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**Japan International Cooperation Agency  
(JICA)**

**Action Plan on Leakage Reduction  
for  
Baghdad Water Supply System  
(Interim Report Draft)**

**February 2007**

**Nihon Suido Consultants Co., LTD  
Tokyo, JAPAN**

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## 1. General

Since Baghdad water supply system had not received an appropriate repair and replacement for a long time period, water supply conditions in the city became worse in both quantity and quality aspect. To meet the city water demand, Baghdad Water Authority (BWA) must increase water supply amount greatly in two ways. One is to enlarge or expand water supply facilities nearly twice the present capacity. The other is to reduce non-revenue water (NRW), of which ratio is said currently approximately 50%. The feasibility study for Baghdad Water Supply System Improvement prepared by JICA in 2006 (JICA F/S) places the target of non revenue water ratio as 38% in 2014 and 25% in 2027 respectively.

A draft guideline for non-revenue water reduction was also prepared in the course of Third Country Training Program (TCTP) separately. The guideline was titled as "Guidelines for Non-Revenue Water Reduction" which includes not only general description on NRW reduction but also its detailed measures. In the guideline, comprehensive technical measures for NRW reduction are described and introducing NRW in Baghdad water supply system is expected to be reduced by those technical measures.

In addition to the guidelines, an action plan draft was developed with a view to realizing actual action to reduce NRW by BWA counterpart team. This action plan covers their achievements made by February 2007. An amendment will be published during the fiscal year of 2007 and plan for 2007 will be prepared taking into consideration the activities for achievement of this fiscal year.

## 2. Priority Items for Action Plan

Firstly, the items to be selected in the action plan were discussed considering descriptions on action plans for NRW reduction in JICA F/S and UNICEF Report ("Assessment Project of the Water and Sanitation Sector in IRAQ" January 2003 SAFEGE). At the moment, through series of workshops made in the course of TCTP, priority items and activities were defined.

### 2.1 JICA F/S Report

The above mentioned JICA F/S report describes the necessity of preparing an action plan for unaccounted-for water (UFW)/NRW reduction as shown in Table-1. In the table, the following two items/activities for the action plan are considered important.

- Water leakage survey at pilot areas in Baghdad
- Setting up of functional units for leakage reduction

Table-1 Necessity of an Action Plan by JICA F/S report

### 6.2.4 Necessity of an Action Plan

The UNICEF report proposed a UFW reduction action plan for Iraq in January 2003 to reduce the water system losses. The UNICEF report suggested that conducting "the implementation of the pilot area program will be governed by a specific procedure involving the setting up of teams dedicated to UFW reduction."

BWA will select the pilot area and conduct the UFW reduction action plan based on the suggestion of the UNICEF report. However, BWA has no experience or equipment for water leakage surveys. JICA has been performing mass training of BWA staff in a water leakage survey course, GIS course, and operation & management course in Jordan to support the BWA UFW reduction program since the beginning of 2005. The JICA training program will provide the required various leakage detection equipment for BWA after the leakage survey training. Consequently, BWA has an opportunity to conduct the action plan by themselves with the fruits of the JICA training program.

The leakage detection and control work is generally composed of leak detection and repair but also includes responding to illegal connections and meter malfunctions. In addition, proper management of the pipe networks is required. Therefore, BWA needs to set up functional units for the action plan. The concept of the functional units for the action plan in the UNICEF report can be applied to the BWA organization as follows:

- UFW Unit: Monitor UFW and other actions in coordination with
  - Leak Detection Unit (To be set up in the Implementation Section, Water Section of the Municipality)
  - Pipe Repair Unit (Implementation Section, Water Section of the Municipality)
  - Consumer Survey Unit (To be set up in the Computer Billing Section)
- GIS Unit: Produce maps from data furnished by field surveys. Building of hydraulic models and analysis. (Design Section)
- MIS Unit: Collect operational and billing data to be incorporated in the MIS database. (To be set up to cooperate with the Planning and Follow Up Section, Administration and Financial Affairs Section, and Computer Billing Section)

But UFW reduction will not be attained without organically combining each unit and carrying out the work continuously. Therefore, the action plan needs to be executed by the Implementation Section of BWA as coordinator of the program with cooperation of the Water Section of the Municipality, Planning and Follow Up Section, Computer Billing Section, Administration and Financial Affairs Section, Computer Billing Section, and Design Section.

### 2.2 UNICEF Report

UNICEF Report describes in its section 4.4 "UFW Reduction Action Planning" as follows.

- Setting up of pilot areas for UFW reduction in Mayoralty of Baghdad is necessary.
- Setting up of UFW reduction teams is necessary.

Setting up of seven functional units as shown in Figure-1 is suggested in the report together with appropriate relationship among the units.

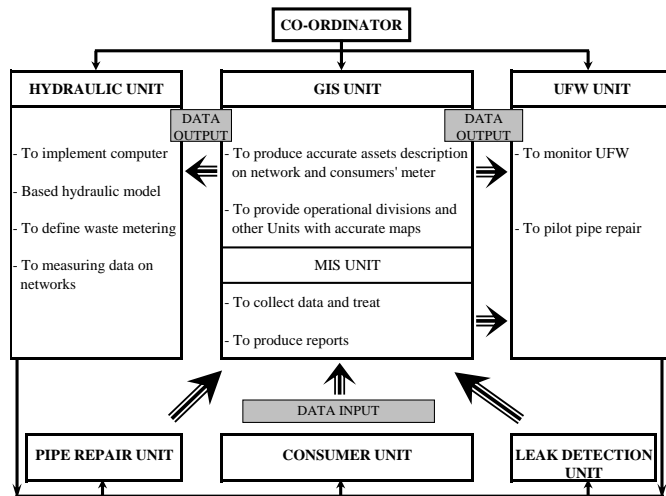


Figure-1 General Organization of Pilot Area Teams

### 2.3 Workshop Results

A project cycle management (PCM) workshop was held in February 2007 between the expert and trainees of Operation & Maintenance (O/M) system and NRW reduction course of TCTP. Problems, causes and countermeasures of water leakage in Baghdad water supply system were identified in the workshop as shown in the Figure-2.

Action plan/Implementation necessary for reduction of water leakage in Baghdad obtained from the workshop are also shown in the figure and they are summarized in the following five categories.

- Quick recovery of peace and order,
- Items under implementation or planning for implementation,
- Items which shall be studied in a master plan of Baghdad water supply system to be implemented in the future,
- Items being implemented in JICA TCTP, and
- Items which shall be implemented in O/M system and NRW reduction course of TCTP.

Basic Problem/Cause	Secondary cause	Particular cause	Countermeasure	Action Plan/Implementation	
Much leakage volume	Large scale pipes damaged	Damage not by usual causes	Recovery of security condition	Quick recovery of peace and order expected	
		Damage by bomb explosion			
	No preventive measures	Little replacement/rehabilitation of distribution main	Storage area dangerous to access	Preparation of pipe replacement/rehabilitation plan	E/S for NRW reduction was made by JICA. Replacement of R2,R3 & R14 pipes are under implementation by USAID & BWA and will be made by JBIC.
		Security problem			
	Insufficient replacement/rehabilitation of house connection	Too many fragile or deteriorated pipes	No proper replacement plan	Preparation of replacement/rehabilitation plan of house connection	Replacement plan of service connections are included in the F/S.
		Insufficient manpower (too much work load)	Insufficient budget		Their replacement is underway by USAID and will be done by JBIC project.
	Insufficient information of the existing main/connection	Too many illegal connections (hard to control)	Little house connection data and drawings	Review of the existing main & connection data and preparation of GIS for water supply use	GIS of a part of the existing pipelines is under preparation in TCTP. Review and survey of the existing mains will be necessary.
		Database not computerized	Some of network installation not recorded		Survey of house connection will be necessary. Adjustment of GIS function from BWA view point may be necessary.
	No measurement of leakage volume	Insufficient communication among related organization	Frequent reshuffle of engineers	Necessary for exchanging information	Preferable to have periodical meeting among related organization
		Lack of metered house connection	DMA not properly formed	Installation necessary meters	Included in JICA F/S and will be implemented by JBIC project in R2,R3 and R14 areas. For other areas, plan shall be made in M.P.
No systematic leak detection	Little information of visible leaks	No organization for measurement	Establishment of leak detection system	Formulation of DMA shall be planned in M.P. Pilot DMA shall be prepared in TCTP. Leak detection system will be planned in TCTP. (See next cell for leak detection system)	
		Leakage phenomena unknown to public	Establishment of public communication system	Public communication system will be studied in TCTP.	
	No underground leakage detection activity	People unknown where to inform leaks found	Establishment of leak detection system	Leak detection system will be planned in TCTP. Leak detection equipments were procured and lent by JICA. Leak detection method has been studied by selected BWA official in TCTP. Transfer of the method shall be made to other BWA staff. Construction of meter chambers enables to survey minimum night flow.	
		No periodical leak detection patrol			
Delay of leak repair work	Insufficient capacity of leak repair party	All leak repair by direct management	Improvement of leak repair system	Leak repair system will be studied in TCTP.	
		Number of repair party insufficient			
	Delay of acquisition of repair pipe materials and equipment	No training of leak repair	Approval for procurement very complex	Improvement of management system	Preparation of funds for repair work including procurement of pipe materials and equipment should be made. Delegation of authority should be made.
Insufficient stock of pipes and repair equipment	No private companies for leak repair	Insufficient budget	Improvement of pipe materials and repair equipment stock system	Stock system will be studied in TCTP.	
		No properly maintained storage of pipes/equipment			
		Lack of manpower for supervision of storage			
		Procure pipes and equipment from local shops			

Figure-2 Problems, Causes and Countermeasures for Water Leakage

Various actions were prepared as listed in the right column. Amongst these items, the colored ones were chosen as priorities taken up by JICA TCTP in 2006 and will be addressed in 2007.

## 2.4 Necessary Items for Action Plan

Considering the results of Sections from 2.1 to 2.3, the following two core items for NRW reduction were selected in this action plan.

- (1) To do a pilot leakage survey in Baghdad.
- (2) To organize appropriate NRW units in BWA.

In order to carry out these two actions, a series of preparatory trainings and workshops were organized during 2005 to 2006. Details of the two items are described in the following sections.

## 3. Pilot Leakage Survey Training

Objective of leakage survey training is to enable BWA officials, especially those who would be a core members of NRW reduction unit in BWA, to perform leakage survey in Baghdad on their own capacities. A systematic training program on site leakage survey has been conducted with the assistance from the team of the JICA Capacity Development Project of Non-Revenue Water Reduction in Jordan (Jordan NRW Project) at the Water Authority Jordan (WAJ). JICA provided necessary leakage survey equipment with BWA to conduct the survey on the ground.

### 3.1 Flow of Leakage Survey Training

Flow for pilot leakage survey in Baghdad is as shown in Figure-3. Training for the pilot survey was started by TCTP in 2005. As shown in the figure, selection of pilot area for leakage survey in Baghdad was made in Stage 6 training course in 2006, which is district 511 in R14 zone. Preparation of the district meter area (DMA) is now underway.

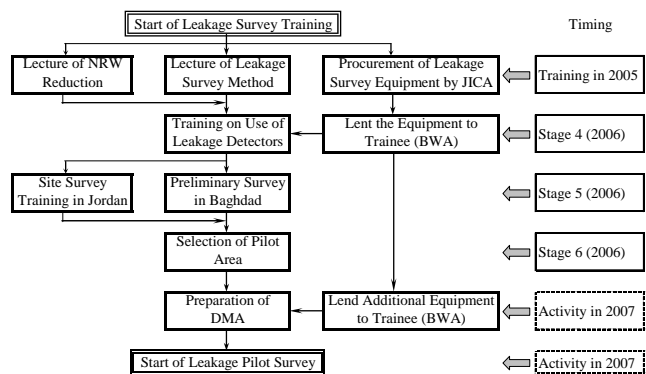


Figure-3 Flow of Leakage Pilot Survey

## 3.2 Lectures on NRW and Leakage Reduction

Lectures on NRW reduction including leakage reduction were made in NRW reduction program of TCTP in 2005. In the program, not only fundamental measures for NRW reduction but also detailed measures were explained and discussed. Lecture materials for NRW reduction are compiled separately in "Guidelines for Non Revenue Water Reduction"

## 3.3 Necessary Equipment for Leakage Survey

JICA procured a minimum set of leakage survey equipment and lent it to BWA. Types and numbers of the equipment are shown in the Table-2. The specifications are attached in Appendix-1.

Table-2 Types and Number of Equipment procured by JICA

Equipment	Number
Potable Ultrasonic Flow meter	1 set
Manometer (Pressure Gauge)	2 Sets
Acoustic Rod	4 Sets
Electronic Leakage Detector	2 Sets
Metal Detector	2 Stes

For effective leakage survey by the NRW trainee team, JICA procured additional equipment and would be transferred to BWA in the near future. Two sets of flow meters and pressure gauges were obtained.

## 3.4 Training in Jordan

In order for the trainees of NRW team to study and understand use of leakage survey equipment, various training programs were performed through the course of TCTP. They are summarized in Table-3.

By the frequent training programs made in Jordan with kind cooperation of PMU of WAJ (Project Management Unit of Water Authority Jordan) and Jordan NRW Project team members, Iraqi NRW trainee team fully understood use of the equipment. Leakage pilot surveys in Baghdad city could be undertaken by themselves.

### 3.4.1 Use of Equipment

Use of leakage detection equipment was instructed in July 2006 just after JICA purchased and lent them to the trainee. As shown in Table-3, the lectures were made by PMU of WAJ and Reetaj company (Supplier of the equipment).

Table-3 Training Program performed in Jordan

Date	Location	Expert	Training Program
July 6, 2006	Amman	PMU of WAJ, Jordan NRW Team	Lecture on "How to use equipment"
July 8-10, 2006	Amman	Reetaj Company	3 days special training for equipment use both in the office and at sites
December 10, 2006	Amman	PMU of WAJ, Jordan NRW Team	General Explanation of Pilot Survey at Wadi Al Hajar pilot site
	Wadi Al Hajar		Installation of flow and pressure meters Measurement of flow and pressure
December 11, 2006	Amman	PMU of WAJ, Jordan NRW Team	Method of data downloading from data logger or recorder
February 6, 2007	Zarqa	PMU of WAJ, Jordan NRW Team	Removal of equipment and data downloading
February 6, 2007	Madaba	PMU of WAJ, Jordan NRW Team	Leakage detection at night
February 8, 2007	Ma'an	PMU of WAJ, Jordan NRW Team	Installation of flow and pressure meters Measurement of flow and pressure

### 3.4.2 Site Survey Training

Site leakage survey trainings were made several times in December 2006 and in February 2007. As shown in right column of the above table, various trainings for handling the equipment including installation, measurement, removal, data downloading, etc. were made at the pilot areas of Jordan NRW project.

### 3.5 Preliminary Survey in Baghdad

Preliminary pilot surveys were made in Baghdad by NRW trainee team twice, the first in December 2006 and the second was in January 2007.

#### 3.5.1 First Preliminary Pilot Survey in Sector 10

First pilot survey in Baghdad was undertaken at Sector 10 of R14 in December 2006. As shown in Appendix-11, the NRW team studied population, water demand, pipe network, etc. Inlet pipeline to the sector was excavated, a sensor of flow meter and a pressure gauge were installed and flow and pressure were measured as shown in the following pictures.

By the first pilot survey, NRW team learned that water table in the city is so high that measures to prevent the equipment from being submerged in the water have to be taken. And they also felt that Sector 10 was not appropriate pilot site considering security and hydraulic isolation of networks from neighboring sectors. They decided to perform second pilot survey at the different location.



Picture-1 Preliminary Survey in Sector 10, Baghdad

#### 3.5.2 Second Preliminary Pilot Survey in District 511

##### 1) Selection of Pilot Site

As to candidate sites for the second pilot survey in Baghdad, District 330 in R1 zone, District 325 in R2 and District 511 in R14 zone (Figure-4) were compared by the NRW trainee team considering criteria as shown in Table-4.

Table-4 Criteria for Pilot Site Selection

Selection of Sector for Second Pilot Study
- Sector having distribution pressure to some extent.
- Sector having 24hr continuous water supply and may be Sector near to the water sources.
- Sector having a little illegal connection by pumps.
- Sector before pipeline replacement.
- Sector having a map of water distribution networks
- Sector having pipe replace plan in the future.
- Sector which needs a few flow meters.
- If possible Sector in R2, R3 or R14 zone.



Figure-4 Alternative locations for Pilot Survey

The NRW team studied characteristics, water supply condition, etc. of the candidate areas as shown in Appendix-11 in its latter half. And finally, among above districts, District 511 was selected for the second pilot area considering security of the area, water supply condition, easiness of work, appropriate pipe network structure, etc.

District 511 has an excellent feature in pipeline network. Distribution pipe networks in the district are hydraulically isolated into three areas, namely Q1, Q2 and Q3+Q4 areas as shown in Figure-5. Sizes of the areas in terms of population or distribution flow are as follows: the smallest is Q1 area, the medium is Q2 area and the largest is Q3+Q4 area.

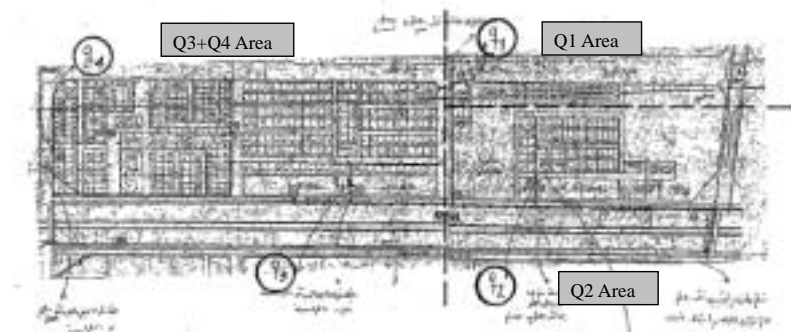


Figure-5 Layout of District 511

## 2) Implementation of Second Pilot Survey

Implementation plan for the second preliminary survey including major features in the district was set and given to the NRW team as shown in Appendix-2. According to the plan, second pilot survey as a preliminary survey was made on January 20<sup>th</sup> 2007. Its outline is described below and details of the survey are shown in Appendix-12.

NRW team first detected a cast iron pipeline with diameter 300mm by the pipe detector, then 150mm asbestos pipes in Q1 area. Measurement of flow and pressure in Q2 area was also made by the team. It was revealed that water supply pressure in District 511 have been low, below 10m in winter which is season of smaller water use.

## 3.6 Implementation of Pilot Survey in District 511

As mentioned above, NRW team has already succeeded in the preliminary leakage survey in Sector 10 and District 511 in Baghdad by themselves, and they will move to a full-dressed pilot survey including measurement of flow and pressure variation over 24hours and minimum night flow.

### 3.6.1 Survey Items and Time Schedule

Items for the pilot survey and those for reporting are as described in Figure-6. Time schedule of the pilot leakage survey are also shown in the figure below taking into account a possible timing of succeeding TCTP in 2007

1) Survey and Report Items									
Survey and Measurement items									
Numbers of connections, Population in each Q area, Flow and pressure variation over 24hours, Minimum night flow									
Items for reporting-1: Q1 and Q2 sites									
Water supply amount per connection and population.									
Difference of per connection/population amount, supply pressure, minimum night flow between Q1 and Q2 sites									
Items for reporting-2: Whole district 511									
Water supply amount per connection and population in Q3+4 sites.									
Difference of per connection/population amount, supply pressure, minimum night flow among Q1, Q2 & Q3+4 sites									
2) Prospective Schedule on Pilot Survey at District 511 in Baghdad and Reporting									
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
Stage-6 Training in Amman	■								
Construction of meter chamber									
2 Nos. (Q1 & Q2 sites)		■							
2 Nos. (Q3 & Q4 sites)			■						
Measurement in Q1& Q2 sites			■		■				Measurement twice (Spring & Summer)
Preparation of survey report-1				■					Report-1 shall be submitted to JICA
Obtaining additional equipment			■						
Measurement in Q3 & Q4 sites					■				
Preparation of survey report-2						■			Report-2 shall be submitted to JICA
Start of next training program							■		
Leak Detection			■			■			Perform in case of security recovered
Division of areas			■			■			Perform in case of security recovered

Figure-6 Items and Time Schedule of Pilot Leakage survey in Baghdad

### 3.6.2 Preparation of DMA

District 511 in R14 zone was selected for location of the pilot survey area considering good feature of the district as mentioned in 3.5.2.

As described above, construction of meter chambers are essential for the pilot survey and BWA has approved for their construction. Four sets of meter chambers are about to be constructed for

preparation of DMA by NRW team. The chambers have two important functions. One is to make possible of continuous measurement of flow and pressure in a pilot area and the other is to make water free in the chamber inside. By construction of the chamber, measurement of flow and pressure can be made continuously or even in the night by automatic equipment installed in the chamber under the present security condition of the city.

For reference purpose, a basic design of meter chambers with important remarks is given in Appendix-3.

### 3.7 Activities after Pilot Survey in District 511

Necessary activities after the pilot survey to be made in District 511 including evaluation of the survey result shall be discussed and identified in the next TCTP in 2007.

### 4. Establishment of NRW Reduction Unit in BWA

The other action to be taken in the action plan is to set up a functional unit for leakage reduction. Since this action plan is yet in interim stage of preparation, we discuss possible organizational arrangement and functions for the time being. The detailed action plan shall be discussed and summarized in the course of the next TCTP.

#### 4.1 Necessary Units for NRW Reduction

UNICEF Report proposes seven functional units for NRW reduction as shown in previous Figure-2.

It is considered however that necessary activities for the time being are such basic ones as,

to find leakages → to inform BWA → to provide equipment and materials → to repair the leakages

and the following four units are selected as a minimum set-up to carry out required actions.

- Leakage detection unit
- Public communication unit on leakage reduction
- Pipe materials and repair equipment store unit, and
- Leakage repair unit.

Necessary units/systems for immediate leakage reduction activities revealed through the PCM workshop were the same as the above four units. Regarding GIS unit, since GIS of Baghdad water supply system is under preparation in other course of TCTP, the unit will be set upon completion of the GIS system.

#### 4.2 Relationship and Function of the Unit

##### 4.2.1 Objectives and Relationship

Objectives and relationship of the above four units are shown in Figure-7. As shown, the four units have close correlation with each other. Not only one or two system but all of four systems shall be studied for a successful leakage reduction.

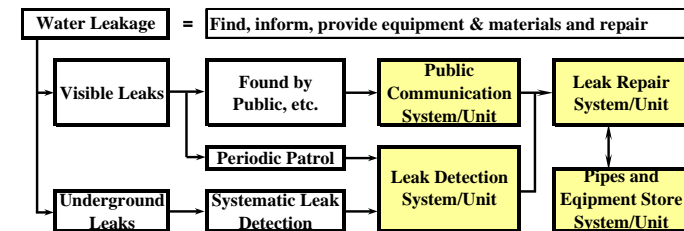


Figure-7 Relation of Each System

#### 4.2.2 Function of Each Unit

General role/function of each system/unit is considered as shown in Table-5.

Table - 5 General role/function of each unit

Name of units	Role/Function
Public Communication Unit	To communicate with public on leakage and to inform it to Repair System
Leakage Detection Unit	To be composed of patrol team and leakage detection team, and to find both of visible and underground leakage and inform it to Repair System
Leakage Repair Unit	To repair leakage on pipelines and house connections using necessary pipes and equipment to be supplied by Store System or ask repair to private firms
Equipment and Material Store Unit	To store necessary pipe materials and equipment for leak repair in cooperation with local shops

#### 4.3 The Existing Organization

The present organization of Baghdad Mayoralty and BWA, both of which are quoted from JICA F/S report, are shown in the following. Positioning of the NRW unit selected above in the organization and relationship between the NRW unit and the present organization shall be studied in 2007.

##### 4.3.1 Baghdad Mayoralty Organization

The NRW unit will be established in BWA organization. Relationship with municipality offices shall be studied carefully in 2007.

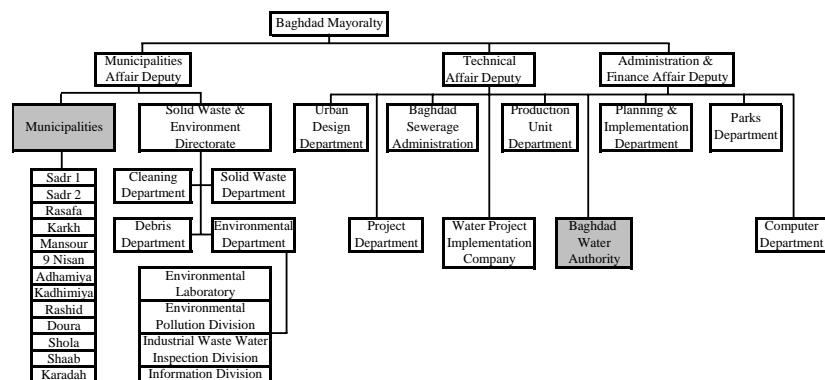


Figure-8 Organization of Baghdad Mayoralty

##### 4.3.2 BWA Organization

Organization of Baghdad Water Authority is shown in Figure-9. Among the four NRW units, Leakage Detection Unit is desirable to be established in the Implementation section. It shall be studied to which sections the other three units belong and their relationships in 2007.

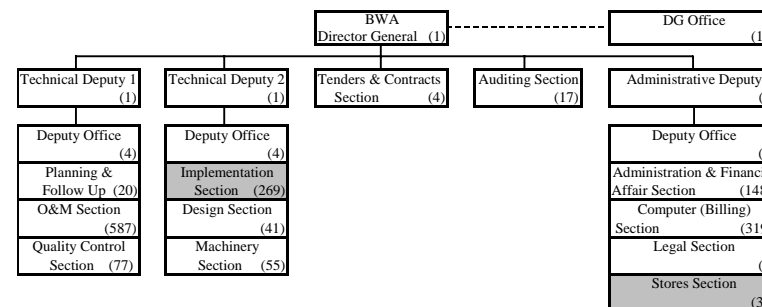


Figure-9 Organization of Baghdad Water Authority

##### 4.3.3 Organization of Implementation Department (Section)

Position of the Detection Unit in the Implementation Department (Section) shall be studied together with relationship with other units in the department in 2007.

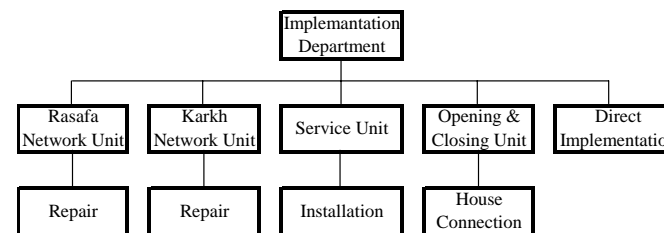


Figure-10 Organization of Implementation Department

#### 4.4 Study on Each System/Unit

Role, function, etc. of the NRW unit shall be studied in the TCTP in 2007.

##### 4.4.1 Public Communication System/Unit

To be studied in the coming TCTP in 2007.



#### 4.4.2 Leakage Detection System/Unit

The following will be studied in the coming TCTP in 2007.

##### 1) Role

Investigate, detect and find water leakage and to inform the leakage to Leakage Repair System.

##### 2) Structure

(1) Patrol Team: to find visible leakage

(2) Leakage Detection Team: to detect underground leakage

##### 3) Activity of Patrol Unit

Study Items	Description
Preparation of patrol route	
Identification/Classification of leakage condition	
Notice of leakage condition	
Confirmation of leakage repaired	
Others	

#### 4.4.3 Leakage Repair System/Unit

To be studied in the coming TCTP in 2007.

#### 4.4.4 Equipment and Materials Store System/Unit

To be studied in the coming TCTP in 2007.

# Appendices

## Appendix-1 Specification and Cost of Leakage Survey Equipment

### 1.Portable type flow meter->

A flow meter which can be installed easily at any required spot is necessary.

Portable Camp on Meters	
Language	English
Protection	IP 66
Keypad Protection	IP 68
Display	Dimension 220 x 60 mm minimum
	Current flow
	Total volume
	Flow graph
	Velocity
	Battery Level indicator
	Error message
	Flow rate can read from distance 7m minimum
Transducers with chain & rail for different Pipe Size	13 mm to 2000 mm
Temperature	0 <sup>0</sup> to + 50 <sup>0</sup> under operation condition
Output	4-20 mA, RS 232 Pulse 5V, 1 pulse/second
Power Supply	Battery Charger Input : 110 V to 240 V Output: 9V DC Vehicle adapter for Battery Charging
Battery Pack	Internal Battery: 24 to 30 h minimum
Data Logging	50, 000 data points (100 K)
Log Blocks	20 block minimum
Memory Capacity	100 k minimum
Accuracy	1% or $\pm$ 0.02 m/s
Pipe Materials	Measure all type pipe materials
Case	Water proof – 1m deep under water for 24h
External Cables	Waterproof connection Transducer Cable length 3.0 m minimum Waterproof Sockets
Thickness gauge	It produces accurate measurements of pipe wall from 0.01 inches to over 2.00 inches

### 2.Water pressure gauge (Pressure Logger)

Auto-record type water pressure gauge which can be installed at fire hydrant is desirable, in case of portable type.

- Data Logger with one channel for Pressure 0.0 bar to 25bar IP68,
- Memory capacity > 50 000
- lithium battery for not less of 5 years
- Display shows pressure value, time, date.
- Sampling interval ( 1s, 5s ) , 1m, 5m,10m,15m, 25m,30m,60m.
- logging period: Max to 192 hours
- Connector 1/8" quick fit nickel plated brass.
- Accuracy +/- 0.05%

### 3.Electronic leakage detector

- A ground microphone using the latest technology in acoustic leakage sounding systems
- MLP(Minimum Level Profiling) and a graphic display for histogram comparisons. leakage noise levels and confirming the leakage position,
- Noise level graphically and digitally, maximum leakage noise ,the lowest level, Leakage transmitted minimum three second intervals
- Good quality headphones and an acoustically shielded ground microphone foot.
- Simple (one button) or manually selectable filters Improved sound quality
- Dynamical sensitivity, (signal strength) control unit with LCD graphic display
- Acoustically shielded Microphone foot for all weather use

### 4. Acoustic rod

- Length:1.5m
- Diameter of part of vibration transmission:7mm
- Material: piano wire

### 5.Magnetic detector

There are two kinds of detector needed for detection of valve box or manhole, and pipes. It is recommended that priority is given to purchase manhole detection type, because BWA is facing difficulty to find location when supply has been suspended.

- Physical construction: Water-proof ,withstands 1m drops onto concrete
- Depth range: up to 4.5m
- Visual indication: Numeric digital bar graph and low battery indicator
- Audio indication: Audio tone through waterproof speaker
- Controls: Manual speaker volume and sensitivity, Push button on/off
- Battery: 6×LR6(AA)1.5V alkaline, 100 hours life, nominal @20 intermittent use
- Operating temperature: -6 to 50

## Appendix-2 Implementation Plan of 2<sup>nd</sup> Preliminary Study in Baghdad

### 1.1 Present Conditions of District 511

- Location = within Zone 14
- Area = 0.370 km<sup>2</sup>
- Population = 8355 in 2004 (by Ministry of Planning)
- No. of Houses = 431
- Family No. =
- Security of District 511 =

- **The security of district 511 is better than other places.**  
- **We can work in the district and using the equipment.**

### 1.2 Water Supply Conditions in District 511

- Feeding Project = Shark Dijla Water Treatment Plant
- Supply Continuity = 24 hours continuous supply
- Pipelines = Mostly asbestos cement pipe not renewed
- Pipe Replacement = Near future by JBIC (Yen) loan
- Pressure = Rather low, shower by gravity but elevated tank by pumpage
- Leakage = Estimated much
- Bill Collection ratio = approximately 90%
- Estimated per capita water use =

- **Estimated per capita water use = approximately 130 liter / day**

- Estimated water supply amount in District 511 =

- **Estimated water supply amount in District 511 = 8355 person \* 130 liter/day=1086150 liter/day**  
**= 45.3 m<sup>3</sup> / hr**

### 1.3 Main Objectives

- To measure water supply amount in District 511
- To measure night flow of District 511 for grasping leakage level
- Others

### 1.4 Survey Period

- Survey Period: from 7/1/2007 to 30/ 1/2007
- Survey Hours: from 8.00 a.m to 2.00 p.m

### 1.5 Methodology of Pilot Survey

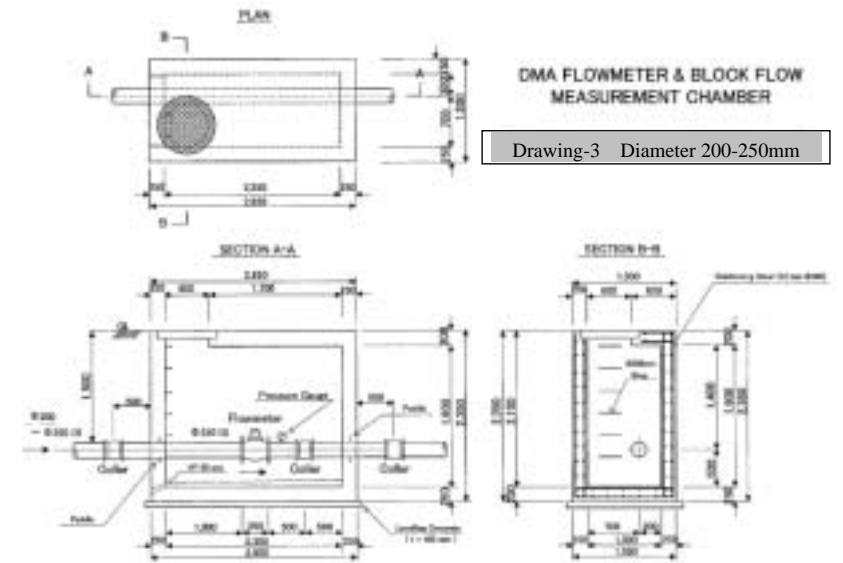
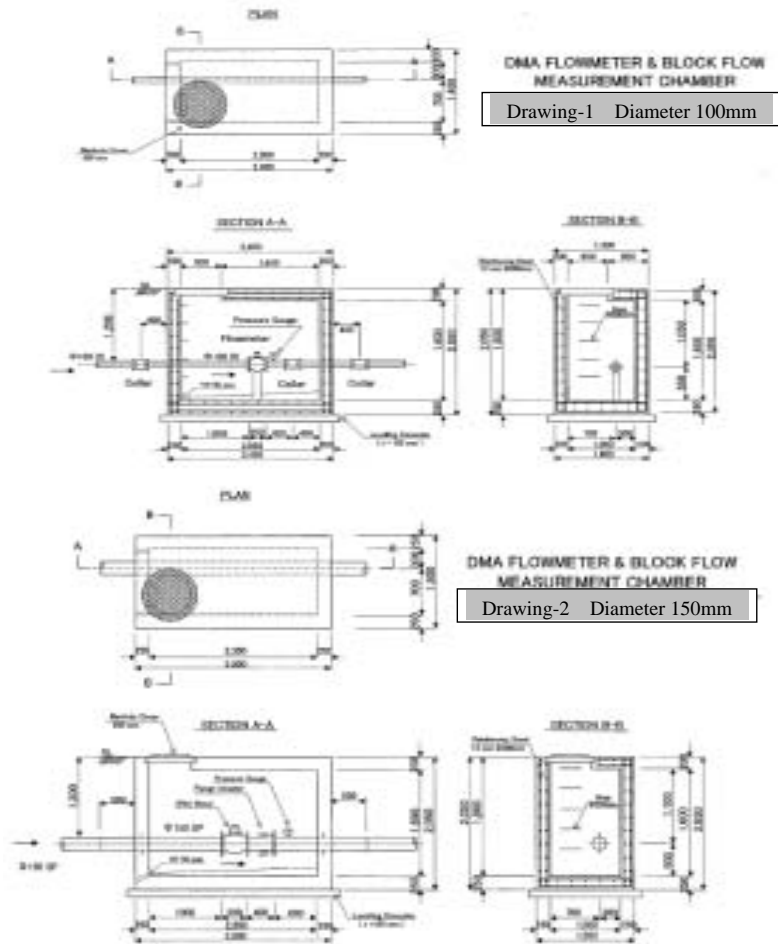
Study Items	Items to be Reported	Remarks
Study Members	Team leader	
	Team members	
	Assistants	
Pressure Measurement	Number of Points	
	Location	Show on the map.
Flow Measurement	Number of Points	
	Location	Show on the map.
	Measuring Method	Describe in Item 1.5 below
Leakage Detector	Plan of Leakage Detector Use	
Pipe Detector	Plan of Pipe Detector Use	
Other Necessary Items		

### 1.6 Measuring Method

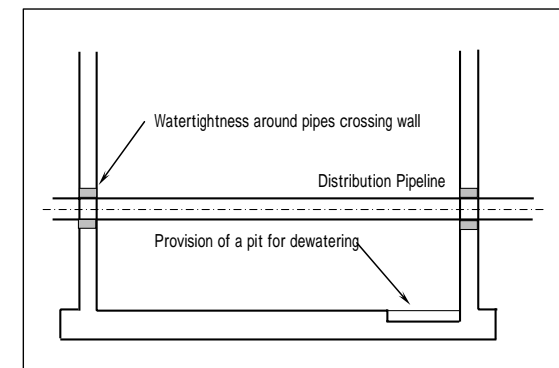
- **When return back to Baghdad and study all the point above and I send to you the details.**

### Appendix-3 Basic Design of Flow Meter Chamber

Typical designs of flow meter chambers are shown in the followings. Three drawings are prepared according to diameter of the pipelines, 100mm, 150mm and 200 to250mm. In the chamber, spaces for installation of an ultrasonic flow meter for testing, a pressure meter and a permanent flow meter shall be prepared.



As water table in the city of Baghdad is very high, a through wall hole of pipeline shall be watertight and a pit in the base floor for dewatering shall be prepared as shown in the following sketch.



# Appendix-11

## HOMEWORK FOR NEXT TRAINING PROGRAMME

### 1) First Pilot Study: In Sector (10)

#### Use The Devices:-

The Devices were Received, Installed  
and Prepared to be Used In Sector (10)

#### The Devices are

- 1) One set of portable ultrasonic flow meter.
- 2) Two sets of manometer.
- 3) Four sets of acoustic rod.
- 4) Two sets of electronic leak detector.
- 5) Two sets of metal detector.

#### *Pipes Feeding in sector (10) :-*

- ❖ Ductile pipes dia. 900mm (D1).
- ❖ Ductile pipes dia. 300mm (D2,D3).
- ❖ Pipes connected sector (10) with the near by sectors ( D4,D5,D6 ).

*The aim behind linking the sector is that in case the water is good in some sectors*

It helps the near by Sector and

circulating the water in these sector

currently the link among these sector is

closed by the valves.



R14

*Therefore, The pipe that feed sector ( 10 ) are*

(D1,D2.D3 )

*For measuring the input water to sector (10)*

And for using one flow meter to measure the discharge

we almost follow the same method of

Mr. Iwasaki and as follows :-



- Measurement of flow at different location in a day.
- Measurement of flow at different location on same hours in different day.

Time (hr.)	9	11	13	Sum.	Ave.
Day					
1	D1	D2	D3	1-3	Sum. $\div$ 3
2	D2	D3	D1		
3	D3	D1	D2		

### ***Number of population in sector (10)***

Number of houses in sector ( 10 ) = 820

house, the area of each house = 144 m<sup>2</sup>

because of increasing in the population,

the married son divides the house and

lives with his parent.

- According to ministry of planning in 2004 the population in the district 527 = 23,336 people.
- The district 527 are contained two sectors, so  $23,336 \div 2 = 11,668$  in each sectors.
- The number of population in sector ( 10 )  $11,668 \div 820 \text{ house} = 14.22926829268$  person in each house.

Area of the district 527 = 0.457867 km<sup>2</sup>

Area of the district 527 = 457866.727 m<sup>2</sup>

Daily consumption of a single person

according to design = 500 liter/day

Because the main project( Sharq Dijla WTP )

is far from al Sader City, the project

( Sharq Dijla WTP) capacity = 765,000 m<sup>3</sup>/day

Al Sader City depends on an compact unit  
its range between ( 50 – 200 ) m<sup>3</sup>/hr.

which does not cover the daily consumption of a

single person acknowledging that al Sader City

has a big population.

compact unit complain from many problem and

needs a permanent maintenance.



The daily consumption rate of a single person in sector ( 10 ) is nearly 100 liter¥person¥ day

Calculating the input water to sector (10 ) theoretically.

Number of population in sector ( 10 ) 11,668

\* The daily consumption of a single person

$$100 \text{ liter¥person¥day} = 1,166,800 \text{ liter¥day} \\ = 1166.8 \text{ m}^3\text{¥day.}$$

Leakages and illegal rate = 10 %

$$1166.8 * 10 \% = 116.68 \text{ m}^3\text{¥day}$$

The total input water in sector ( 10 )

$$= 1166.8 + 116.68 = 1283.48 \text{ m}^3\text{¥day}$$

$$1283.48 \text{ m}^3\text{¥day} \text{ ¥ } 24 \text{ hr¥day}$$

$$= 53.478333 \text{ m}^3\text{¥hr}$$

## 2) Selection of sector for second pilot study

- Sector having distribution pressure to some extent.
- Sector having 24 hr continuous water supply and may be sector near to the water sources.
- Sector having a little illegal connection by pumps.
- Sector before pipe line replacement.

- Sector having a map of water distribution networks.
- Sector having pipe replace plan in the future.
- Sector which needs a few flow meters.
- If possible within R2, R3, R14.

## District :- 511

- Zone :- R14
- Kind of pipe used in the network : Asbestos.
- Feeding project to the district : Shark Dijla WTP
- Water supplying to the network 24 hr

According to ministry of planning in 2004 the number of population in the district 511 = 8355 people

Area of the district 511 = 0.369957 km<sup>2</sup>

Area of the district 511 = 369957.344851 m<sup>2</sup>

- Drawing availability which illustrate the network of potable pipes network.
- Potable water network not renewed.
- Leakage in network are very much because the network is old.

- Number of the houses in the district

= 431 house

- The water reaches the sink and shower dash with out using pump

- Used the pump when we want to full the tanks.

- The average people in each house  
=9 people

- 90% from participant paying the bill

## District :- 325 ALShaab

- Zone :- R2
- Kind of pipe used in the network :  
Asbestos 80%, Ductile and Aheen 20%
- Feeding project to the district :  
Shark Dijla WTP
- Water supplying to the network 24 hr

According to ministry of planning in 2004  
the number of population in the district  
325 = 23.682 people

Area of the district 325 = 1.047930 km<sup>2</sup>

Area of the district 325 = 1047933.977 m<sup>2</sup>





- Drawing availability which illustrate the network of potable pipes network
- Potable water network not renewed
- Leakage in network are very much because the network is old

- Number of the houses in the district  
= 1276 house
- The water reaches the sing and shower dash with out using pump

- Used the pump when we want to full the tanks.
- The average people in each house  
= 8 people
- 80% from participant paying the bill

## *District :- 330 Hai Tones*

- **Zone** :- R1
- **Kind of pipe used in the network** :  
Asbestos
- **Feeding project to the district** :  
Shark Dijla WTP
- Water supplying to the network 24 hr

According to ministry of planning in 2004 the number of population in the district 330 = 10,753 people

Area of the district 330 = 0.777728 km<sup>2</sup>

Area of the district 330 = 777728.153302 m<sup>2</sup>

- A little illegal connection by pumps
- Drawing availability which illustrate the network of potable pipes network



- Potable water network not renewed
- Leakage in network are very much because the network is old
- Number of the houses in the district  
=1511 house

- The average people in each house  
= 6 people
- 80% from participant paying the bill