lab (UC/Riverside).

3:00 Visit at salinity lab. [reuse of high-saline water, low-cost land application technologies, O&M considerations for land application processes]

4:30 Review learnings from visit.

5:00 Leave UC/Riverside for Newport Beach.

PM Free time.

***Tuesday, August 3***

8:30 Design practice.

10:30 Coffee break.

1:00 Lunch.

3:00 Three teams form to share and compare their solutions for each of the three mythical data sets.

4:00 Coffee break.

4:15 Group reports and discussion in plenary.

5:00 Wrap-up day.

***Wednesday, August 4***

8:30 Continue presentations by participants.

9:30 Follow up from WASH "Lessons Learned" as linkage to local community health programs and community participation in sustainable water and sanitation systems. (Phil Roark/WASH)

10:30 Suggestions for follow-up.

11:30 Closing comments by trainers, participants, and sponsoring organizations.

12:00 Final evaluation.

Afternoon free

7:00 Closing dinner and presentation of certificates with U.S. Department of State and A.I.D.

***Thursday, August 5***

Participants depart for airports and return trip home.