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WHO ORDEV UNDP UNICEF

DRINKING WATER SUPPLY AND SANITATION SECTOR SUPPORT PROJECT IN EGYPT

(UNDP : EGY/82/002 WHO : EGY/CWS/001)

LEAKAGE DETECTION AND CONTROL



WORLD HEALTH ORGANIZATION
 Regional Office for the Eastern Mediterranean
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DRINKING WATER SUPPLY AND SANITATION SECTOR SUPPORT PROJECT IN EGYPT

LEAKAGE DETECTION AND CONTROL

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6. Leakage Detection and Control

CONTENTS

	<u>Page</u>
FOREWORD	
PREFACE	
INTRODUCTION	1
SPECIFIC OBJECTIVES	2
PROJECT APPROACH	3
1. Study of Leakage Aspects	4
2. Specifications for Equipment	5
3. Demonstration of Equipment	9
4. Training Activities	10
5. Guidelines for Equipment Operation and Data Interpretation	13
6. Expanded Leakage Control Programme	21
EVALUATION	23
LINKAGES	25
FUTURE ACTIVITIES	26
REFERENCES	27

In the name of God, the Compassionate, the Merciful



FOREWORD

I am pleased to have the opportunity of contributing a foreword to this series of six booklets prepared to describe the work which has been done under the project, "Drinking Water Supply and Sanitation Sector Support", in Egypt.

It is appropriate that, at the end of the project, we should analyze what has been achieved, what have been the successes and shortcomings of the project, and what lessons we can learn for the future development of the water supply and sanitation sector not only in Egypt, but also in other countries of the Eastern Mediterranean Region.

WHO has executed this project, with the financial support of UNDP and UNICEF, to provide technical support to the Organization for Reconstruction and Development of Egyptian villages (ORDEV), in order to extend water supply and sanitation services to rural communities. WHO has been guided by the approaches of the International Water Supply and Sanitation Decade which have called for the complementarity of sanitation development with that of water supply, the involvement of communities in the planning and execution of projects, the utilization of appropriate technologies, and the training of personnel. The project has covered both software and hardware aspects, has used improved, self-sustaining and affordable methodologies, and, with its inter-sectoral approaches, has achieved a marked success in the rural areas of Egypt where it has been possible to implement demonstration activities.

I commend these booklets as illustrative of the success of this innovative project. If they can in some small way arouse interest in the importance, to us all, of the development of a sustainable programme of water supply and sanitation in rural areas, they will have served their purpose.

A handwritten signature in dark ink, appearing to be 'H. Gezairy'. The signature is fluid and cursive, with a large initial 'H' that loops back.

**Hussein A. Gezairy, M.D., F.R.C.S.
Regional Director for the Eastern
Mediterranean**

PREFACE

This booklet is one of a series of six in similar format prepared to demonstrate the objectives, activities and outputs of the project of the Government of the Arab Republic of Egypt, in cooperation with the United Nations Development Programme (UNDP), the United Nations Children's Fund (UNICEF), and the World Health Organization (WHO), for Drinking Water Supply and Sanitation Sector Support project.

The booklets in the series are entitled:

1. Social Aspects and Health Education
2. Sector Information Management
3. Human Resources Development
4. Rural Sanitation Technology
5. Rural Water Supply Technology
6. Leakage Detection and Control

Copies of any of these booklets can be obtained from:

World Health Organization
P.O. Box 1517
Alexandria 21511
Arab Republic of Egypt

INTRODUCTION

The activities of the project, "Drinking Water Supply and Sanitation Sector Support", started formally in January 1987, having been preceded by a preparatory phase (Phase I) from October 1984 to May 1985. The project was formulated within the context of the International Drinking Water Supply and Sanitation Decade (IDWSSD), 1981-1990, with the development objective of assisting the Ministry of Local Government to extend water supply and sanitation coverage to Egyptian villages (numbering about 30000) and to other underserved sections of the population through improved infrastructures, human resources development and transfer of appropriate technology.

It was recognized that activities in the water supply and sanitation sector had been considerably accelerated in the first half of the Decade. The purpose of this project has been to build on this initiative and to support further development through:

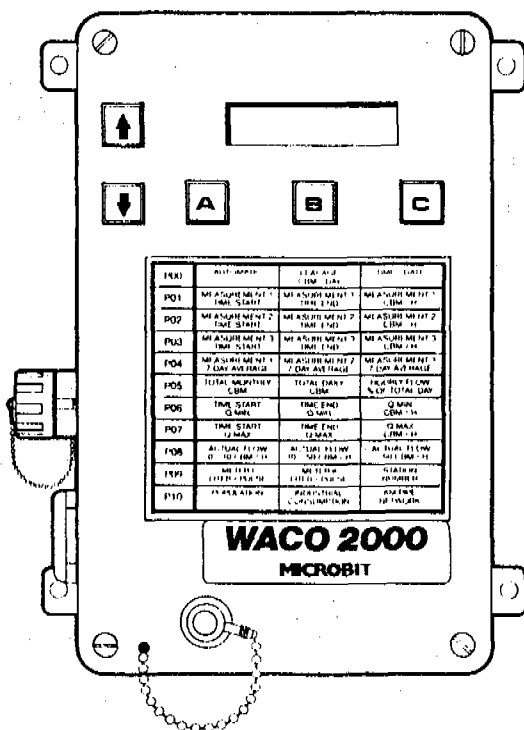
- introduction and demonstration of affordable, appropriate technologies based on technical, economical and social feasibility;
- establishment of human resources department consisting of specialists and trainers for the planning and organization of training of water supply and sanitation personnel;
- upgrading of local capabilities in operation and maintenance, management, water and waste-water analysis, through appropriate training courses;
- assessment of sector information processes, identification of needs, and development of improved management information systems.

It was reported during the preparatory phase of the project that there were substantial losses of water due to leakage at all levels of supplies. These were recognized as a problem relating to the quantity of water which reached the consumer, but it was also observed that leaking pipes, fittings, joints and plumbing fixtures could result in contamination of water, especially if the system pressures were low and the service intermittent, thus constituting a health hazard. Therefore, one of the measures that the project would undertake will be the protection and conservation of water supplies through developing and demonstrating appropriate methods and procedures for leak detection, reduction and control.

SPECIFIC OBJECTIVES

The project's specific objectives in respect of leak detection and control have been to:

- study all aspects of leakage in water supplies in rural Egypt;
- prepare specifications for appropriate equipment to be used for leak detection and control;
- procure such equipment, oversee its installation and demonstrate its operation in selected representative villages;
- prepare and conduct workshops for senior governorate officials and training sessions for engineers from water authorities and sector organizations involved;
- prepare guidelines for equipment operation and data interpretation; and
- prepare an outline of an expanded leakage control programme to be implemented by governorates.



WACO 2000 RECORDER

PROJECT APPROACH

In view of the fact that there was a lack of local, up-to-date expertise in leak detection in Egypt, it was decided to rely extensively on external consultant services, recruited under the project, to work closely with project staff and government counterpart professionals and operational personnel. Accordingly, the following programme of missions and contractual service tasks was undertaken, and the summarized terms of reference are given below.

<u>Assignment</u>	<u>Terms of Reference</u>
Mission 1 July/Aug. 1987	Study of aspects of leakage in rural Egypt, preparation of case-studies.
Contractual Service Oct./Nov. 1987	Specification of equipment for leakage control and reduction, collection of material for training courses.
Mission 2, Part 1 Jan./Feb. 1988	Demonstration of equipment for leakage and consumption control, and pipe/leak detection, preparation of a plan of action.
Contractual Service Feb./Mar. 1988	Preparation of an orientation workshop for senior government officials and a training course for water authority engineers.
Mission 2, Part 2 Mar./May 1988	Conduct of workshop/training sessions, including evaluation, analysis of flow recordings and revision of the plan of action.
Contractual Service May 1989	Reporting on all missions, outlining expanded leakage control programme and preparation of guidelines for equipment operation and maintenance, and data interpretation.

The activities undertaken in line with the consultants' terms of reference, and the findings recorded under this part of the project are given in the following paragraphs.

1. STUDY OF LEAKAGE ASPECTS

The present assessment of leakage and wastage of water in Egypt was imprecise since flow measurement facilities did not exist to measure the quantities of water supplied to the distribution system nor to the consumers.

In the two governorates of Fayoum and Daqahliya, the annual rates of pipe failures (i.e. repair of leaks on the main distribution pipes) appeared to be higher than normal. It was assumed that the observations made in these two governorates were representative of other governorates also.

The custom in Egypt was for leakage to be expressed in terms of percentages of water supplied to the distribution systems related to quantities of water legitimately consumed. This could be misleading since leakage was related to the length of the distribution network and the number of connections, rather than to the amount of water consumed.

Methodologies and procedures which might be acceptable in countries where the situation was different from that cited above would not generally be justified in many piped water supply systems in rural Egypt. This would apply, for example, to traditional leakage surveys of an entire network, which were normally uneconomical, particularly when the network had a high failure rate such as might be the case in many distribution systems in rural Egypt.

On the basis of observations in Fayoum and Daqahliya Governorates, adequate human resources were available who could be trained and used for systematic improvement of distribution networks, once the requirements had been clearly established.

In respect of distribution network rehabilitation measures, Egyptian water authorities would need to readjust policies related to:

- application of low-cost technology in distribution systems;
- pipeline replacement;
- economic assessment of leakage;
- budgetary allocation for network maintenance;
- improvement of networks prior to increasing water production capacity for augmentation of supply;
- collection and processing of data on existing networks, consumption assessment, leakage and wastage identification.

2. SPECIFICATIONS FOR EQUIPMENT

The equipment to be used under the prevailing conditions in rural Egypt would have to meet the following requirements:

- measurement facilities for the continuous monitoring of flows in the distribution systems to determine consumption, leakage, wastage and where applicable illegal consumption, suitable not only for 24-hour analysis but also for intermittent supplies;
- measuring facilities designed to be controlled on site either by professional staff or by operators;
- leak detection equipment to detect leaks in pipes, including those which were non-metallic, in pipes under low pressure, and in those which were embedded under earth roads or in soft soil.

Accordingly specifications were prepared for the following four types of equipment:

- bulk water meters
- flow analysis instrumentation
- pipe and valve locating equipment
- equipment for pinpointing leaks.

Criteria for measuring flow metering devices in flow measuring points were established as follows:

- devices measuring the full flow (Woltmann-type)
- wide range of accurate flow measurement
- particularly good performance in low flow range
- installation in any position
- pulse units with favourable flow volume per pulse
- independence from public electricity supply system
- easy to service (changeable metering devices).

The traditional recording of flows by using chart recorders was not considered suitable in view of their inability to quantify flows accurately enough to observe irregularities in the flow pattern. Therefore, microprocessor techniques were preferred in flow analysis instrumentation, requiring only battery power and with the possibility of data storage and automatic analysis on the measurement site. The

type of data which the equipment should be capable of recording for the different purposes was as follows:

- monthly, weekly, daily and hourly totals of consumption up to the time of instrument reading;
- monthly, weekly, daily and hourly totals for consumption, etc. analysis in fixed periods of time (e.g. 00 hours on the first day of the month to 24 hours on the last day of the month).
- consumption in programmable periods (e.g. in intermittent supplies).
- maximum and minimum values of short duration according to available pulse units/frequencies of the metering device;
- maximum and minimum values to be controlled over the full day or the programmed period (intermittent supply);
- automatic leakage analysis;
- special flow controls for step tests;
- specially programmed flow values as required especially for wastage and illegal consumption assessment;
- remote reading of water meter.

The specifications for the pipe and valve locating equipment are:

(a) Pipes

- sensor plus signal generator for pipe location;
- freely selectable transmission frequency for induced signals for pipe detection;
- induction of signals in addition to direct signal transmission to pipes;
- adjustability of detection facilities to ground conditions;
- elimination of errors (identification of other underground facilities);
- use of intermittent signal system to facilitate location;
- locating capacity up to 6 metres below surface;
- simple handling of equipment preferably by untrained and unskilled staff;
- light in weight.

(b) Valves

- detector rod and detecting field (e.g. ring-system) and earphones;
- generation of an acoustic signal over pipeline accessories such as buried valves;
- elimination of signals from small metallic pieces such as nails etc.;
- signal transmission in such a way as to identify shape of the buried object;
- detection depth, approximately 1 metre;
- light in weight;
- easy to handle by unskilled personnel.

The preferred equipment for pinpointing leaks is based on electro-acoustic sounding with or without contact to the pipeline system. It should have the following characteristics:

- combination of acoustic and optical leak indication;
- capacity to detect leaks in any pipes, including non-metallic pipes such as PVC;
- earth microphones, to be used on top of the ground, without contact to pipes in the ground, including and particularly where soft soils and unpaved roads exist;
- possibility to combine pipe and leak detection equipment;
- easy to handle by the operator;
- light in weight.

In accordance with the above specifications, the following equipment was ordered by the project:

Kent Meters Ltd, England

Helix 3000 Water Meter with pulse unit PU 10 and strainer unit: 2 each of sizes 80 mm, 100 mm and 150 mm.

Microbit GmbH., Germany

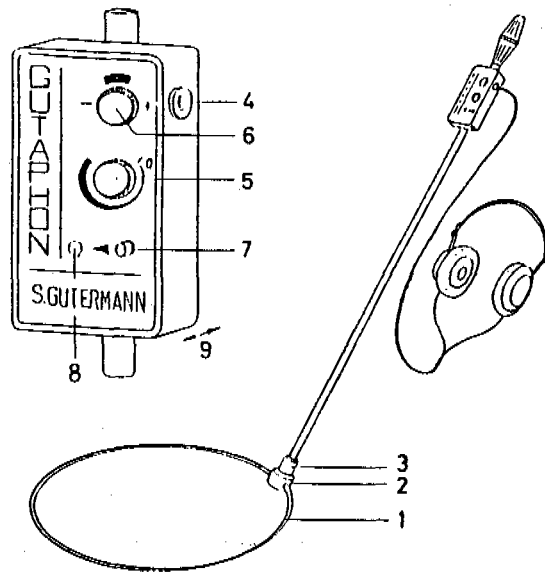
Microprocessor-based flow analysis equipment with display, data processing, data storage, battery operated: 2 each of WACO 200 and WACO 3000 with connection to reed switch, and WACO 3000 as before, but with automatic indicator of leak location and leak characteristics.

Gutermann Messtechnik, Switzerland

Combination of pipe and leak locators, with all accessories and carrying box as well as test microphone for preliminary leak locating, and ground plate for leak locating in soft soils: 2 No. AQUASCOPE + DETECTON.

Valve locator with all accessories such as earphone, search rod, search coil and carrying box: 2 No. GUTAPHON.

G U T A P H O N



LEAKAGE DETECTION PRACTICE

3. DEMONSTRATION OF EQUIPMENT

Flow measuring equipment was installed in the following locations:

Naser Hospital	Cairo
Saft el Laban Village	Giza Governorate
Mit Mazah Village (1)	Daqahliya Governorate
Mit Mazah Village (2)	Daqahliya Governorate
Demo Line	Fayoum Governorate
El Nazla Village	Fayoum Governorate.

The detection equipment was demonstrated at several locations but systematical surveys had not been performed since it was not possible, until metering of flows into supply districts and the study of flow characteristics had been completed, to proceed with assessment of network pressure regimes, identification of areas with high leakage, location of pipes and leaks, or training of staff in the application of the techniques.

Deficiencies in network installations were identified. Many distribution systems require improvement in the provision of valves, hydrants, and pipeline "as-built" drawings for pipe sections with a high failure rate. Further, many valves were buried in the ground and would need to be excavated before they could be operated.

4. TRAINING ACTIVITIES

Training sessions were held for engineers from Giza, Daqahliya and Fayoum Governorates as follows:

8 Feb. 1988	WHO Project Office, Cairo	Giza Governorate
14 Feb. 1988	ORDEV Office, Mansoura	Daqahliya Governorate
15 Feb. 1988	Fayoum Water Authority	Fayoum Governorate.

An orientation workshop for senior government officials and a training course for engineers were held at the Sakkara Training Centre, Giza, from 12 to 14 April 1988. These activities are described in the following paragraphs.

Training for Giza Engineers

A preliminary discussion on 3 February in Giza Governorate had made preparations for this session which was attended by eight participants. The subjects were:

- what is leakage and what causes it;
- how to find leakage;
- how to find illegal consumption (WACO 3000 programme);
- discussion on specific aspects related to leakage assessment and reduction in the Markaz of Giza;
- selection of subjects for the next discussion session.

There was keen interest in the training session and a healthy exchange of experience related to causes of leakage, particulars of the distribution systems of the markaz, and special interests of the participants. Leakage control and detection equipment was briefly introduced and a field demonstration, covering detection of cables, pipes and buried valves, was arranged on the following day.

Training for Daqahliya Engineers

There were 26 participants at this session, the subjects treated being the same as those in the previous one. As before, great interest was shown in the different aspects of flow analysis for consumption and of leakage control. Information on the frequency of leakage occurrence, magnitude from different types of leaks and the effect of soil types on leakage, was well received. The participants appeared to have little experience in bulk metering, selection of water meter sizes and suitable

locations for bulk meters, and accordingly were not forthcoming in proposing sites for permanent leakage control measurements. It was therefore apparent that one or two flow measuring points in each governorate might not be sufficient to enable flow characteristics and variations to be studied. In view of the small room provided for the session, the demonstration of leakage control and detection equipment was somewhat limited.

Training for Fayoum Engineers

The subjects of this training session, attended by ten participants, were the same as in the earlier ones. In addition to the valve-, cable-, pipe- and leak-detection equipment, a complete set of flow measuring equipment (water meter, pulse unit, microprocessor for flow analysis, and data printer) was explained and its functioning demonstrated. It was an advantage that the number of participants was smaller than at Daqahliya, and the participants played an enthusiastic and active part in the discussions. The proximity of the waterworks facilitated equipment demonstration (e.g. pipe detection). It was claimed that more than two demonstration points were needed in such a large governorate. Several sites were proposed, in particular one on the Demo Branch line, a 175 mm AC pipe with connection to 25,000 to 30,000 people, where considerable pressure loss had been observed a short distance after the feeding point. A 150 mm water meter with pulse unit and strainer was provided to the Fayoum Water Authority which undertook to instal it and provide a steel meter chamber.

Orientation Workshop and Training Course

These activities were held simultaneously in the Sakkara Training Centre at Giza. The Orientation Workshop was attended by 27 senior officials of governorate from Giza, Minya, Fayoum and Daqahliya, and the the Training Course on Leakage Reduction by 22 engineers from water authorities in the Giza, Fayoum and Daqahliya Governorates. The major objectives were to:

- provide orientation to the senior governorate officials, engineers of the water authorities and ORDEV staff on the ORDEV/UNDP/WHO/UNICEF project and its activities related to leak reduction;

- ascertain from the participants as to how leakage reduction activities can be implemented, taking into account the water supply conditions in rural Egypt, the technical aspects and the administrative procedures; and
- review a draft Plan of Action for a Leakage Reduction Programme in Rural Egypt.

In introductory lectures, representatives from ORDEV, NOPWASD, the Ministry of Health, UNICEF and USAID provided information on their roles in the Drinking Water Supply and Sanitation Sector Support Project and on water distribution in rural Egypt. The technical lecturers were the WHO consultant on leakage reduction and the two national project engineers. There was general agreement that there had been insufficient time to cover all aspects of the subject in the required depth, but that, nevertheless, the programme had been very successful. The principal conclusions to be derived from the workshop and the training course are summarized below.

Both groups showed keen interest in the fundamentals and in further orientation on leakage, common mistakes made in efforts to reduce leakage, and basic changes in approach needed for a successful programme to reduce leakage, wastage and illegal water consumption in rural Egypt;

There was unanimous concern regarding an urgent action programme to assess the distribution network performance and leakage problem in all governorates of Egypt.

Demonstration and training on a large scale of the equipment, methods and procedures to reduce leakage, wastage and illegal consumption was strongly recommended;

The plan of action needed revision in the light of the discussions held, and possibly a further course should be held prior to its finalization.

The ORDEV Training Centre at Sakkara had been a very suitable location for conducting the workshop and training course simultaneously.

5. GUIDELINES FOR EQUIPMENT OPERATION AND DATA INTERPRETATION

The equipment provided (see 2 (g) above) was accompanied by a "Trainers Manual" which includes detailed operating instructions covering the WACO, Detection, Gutaphon and Aquascope equipment. Abbreviated instructions for the use of the detection equipment were prepared in Arabic.

Specific observations related to the use of the equipment in rural Egypt are divided into the following sections:

- Leakage and Consumption Control Equipment

- flow measurement, meter pits
- flow measurement, water meters
- flow measurement equipment WACO200/3000
- pressure measurements
- network valves
- maintenance of equipment.

- Detection Equipment

- Collection and Interpretation of Data

- options
- demonstration of data collection
- data interpretation.

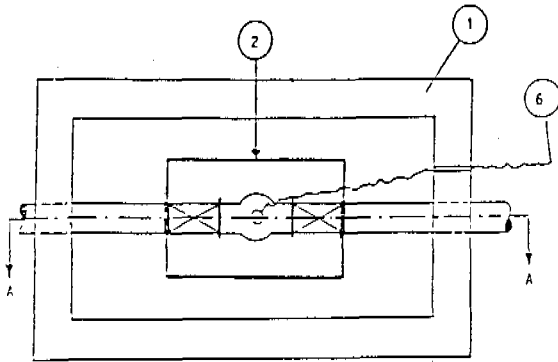
Meter Pits. Due to the high groundwater levels in several parts of rural Egypt, underground structures can either be wet or partially flooded depending on the season of the year. When working under flooded conditions, the devices can have a shortened lifetime. To achieve meter pit conditions which will ensure reliability, the options are:

- tight steel manholes with corrosion-free coating and special covers and anchors;
- watertight concrete or brickwork manholes;
- water meter protection box in already existing pits (see drawing).

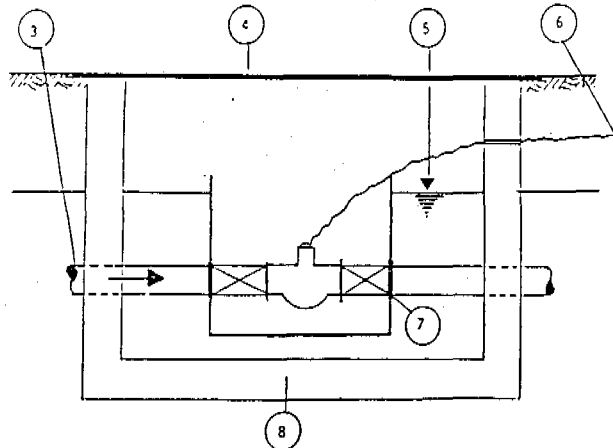
LEGEND :

- 1 Brickwork or concrete meter pit as in MIT MEZAH.
Base plate preferable, but not absolutely necessary. Structure should be in side walk to avoid traffic load on cover plate.
Alternative steel structure see case study 20, page 11
- 2 Water meter protection box of steel, sandblasted before coating with bitumen (applied on metallic, up to 80° C heated steel surface)
- 3 Incoming pipe from strainer box
- 4 Steel cover plate, alternatively concrete slab with with large opening and steel cover
- 5 Maximum groundwater level in the meter pit.
- 6 Cable to instrument box, see ANNEX 3.5.
- 7 Water meter protection box to be fixed between flanges of the water pipe and flange of the valve
- 8 Bottom of meter pit, see note 1

WATER METER METER PROTECTION BOX



SECTION A - A



WATER METER PROTECTION BOX

Water Meters. Water meters have to be carefully installed according to the manufacturer's instructions and in particular any damage to the coating of the meters must be avoided so that external corrosion cannot start. With regard to blockage of strainers and internal corrosion, it may be necessary to clean strainers and the inside of meter bodies more frequently until improved quality standards are met.

WACO 200/3000 Equipment. Initial tests with the WACO micro-processor instruments showed some inconsistencies in data print outs (Mit Mazah) and corrosion due to high humidity (Demo station). It is recommended to instal the equipment above surface in a box adjacent to the meter pit or in a small separate box next to the pit (see illustration). Various improvements in respect of recording, print out and transmission of data have been made.

Pressure Measurements. Because of suspected pressure limitations in many zones of distribution networks in rural Egypt, more attention must be paid to the permanent control of pressure variations. The objectives are:

- to identify and control network points with the worst pressure conditions;
- to identify network disturbances (leaks, blockages, air pockets, closed valves, etc.);
- to identify blockages at flow measuring points to determine the timing of cleaning cycles;
- to determine the timing of specific pressure surveys for assessing the hydraulic network properties.

Since the cost of pressure controls is lower than that of flow measuring stations (meter pits, water meters, strainers), the introduction of pressure control points should be given priority.

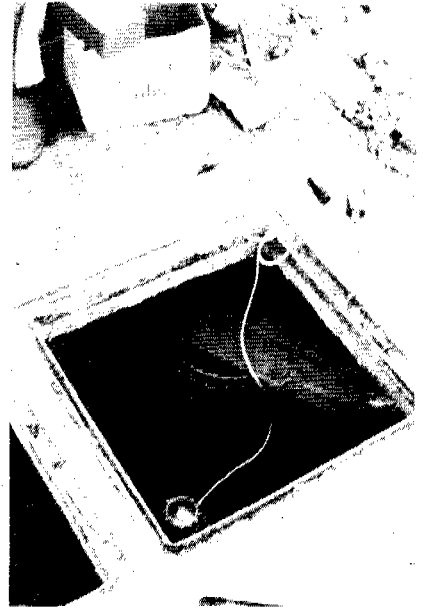
Network Valves. In order to be able to identify network areas or pipe sections with disturbances or leakage, it is imperative to have a system of properly functioning, correctly located valves.

Maintenance of Equipment. Attention must be paid to the following maintenance requirements:

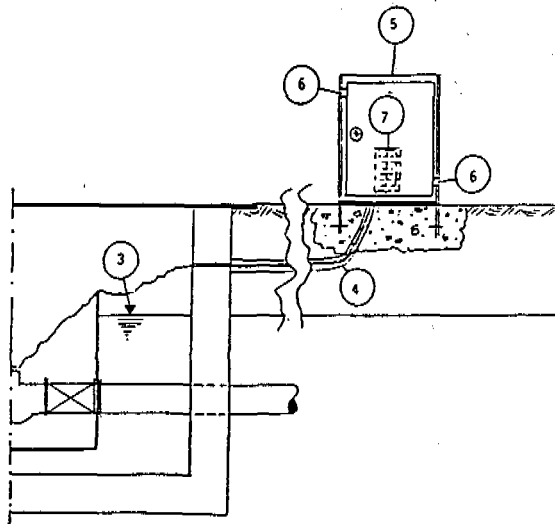
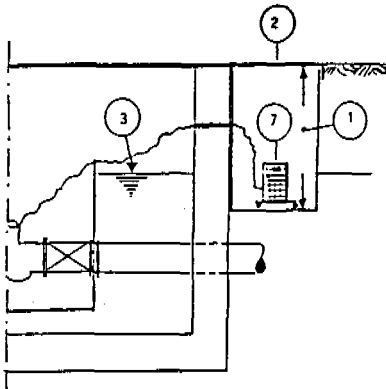
- cleaning of strainers and blocked water meters;
- replacement of batteries in instruments;
- cleaning and re-coating damaged parts of water meters;

LEGEND :

- 1 Steel box, close or at a certain distance to the water meter pit. WACO instrument should be at least 1 meter below the surface
- 2 Steel cover
- 3 Maximum groundwater level
- 4 Connection cable pulse uni / WACO instrument (7). Cable in protection hose through earth or concrete (foundation of the instrument box)
- 5 Instrument box, made of steel, painted with bright colour. The instrument box must be positioned in the shade. The instrument box could also be fixed on a pole in an elevated position in order to facilitate the readings.
- 6 Openings, fly screen protected in order to allow ventilation
- 7 WACO instrument



BOXES FOR FLOW CONTROL INSTRUMENTS



BOXES FOR FLOW CONTROL INSTRUMENTS

- greasing of dried bolts and nuts after installing flow measuring equipment;
- testing of pulse units;
- occasional tests of water meters in low flow range;
- regular testing of bulk flow meters on test benches;
- comparative tests of WACO 200-S pressure measuring chains in order to perform calibrations over the range of measurement.

Spare parts at the rate of 1 spare unit to 10-15 installed units should be kept for strainers, water meter flow mechanisms, pulse units, pressure transducers, WACO instruments, and battery supply.

Detection Equipment. Efficient usage of the equipment requires patience and the acquisition of experience which has not been possible through mere demonstration. The required corrective measures to systems should be given high priority. In operating detection equipment, the following aspects need to be considered:

- pipes of non-metallic material transduce leakage noise to a limited extent, particularly at low pressure and when in ground water or soft soil, so that more sensitive equipment may be needed in some places;
- in these situations, pressure increasing devices may be used;
- many valves in rural Egypt are buried, involving magnetic detection methods which require additional equipment;
- a detection expert should be employed by the project for three months to ensure that the detection techniques will be practised as required;
- the detection equipment should preferably be practically maintenance free, apart from the regular changing of batteries to ensure instrument efficiency.

Data Collection Options. Using the WACO 200, 3000 and 200-S measuring instruments, the following options for the collection of data recorded are available:

- obtaining of data through the display of the WACO instrument and entering into forms;
- print out on site by mobile printer;
- retrieval through data transfer unit and subsequent loading on to a computer;
- direct retrieval from WACO instruments by a computer.

Demonstration of Data Collection. For demonstration purposes, data were collected through WACO flow measuring instruments from February to December 1988, using mainly the second and fourth of the above options. Relevant forms were drafted for use by operators on the site of the measurement. The major objectives were to:

- demonstrate how a very limited amount of essential data should be collected by operators responsible for a measuring station;
- demonstrate steps to be taken by operators when recordings or indicators exceed prescribed limits (e.g. notify supervisor);
- demonstrate handling of a large volume of data with a view to analyse consumption characteristics and variations, and gradually to establish planning and design criteria for the future.

Data Interpretation. The following general comments were made in interpreting the consumption recordings in 1988 taken as part of the demonstration programme.

Efforts were made to obtain various basic data about supply areas where flow measurement facilities were installed, as being fundamental for the assessment of consumption fluctuations, leakage, wastage of water, and indications of illegal consumption.

At all measuring stations there were comparatively high flows during night hours.

It is unknown up to what extent a build up in pressure during the night hours allows a supply to network zones which have no supply during the day due to insufficient network pressure.

Unless it is possible to supply, step by step, network section after network section, for several subsequent days continuously with water under adequate pressure conditions, it will not be possible to assess legitimate night consumption, leakage and wastage of water sufficiently accurately.

When applying the provisional population figures for the areas tested, the per capita consumption figures varied but were not exceptionally high, so that possibly levels of network leakage are reasonably low; this conclusion needs to be checked when more reliable data and accurate flow and pressure recordings have been made.

Examples of total daily consumption recordings

STATION (POPUL. +)	No. (2)	PERIOD 1988 (3)	TOTAL DAILY m ³		PER CAPITA/DAY l/c/d	
			MIN. (4)	MAX. (5)	MIN. (6)	MAX. (7)
SAFT-EL-LABAN (40,000)	1	17.03-02.04	1,001	1,902	25.0	47.6
	2	10.04-12.04	1,399	2,316	35.0	57.9
	3	13.04-18.04	496	2,137	12.4	53.4
	4	19.04-24.04	1,223	2,261	30.6	56.5
	5	26.04-07.05	571	3,996	14.3	100.0
	6	16.05-05.06	2,252	3,887	56.3	97.2
	7	17.07-02.08	742	4,180	18.6	104.5
MIT MAZAH I (8,500 incl. MIT MAZAH II)	8	27.04-08.05	842	999	121	147
	9	10.05-06.06	588	1,042	101	153
	10	09.06-06.07	855	1,010	126	149
	11	08.07-19.07	797	1,020	117	150
	12	23.08-21.09	740	1,150	109	169
MIT MAZAH II	13	27.04-09.05	162	263	-	-
	14	26.05-06.06	228	297	-	-
	15	27.11-04.12	234	309	-	-
NAZLA (10,000)	16	12.05-23.05	406	514	40.6	51.4
	17	19.08-28.08	522	568	52.2	56.8
	18	30.08-20.09	439	551	43.9	55.1
	19	10.11-07.12	422	618	42.2	61.8
DEMO-LINE (9,000)	20	04.05-10.05	1,055	1,091	117.2	121.2
	21	12.05-23.05	983	1,077	109.2	119.7
	22	27.11-07.12	899	1,341	99.9	149.0

* Since the total population of Mit Mazah is 8,500⁺ and the consumption through the feeding point Mit Mazah II is about 25% of the consumption through feeding point Mit Mazah I, the per capita consumption in liters per capita per day (l/c/d) has been calculated by multiplying the Mit Mazah I consumption figures by a factor of 1.25 .

+ Unless more reliable population figures, as well as specific consumption figures of large consumers are available, the per capita consumption figures in columns (6) and (7) are questionable.



LEAKAGE DETECTION EQUIPMENT



INSPECTION OF LEAKAGE STATION
MIT MAZAH

6. EXPANDED LEAKAGE CONTROL PROGRAMME

A draft Plan of Action for Leakage Reduction was prepared by the WHO consultant and was presented to the Orientation Workshop and Training Course which were held at the Sakkara Training Centre, Giza, in April 1988. The contents of this Plan of Action are shown below.

DRAFT PLAN OF ACTION FOR LEAKAGE REDUCTION

- 1. Action Requiring Government Sanctioning**
 - 1.1 Preparation of rules and regulations for the assessment and monitoring of leakage, wastage and illegal consumption in piped rural water supplies.**
 - 1.2 Preparation of rules and regulations for the establishment of priorities in distribution network improvements.**
 - 1.3 Establishment of evaluation criteria for methodologies and procedures suggested by different internal and external institutions.**
 - 1.4 Revision and temporary increase of maintenance budgets for improving distribution networks in water supplies of rural Egypt.**

- 2. Action Requiring the Input of Water Authority Management**
 - 2.1 Establishment of a development plan for mobilizing and instructing staff in respect of methods and techniques to better assess network leakage, wastage, illegal consumption.**
 - 2.2 Instructing and advising of staff in the use of leakage pinpointing equipment, improved pipe repairs and laying of replacement pipes or rehabilitation of pipes in the ground as applicable.**
 - 2.3 Determining of financial needs by Water Authorities, ORDEV, NOPWASD, as required for data collection and processing network improvement measures to be submitted to the government for approval and budgeting.**

- 3. Action Requiring the Special Input of Water Authority Operational Staff in Addition to the Action of the Management**
 - 3.1 Improvement of the collection of network data, such as repair records, pipeline location data in connection with repair work.**

- 3.2 Updating of records about network lengths, especially where pipe-laying was performed in the past through village initiative without preparing as-laid drawings.
 - 3.3 Gradual updating of as-laid drawings.
 - 3.4 Identification of suitable points for continuous consumption, leakage, wastage, illegal consumption as well as pressure control measurements, and installation of such points.
 - 3.5 Improvement in consumer metering through identification of faulty consumer meters, replacement of meters and installation of new meters as well as through expanded meter reader responsibilities.
-
4. Possible Areas for WHO Involvement or Continued (Ad Hoc) Assistance to be Provided by WHO in the Leakage Reduction Programme
 - 4.1 Communication of approved methodologies and procedures for leakage control to Water Authorities in governorates.
 - 4.2 Establishment of approval criteria for leakage reduction methodologies and procedures suggested by others.
 - 4.3 Assistance in mobilizing staff for the performance of leakage control and reduction measures.
 - 4.4 Assistance in the collection and processing of network data.
 - 4.5 Assistance in actions related to operational staff performance supported through local consulting engineers or specialized firms in leakage detection.

EVALUATION

The outputs of the section of the project concerned with leakage detection and control have largely been mentioned in the foregoing chapter relating to project approach and activities. They may be summarized here as:

- Preparation of a Technical Assessment Report on the Existing situation, actions taken and recommendations for follow-up action.
- Compilation and distribution of 20 case-studies on a variety of topics related to leakage reduction (see list).
- Procurement of leakage control and detection equipment for installation and demonstration.
- Installation and demonstration of leakage control stations in five village locations in three governorates.
- Installation and demonstration of computerized water flow measurement and recording, and data interpretation.
- Three training sessions for engineers of Giza, Fayoum and Daqahliya Governorates.
- Orientation workshop for senior governorate officials and a training course for engineers.
- Preparation of a Draft Plan of Action for Leakage Reduction to cover Rural Egypt.

The enthusiasm of the engineers from water authorities in governorates who participated in the training activities is evidence of the importance attached to this subject and to their realization that considerable efforts must be made to improve the existing situation as far as unaccounted for water is concerned. The equipment supplied and demonstrated was shown to be appropriate for the needs of rural Egypt, but requires adaptation to suit the local conditions of water quality and pressure fluctuation. Additional funds are required for this purpose and it is apparent that, provided these are made available, the technology which might be utilized has been identified and a core of engineers has been trained in the use of the equipment.

Case Studies Leakage Reduction

No. of Case Study	Main Subjects	No. of Pages
FUNDAMENTAL MISTAKES AND BASIC CHARGES IN THE APPROACH		
1.	Unvisible leakage and network maintenance.	2
2.	Leakage and age of pipes.	2
3.	Low cost technology and network leakage.	2
HEALTH ASPECTS		
4.	Network leakage and health hazards.	1
5.	Network leakage and notifiable diseases.	1
SPECIAL PROBLEMS		
6.	Maintaining of network pressure over 24 hours in networks with many leaks.	3
7.	Ground water rise through network leaks.	1
HOW TO ASSESS AND CONTROL LEAKAGE , WASTAGE AND ILLEGAL CONSUMPTION.		
8.	Network leakage in percentage figures.	2
9.	Actual network losses.	2
10.	Consumption analysis.	2
11.	Network losses, wastage and illegal use.	6
POSSIBLE MAGNITUDE OF LEAKAGE AND BASIC DATA COLLECTION		
12.	Possible network damage and losses.	3
ECONOMIC ASPECTS		
13.	Network leakage and the Egyptian water charges - economic consideration.	3
14.	Economic of permanent consumption and leakage control.	8
15.	Economy of leakage reduction.	1
ESTABLISHMENT OF PRIORITIES		
16.	Package of measures for reducing network leakage.	2
17.	Staff requirements for leakage reduction.	2
DATA COLLECTION		
18.	Computerized management information system - network.	9
GOVERNMENT POLICY		
19.	Government investment and operation/maintenance budgets for distribution network improvements.	2
EQUIPMENT AND TRAINING REQUIREMENTS		
20.	Equipment and training requirements for distribution network improvements.	31

LINKAGES

The WHO consultant's linkages were principally with the ORDEV/UNDP/WHO/UNICEF project and its staff, and through them with the staff of ORDEV at the central level, the water supply authority staff at governorates and markaz, and the administrative staff in governorates, as necessary. Direct contacts with UNDP and UNICEF were limited, but the tacit support of these offices was appreciated. The Ministry of Health displayed an interest in the health-related aspects of leakage reduction and was represented at the orientation workshop for senior governorate officials.

Unfortunately, it had not been possible for the assignment of another WHO consultant on information systems to be timed to coincide with that on leakage detection. There is a clear linkage between the development of the sector information management system and the requirements for improved information on water distribution networks. When this management system is fully operative, the expansion of the leakage reduction programme will have a firm statistical base to rely on.

FUTURE ACTIVITIES

The project has been requested by Government offices to make available additional consultant services to continue the leak detection programme which was initiated. Some adjustments to the flow recorder equipment purchased still need to be carried out and further practical training in the operation of the leak detection equipment is needed. In the Governorate of Fayoum, where some of the demonstration and training activities took place, a sum of money has been set aside for an expanded leak detection programme, but expert assistance in implementing it is required.

It is evident that this subject is a particularly important one in Egypt and that improvements, as recommended by the expert consultant, would make a considerable difference to the quantity and quality of treated water reaching the consumer. In any extension of the project, it is to be hoped that adequate funds will be set aside for more training, purchase of equipment, demonstration projects and programme planning for leakage reduction and control.

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Associated Reports

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Relevant Publications/Documents

5. Leak Detection in Water Supply Systems. Swedish Water and Wastewater Works Association. July 1982.
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