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RURAL WATER SUPPLY PROJECTS  
MINISTRY OF WATER AND ENVIRONMENT  
THE REPUBLIC OF YEMEN

RURAL WATER SUPPLY COMPONENT OF  
THE STUDY FOR  
WATER RESOURCES MANAGEMENT AND  
RURAL WATER SUPPLY IMPROVEMENT  
IN THE REPUBLIC OF YEMEN

FINAL REPORT  
SUPPORTING REPORT

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JAPAN TECHNO CO., LTD.  
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## **1. STUDY ACTIVITIES**

# 1. STUDY ACTIVITIES

## 1.1 Phase I: Formulation of Rural Water Supply Improvement Plan for Screened Sites and Capacity Development of GARWSP

### 1.1.1 First Fiscal Year Activities

#### (1) Inception Report and Minutes of Meetings

An Inception Report was prepared in Japan to introduce the present Study to the Yemeni side and explain the basic concepts and policies as well as the procedures and methodologies of the Study. Upon arrival of the JICA Study Team to Yemen, the Inception Report was submitted and explained to GARWSP, MWE and other relevant organizations. Issues agreed during the discussions with relevant organizations were compiled as “Minutes of Meetings on Inception Report” and signed on 21 December 2005 in Sana’a between GARWSP, as the executing agency, and JICA Study Team. The main topics agreed in the Minutes of Meetings are the following.

1. The extent of assistance to capacity development for GARWSP branch offices will depend on necessity through results of the study.
2. Number of pilot project sites will be decided upon survey results, as well as consideration of implementation period and budget constraints.
3. Member list of counterpart team from GARWSP was submitted.
4. At candidate sites without existing water sources, borehole drillings are either on-going or in the planning.
5. One candidate site in Sana’a Governorate is to be replaced with an alternative site.
6. GARWSP requests early implementation of water supply improvement plan.
7. GARWSP requests acceptance of trainees for counterpart training in Japan.

#### (2) Note of Agreement

In the course of the first fiscal year study in Yemen, issues other than those agreed in the Minutes of Meetings needed discussions. These were compiled into a “Note of Agreement” and signed on 11 February 2006 between GARWSP and the Study Team. The main points agreed were as follows.

- Field surveys for some of the candidate sites had problems with security, and therefore in the future, GARWSP will fully assure the safety of the Study Team.
- A borehole targeted as a candidate water source for the Study was found to be privately owned, but GARWSP explained that it was handed over to the community for public use and agreed to submit documents to justify this explanation.
- Field surveys revealed that pumps are installed in some of the target boreholes, and GARWSP agreed to remove the pumps before the pumping test.
- Changes were made in the GARWSP counterpart team members.

### (3) Socio-Economic Survey

#### a. Survey Description

As part of the baseline survey at the 36 candidate sites, basic data and information on socio-economic conditions necessary for water supply improvement planning were collected and analyzed. These activities included review of existing statistical data and related documents, interviews to relevant organizations and enquiries at candidate sites. The enquiry survey was subcontracted to a local social consultant under supervision of the Study Team. The survey items subcontracted were as follows.

##### Interview Survey on District and Sub-District Authorities

General information on socio-economic situation, relation between local government and villages, and social structure of candidate sites were collected through interviews with local authorities of Districts in charge of the candidate sites and chiefs of sub-districts heading the candidate sites.

##### Interview Survey on Village Representatives

Information on population movements, infrastructure conditions, socio-economic structure, present water supply and sanitation environment, needs for water supply improvement and other conditions were collected through interviews with village chiefs and community leaders.

##### Questionnaire Survey on Sampled Households

Water use situation, health and sanitation conditions, needs for water supply improvement, willingness to pay, and household accounts were surveyed using questionnaires to 1,500 sample households randomly selected from households located in the candidate sites.

#### b. Selection of Local Consultant

Three local consultants were short-listed and called to submit proposals for the socio-economic survey. Conditions for short-listing were as follows.

- Experience in conducting socio-economic surveys for rural water supply and sanitation projects in Yemen
- Experience in related work for projects of GARWSP, other ministries or donors in the past 10 years

Two companies submitted proposals within the submission deadline. The submitted proposals were evaluated by GARWSP staff counterparts and Study Team members. As a result, Interaction in Development received higher points and after negotiations, this company was assigned to the survey.

### c. Results of Survey

Upon completion of the field survey by the local consultant, the collected information was compiled into a report which was submitted to the Study Team. The report was analyzed and along with information collected by the Study Team, the results were organized and compiled to identify the socio-economic situation of candidate sites.

### (4) Water Resources Survey

At the candidate sites, existing water sources presently used or planned to be used for water supply were surveyed. The peculiar topography and geology of Yemen has great influence on water resources, and hence topography and geology as well as meteorology of the study area were surveyed. Since the main water source for this study is groundwater, drilling data were collected to confirm conditions of boreholes as well as pumping equipment.

#### a. Survey Description

##### Data Collection

Information on existing water sources of candidate sites was collected. Moreover, information related to water resources potential to be determined in the Second Fiscal Year study was also collected.

##### Field Survey

Field surveys were conducted to identify the water sources of the candidate sites and hydrogeological conditions of areas surrounding the candidate sites.

##### Data Compilation and Preparation for Second Fiscal Year Study

Collected data and results of field surveys were compiled to prepare an inventory of water sources. Information and data related to pumping tests and water quality analyses were collected in preparation for their execution in the Second Fiscal Year.

#### b. Survey Results

##### Present Condition of Water Sources

- Some sites have multiple water source wells, and including the spring source at Al Azaez (Taiz), a total of 43 water sources are targeted for the 36 candidate sites.
- Of the 43 sources, 24 wells are unused and capped, while another well is unused but uncapped.



- The target well at Al Khunah (Taiz) is capped but water is flowing out from a pipe installed on the side of the well casing near the ground level.
- Vertical or submersible pumps are installed in some of the wells, but most of these pumps are in need of repair.
- Wells are drilled along the ridge of wadis, in areas surrounded by outcrop of rock formation and at sides of roads along mountain ridges.
- For most of wells installed with pumps, the pump is directly fixed on the well head, and therefore water level measurements cannot be made.

#### Data Collection

- Although information on wells (such as drilling reports) were collected, only basic information such as well depths and water levels are described, and some data are not reliable.
- According to results of surveys conducted locally, some wells have very large drawdowns, while others have pumping water levels going down to near the well bottoms. These data give doubts as to the sustainability of the wells.
- Data and information for water source evaluation were collected from GARWSP, NWRA, Ministry of Agriculture and other related governmental organizations.

#### (5) Survey on Water Supply Facilities/Water Supply Plan

Existing water supply facilities at the candidate sites were surveyed to determine the technical aspects on the present condition of existing facilities and identify the needs for their improvement. From environmental and social conditions of Yemen, water supply facilities are served mostly on Level 2 or 3, and therefore, this study will focus on these service levels.

##### a. Survey Description

#### Data Collection

To determine the present situation of water supply facilities design and plan for water supply in rural areas, the following data and information were collected.

- Existing information of GARWSP and related organizations concerning plan and design of water supply facilities for the candidate sites
- Project implementation situation of other donor organizations
- Methods and process of water supply facilities design of GARWSP
- Standards and criteria related to rural water supply
- Presently owned equipment and tools of GARWSP for water supply planning

#### Site Survey

Field surveys were carried out at the 36 candidate sites to identify and confirm the following conditions to formulate plans for water supply and design water supply facilities.

- Present and requested water supply service area of each candidate site
- Topography
- Locations of water sources
- Layout and conditions of existing water supply facilities
- Water supply plan requests of residents
- Contributions to construction of water supply facilities

#### Compilation of Survey Results

Collected data and information were compiled to prepare an inventory of existing water supply facilities and water supply plans. Also, existing plans and designs for water supply were reflected on actual site conditions to determine their appropriateness.

#### b. Survey Results

- The water supply planning for the 36 candidate sites can be divided broadly into 2 categories of “New facilities construction” (27 sites) and “Rehabilitation of existing facilities” (9 sites).
- “New facilities construction” sites have no existing water supply facilities or existing water supply facilities are completely non-functioning. At these sites, the residents are fetching water from sources located a number of km away, cisterns containing polluted rainwater, dug wells susceptible to contamination, or spring sources which have drastic seasonal fluctuations in flow rates. Therefore, needs for water is much higher at these sites than those sites which possess functioning water supply facilities.
- Since the “New construction” sites have at least one borehole, the plan would involve (1) using this borehole as the water source, (2) installation of pumping and booster equipment, and (3) construction of pump houses, booster facilities, storages tanks and pipeline network.
- The residents of sites for “Rehabilitation of existing facilities” are somehow supplied with water from existing water supply facilities but the supply is not satisfactory. The works required at these sites include (1) replacement of pumping and booster equipment, (2) rehabilitation/expansion of storage tanks, and (3) replacement/extension of pipelines.
- Some sites have more than one water source as targets for the study, but the sources to be used for planning and the coverage area were determined as a result of the pumping tests. If the water source has limited capacity, in consideration of fair allocation of water to residents, water supply coverage is determined based on adjustments in operation hours and unit supply rates.
- The water supply systems are expected to be of very large-scale since most of the sites require water supplied to a wide area consisting of many villages (maximum of 9km width) and booster facilities are essential due to large height differences between the water intake point and final transmission point (differences at some sites are more than 500m).
- Concerning water service level, since most of the sites prefer household connections (Level 3 services), the pipeline plan will be to lay the pipes to a central area within each service area and each household will make their own connections. However, depending on topography, restrictions in facilities allocation and location of households, if house

connections are difficult, then public tapstands will be considered. On the other hand, for sites which prefer Level 2 services, installation of public tapstands will be taken into account. Level 1 service is not preferred.

- Access to sites and transport within the sites are basically possible with a 4WD vehicle, but travelling across wadis during floods, along dangerously inclined slopes and on narrow dirt roads along cliffs is sometimes necessary and therefore, careful attention is required.

#### c. Issues for Consideration

##### Standards for Water Supply Planning

The standards adopted by GARWSP for rural water supply planning were studied and discussed. Whether to adopt these standards for this study will depend on study results and discussions with GARWSP.

##### Water Source for Planning

The water sources targeted for the study are public boreholes or spring source for public use provided by the Yemeni side which were confirmed by the Study Team during field surveys. If a water source has problems with quantity or quality, then that site is considered as not having a water source and that site will be screened out for planning.

##### Work Allocation

Possibilities for work allocation of water supply facilities construction which were identified during the field survey are as follows, but confirmation is needed at later stages.

- GARWSP and local authorities have possibilities of implementing the following works, but actual budget allocation for construction work is expected to be delayed.
  - a) Construction of machinery house
  - b) Construction of storage tank
  - c) Pipeline installation
  - d) Procurement and supervision
  - e) Coordination
  - f) Committee formation and awareness activities
- Many of the target residents explained that they can share the works listed below, but final confirmation is necessary.
  - a) Transport of materials within the site
  - b) Laying out pipe material along design route
  - c) House connections
  - d) Operation and maintenance of water supply facilities
- The donor can handle the remaining works after the above demarcation.
  - a) Procurement and installation of pumping and booster equipment
  - b) Construction of pump house and storage tank
  - c) Pipeline procurement and installation
  - d) Overall supervision

## (6) Survey on Operation and Maintenance

To identify the present conditions and problems related to operation and maintenance of water supply facilities at the candidate sites, an interview survey (group focus discussion) was carried out to village heads (Sheikhs), leaders (Aqils) and influential persons in the village, as well as representatives of community organizations in charge of management of water supply facilities. The survey was conducted at sites with existing water supply facilities, whether they are functioning or not. Unsuccessful and successful factors of management/operation/maintenance of water supply facilities being initiated by the community were determined. The survey results were compiled into the site inventory. Characteristics observed in unsuccessful and successful community-based management are summarized below.

### a. Characteristics in Unsuccessful Community-based Management

#### Traditional Management System centred on Village Head (Sheikh)

The formation of a community based organization for operation and maintenance of water supply facilities such as the water user association (WUA) is presently a condition for implementation of water supply projects. However, most of the water supply facilities which have become non-functional are managed by Sheikhs, and operation and maintenance is often non-systematic. Some facilities are working after more than 15 years since construction without any technical problems, but these are run by Sheikhs with high leadership and economic capacity.

#### Ownership Centered on Village Head

At sites with water supply facilities managed by Sheikhs, awareness towards community ownership is very low. For many of these sites, when funds are needed to repair facilities, the level of contribution from the community is very low, and therefore repairs are not made and the facilities are left neglected.

#### Non-transparency of Accounting and Decision-Making

In some management systems run by community organizations or Sheiks, accounting of collected water fees for operation and maintenance is non-transparent. This concept is not unlawful, but if information is not released and auditing by users is not possible, a planned accounting cannot be realized and this situation can lead to facilities being left without repair. Also, when decision making on management of facilities is limited to a specific person, a similar situation can occur where accounting is executed without planning.

#### Establishing a Water Tariff Too Low

Some communities cannot handle relatively large repairs because they have set the water tariff just enough to keep funds for daily operation (fuel costs and salaries only).

#### Small Scale-Merit of Operation and Maintenance

For communities with relatively small populations (from 500 to 2,000 persons), scale-merits for operation and maintenance of facilities are small. Also, collectable fees for operation and maintenance are limited due to population size. Therefore, at these sites, since available fees are sufficient to cover costs only for daily operation, future investments and rehabilitations are not possible.

#### Water Deficit due to Abrupt Population Growth

Since many of the existing water supply facilities were constructed more than 10 years ago, these cannot cope with increase in water demand due to sudden growth in population. Consequently, wells become dry due to overpumping beyond the capacity of the well, and pumps become non-functional due to groundwater level lowering below the pump installation depth. This is the reason for facilities failure at most of the sites with non-functioning facilities.

### b. Characteristics in Successful Community-based Management

#### Accountability of Community Organization to Users (Transparency of Decision Making and Accounting)

At most of the sites with efficient and financially sound operation and maintenance of water supply facilities, water committee executive members are selected through elections, rules are established, committee is registered, accounting is reported to users, and important matters are decided through general meetings of the community.

#### Interface with Authorities and Private Companies

For sites capable of receiving constant maintenance service or proper technical assistance from local authorities, especially GARWSP branch office, or local companies with appropriate technical skills, they are able to continue proper operation and effectively cope with technical problems.

#### Clarity of Ownership

In accordance with Law No. 1 of 2001 regarding Non-Governmental Organization and Society, when community organizations such as the Water User Association (WUA) are formed, that organization must be registered under the Ministry of Social Affairs and a memorandum on ownership of water supply facilities is prepared, and then the target community will have legal ownership. When ownership is legally assured, awareness of the community increases and responsibility for operation and maintenance strengthens.

#### Important Decision Making is Approved by Users

Other than executives of WUA or other community organizations, about 10 representatives from the users are selected. When repairs of a certain scale are needed, a system of receiving understanding and approval from the user representatives is established. Furthermore, accounting is periodically reported and some communities adopt a system of internal auditing by the user representatives.

#### Tariff by Metered System

At most of the candidate sites, house connections are common and water meters are installed, and therefore metered system of fee collection is being adopted. Also, some communities have adopted a weighted system for large volume consumers to assure sufficient income for proper management.

#### Population is Relatively Large

Managerial scale-merit is maintained at communities with relatively large populations since tariffs can be restrained while incomes from service provisions become large.

#### Facilities Extensions due to Population Increase include Water Source Development

When water supply facilities are expanded to cope with water demand increase due to population growth, development of water sources is also included. Also, operation of wells and pumps is not overburdened to meet the increase in demand.

#### Income of Population is High

The financial status for management of water supply facilities is more stable at sites located near centers of governorates and districts, and for communities with relatively high income.

#### c. Characteristics Both in Successful and Unsuccessful Community-based Management

The following issues were commonly observed both in successful and unsuccessful management of the supply scheme. These issues affect both positively and negatively for community-based management of the supply schemes.

#### Authorities (GARWSP and local bodies) are basically distrusted

Distrust towards local authorities such as GARWSP branch offices and local councils among communities are rather common. It may be due to negligence and failure of such local authorities to provide technical and financial support to the communities. Although distrust towards local authorities is obvious, there are some communities which established relatively improved interface with local authorities as it is observed above. Capacity of local authorities in provision of technical guidance shall be further developed to enhance community-based management of the supply scheme.

Water supply is planned with consideration of tribal relations, and hence, water supply plan is technically and managerially inefficient

All water supply schemes surveyed have planned to cover a particular tribal community, without expanding to other tribes. It may not only facilitate community ownership, but also prevent conflicts in scheme management among communities, clarifying water rights for the tribe in ownership, usage, and management. However, it also prevents smaller communities from possessing water supply schemes with larger economic scale of merit as mentioned above, since “tribalism” often denies sharing of larger supply schemes among different tribal communities.

Water supplied to the poorest is free.

It is observed that most of the communities with supply schemes provide poor households with minimum amount of water at free of charge or relatively lower tariff. Each community defines “poor” by their custom and criteria, and it functions as measures developed by communities to relieve poorest households in the communities. However, it often hinders necessary cost recovery for operation and maintenance of the supply scheme, particularly in the smaller and poorer communities which also set general tariff at lower rates.

#### (7) Inventory of Candidate Sites

The results of surveys on socio-economic conditions, water resources, existing water supply facilities and operation and maintenance conditions were compiled to prepare an inventory of the candidate sites. This information will be used as baseline for screening of sites conducted in the second fiscal year.

#### (8) Capacity Assessment

The Ministry of Water and Environment is preparing the Rural Water Supply and Sanitation Reform Policy to clarify the responsibilities of relevant authorities. Capacity assessment in this Study was initiated through the confirmation on the progress of the sector reform policy, and clarification on new directions for rural water supply policy. Functional responsibilities of GARWSP and each stakeholder redefined under the sector reform were also confirmed. Then, capacities of present GARWSP headquarters and branch offices of Sana’a, Dahmar and Al Mawheet were evaluated and capacity gaps with redefined functional responsibilities were assessed, using an assessment matrix. In the process of capacity assessment, the needs for capacity development were identified and prioritised through consultation and workshop with relevant stakeholders, and the results will become basis for policy and action plan for capacity building. Furthermore, precedent capacity building activities were reviewed to identify the problems and issues of capacity building and evaluate the needs to supplement assessment of this study. The results of capacity assessment are shown in Chapter 5 of the Main Report.

## (9) Activities of Related Organizations

International organizations such as World Bank and UNICEF, and European countries such as the Netherlands and Germany have continuously assisted the water sector of Yemen. For the rural water sector, the Netherlands has given assistance on a long-term basis since 1980 along with Japan. Japan has mainly assisted in construction of water supply facilities, and assistance for software-component such as capacity building was very limited. On the other hand, the Netherlands' strategy is water supply promotion and expansion including software assistance to one governorate at a time (Dahmar governorate in the 1980's and Hodeidah governorate in the 1990's, while branch offices were also established in each governorate). This study aims to contribute to the promotion of the National Water Sector Strategy and Investment Program (NWSSIP) as the national program for the water sector. Refer to Chapter 4 of the Main Report for summary of activities of organizations in the water sector.

### 1.1.2 Second Fiscal Year Activities

#### (1) Note of Agreement 2

During the second fiscal year study in Yemen, discussions were made between GARWSP and the Study Team related to decision of JICA on security problem areas, screening/ranking of candidate sites, design standards and pilot project. The results of discussions were presented into a "Note of Agreement 2" which was signed on 15 October 2006 between GARWSP and the Study Team. Following are the main issues agreed.

- Due to security risks, JICA has designated areas restricted to Japanese nationals, including the Study Team, and sites located in these areas cannot be surveyed directly by the Study Team.
- Criteria for screening of candidate sites and conditions for ranking of the screened sites were discussed and agreed.
- Design standards for rural water supply planning as well as water quality standards to be used for this study were agreed by both sides.
- The concept for pilot project implementation which is scheduled for the next fiscal year was discussed and agreed.

In succession, results of screening of sites in accordance with criteria agreed above were compiled as the list of screened sites, and reasons for screening out sites were discussed. The results of these discussions between GARWSP and the Study Team were agreed as "Addition to Note of Agreement 2" and signed on 28 October 2006.



## (2) Groundwater Survey

In the design of water supply facilities, the water source is the most important factor. To identify the continuous potential and quality assurance of the water sources planned for the candidate sites, pumping tests and water quality analyses were conducted.

### a. Pumping Test

Pumping tests were carried out on boreholes selected as candidate water sources for the 36 candidate sites. The pumping tests were contracted out to local contractors with the following results.

- 42 Boreholes Contracted: Divided into 4 lots
- 38 Pumping Tests Conducted: Could not test 4 wells due to reasons such as well collapse, low water table and small diameter casing
- 31 Boreholes Recommended for Safe Use: 7 wells are not recommended for use due to reasons such as low yield, slow recovery and uncertainty from incomplete pumping test

### b. Water Quality Analysis

To analyze water quality, samples were taken from the wells where pumping tests were carried out as well as other water sources. Water samples from candidate water sources (total of 43 samples) were collected to determine their acceptance for drinking. Samples from other water sources were also analyzed to identify the present conditions of water used for drinking by residents of the candidate sites. A total of 70 samples were taken and analyzed. Out of the 43 samples from candidate water sources, 35 samples were determined as having water quality satisfactory for drinking, while quality indicators such as F, Mn and pH of 8 samples were not in accordance with agreed standards.

## (3) Water Source Potential and Water Balance Analysis

The water sources targeted for the candidate sites were evaluated for their potential as reliable water sources. Evaluations were made for transmissivities, water level recovery rates and depths of water tables from results of pumping tests, as well as analysis of water balance from ratios of projected discharge to estimated recharge.

The water balance was analyzed by taking the ratio of groundwater consumption for irrigation and domestic use against the estimated annual groundwater recharge in a catchment. A ratio of 100% means that discharge is equal to recharge in the area, and a ratio above 100% means that groundwater storage is unlikely to be sustainable in a long term. At sites showing more than 200% discharge ratio, the design pumping rate may cause critical conditions to the aquifer within a short period.

The recovery time ratio should recover to its original static water level as soon as possible after the pump is stopped. If the ratio is greater than 1, then the water level will probably lower continuously to drain off the aquifer.

A transmissivity value of  $10\text{m}^2/\text{day}$  implies good potential which is sufficient for rural water supplies. A value below  $0.1\text{ m}^2/\text{day}$  is considered to be infeasible for water supply.

The pumping water level is the level of water which lowers from the static water level when a pump is in operation. The pumping water level has effect on pump cost and operation cost.

The evaluation results were grouped into potential levels as shown in Table 1-1.

Groundwater consumption for irrigation, which is mainly used for qat cultivation, is probably the main cause of the present over discharge of some catchments. The volume of water used for qat irrigation can supply a population living in an area more than 100 times that of the qat field. Therefore, an efficient and conservative irrigation water use is the most important issue for groundwater management.

For some catchments in Yemen, if construction of an additional well is to be planned due to insufficiency of the existing production well, then exploring other catchments to develop another aquifer may be a better solution rather than to construct another production well near the existing borehole. Especially at sites where the water balance may be critical, it is advisable to construct an additional well in another larger catchment.

Table 1-1 Evaluation of Water Source Potential

Site Name	Code	Water Balance	Recovery	Transmissivity	Water Level	Potential Evaluation		
						Rank	Potential	
Jabal Al Taraf	A-02	A	A	A	A	1	High	
Qamlan-Bait Al Najrani	S-04	A	A-	A	A	2		
Mahdah	S-12	A	A	B	A	3		
Al Muayteeb	T-01	A-	A	(B)	B	4	Moderately High	
Masneat Abdul Aziz	D-08	A-	A	C	B	5		
Al Sana	I-02	A-	B	C	B	6		
Al Jahlah & Al Meshraq	I-04	A-	B	C	B	6	Moderate	
Mayfa'at Yaer	D-05	B	A	A	A	8		
Sheb Humran	T-03	B	A	A	A	8		
Asfal Bani Saba	I-01	B	A	A	B	10		
Elow Al Mikhlaf	D-01	B-	A	A	B	11		
Yafoq Bani Hamad	T-04	B-	A	A	B	11		
Jarban	S-02	B-	A	A	D	13		
Al Khamis-Bani Ali	A-04	B-	A	B	A	14		
Al Kharaba	S-03	B-	B	B	A	15		
Ozlat Al Jaradi	A-03	C	A	A	A	16		Fair
Bani Al Suror	T-02	C	A	A	B	17		
Bait Al Hadrami	S-07	C	A	A	B	17		
Hamal-Bait Al Jabar	D-02	C	A	A	C	19		
Al Azaez	T-05	C	A	C	A	20		
Ruhm	S-09	C	A	C	C	21	Low	
Mamsa Al Marqab	I-03	C	C	A	A	22		
Al Khunha	T-06	C-	A	A	A	23		
Al Asakera	D-07	C-	A	A	B	24		
Afesh	S-05	C-	A	A	C	25		
Al Lejam	S-06	C-	A-	A	B	26		
Hegrat Al A'asham	D-03	C-	B	A	B	27		
Al Hesn-Al Abyad	S-11	C-	B	C	C	28		
Dajah & Sarfah	S-08	C-	-	-	(D)	29		Very Low (Not Sustainable)
Al Ghail	S-14	C-	-	-	-	30		
Tawa'ar	S-10	D	A	A	B	31		
Al Kuob	D-04	D	A	C	A	32		
Wardasan	D-06	D	B	C	B	33		
Al Sha'afel Al Olyah & Al Sufla	A-01	D	C	B	A	34		
Al Ga'ra	S-13	D	-	-	(D)	35		
Bani Waleed-Al Asboor	S-01	B-	D	B	B	36		
Classification	A	$R \leq 50\%$	$t_r \leq 1.0$	$T \geq 10$	$PWL \leq 100$			
	B	$50\% < R \leq 100\%$	$1.0 < t_r \leq 1.5$	$5 < T < 10$	$100 < PWL \leq 200$			
	C	$100\% < R \leq 200\%$	$1.5 < t_r \leq 2.0$	$1 < T < 5$	$200 < PWL \leq 300$			
	D	$R > 200\%$	$t_r > 2.0$	$T < 1$	$PWL > 300$			
Where, R = Ratio (discharge/ recharge) t <sub>r</sub> = Recovery time ratio T = Transmissivity in m <sup>2</sup> /day PWL = Pumping water level in m								

#### (4) Water Demand Projection

The required water demands for the candidate sites were predicted for the design year based on results of the socio-economic survey and other information following the procedures listed below.

##### a. Determination of Water Coverage Area

The coverage area for water supply was determined based on socio-economic survey and field survey of candidate sites. Requests of the residents and GARWSP as well as potential of the targeted water source were considered.

##### b. Determination of Design Year

The design year set by GARWSP is 20 years. However, in consideration of uncertainties in growth predictions and area-wise growth differences if a long term planning is made, 20 years is considered to be too long. Therefore, a design period of 10 years will be used in this study to facilitate necessary adjustments during this period.

##### c. Population Projection for Design Year

The population growth rates to be adopted for this study were based on the 2004 population census. District-wise growth rates were considered, but they are too localized that differences are too wide, where many districts have minus growth rates. Therefore, growth rates by governorates are predicted to be closer to the actual situation. Consequently, by applying governorate-wise growth rates on the present populations determined through the study, the populations for the design year were projected.

##### d. Determination of Unit Supply Rate

The standard of GARWSP for unit supply rate is 40 liter/capita/day (l/c/d). Decision factors for unit supply depend on parameters such as present consumption rates, user demands, future social changes, and adopted service level. In this study, for sites having sufficient pumping rates, 40 l/c/d will be used as the maximum unit supply rate. However, due to low yields of some target water sources according to pumping test results, a minimum unit supply rate of 25 l/c/d will also be adopted.

##### e. Projection of Water Demand for Design Year

Based on the above conditions, water demand projections were determined for all candidate sites. These projections are listed in Table 1-2.

Table 1-2 Water Demand Projection

Gov.	No.	Code No.	Site Name	Present Population (2006)	Population Growth Rate (%)	Population Forecast (2016)	Unit Supply Rate (l/cap/day)		Demand Projection (m <sup>3</sup> /day)	
							Max.	Min.	Max.	Min.
Al Mawheet	1	A-01	Al Sha'afel Al Olyah & Al Sufla	9,405	2.87	12,481	40	25	499	312
	2	A-02	Jabal Al Taraf	2,727	2.87	3,619	40	25	145	90
	3	A-03	Ozlat Al Jaradi	20,786	2.87	27,584	40	25	1,103	690
	4	A-04	Al Khamis-Bani Ali	1,602	2.87	2,126	40	25	85	53
Sana'a	5	S-01	Bani Waleed-Al Asboor	1,923	2.07	2,360	40	25	94	59
	6	S-02	Jarban	1,611	2.07	1,977	40	25	79	49
	7	S-03	Al Kharaba	1,361	2.07	1,670	40	25	67	42
	8	S-04	Qamlan-Bait Al Najrani	629	2.07	772	40	25	31	19
	9	S-05	Afesh	3,680	2.07	4,517	40	25	181	113
	10	S-06	Al Lejam	1,068	2.07	1,311	40	25	52	33
	11	S-07	Bait Al Hadrami	2,550	2.07	3,130	40	25	125	78
	12	S-08	Dajah & Sarfah	2,647	2.07	3,249	40	25	130	81
	13	S-09	Ruhm	4,567	2.07	5,605	40	25	224	140
	14	S-10	Tawa'ar	4,593	2.07	5,637	40	25	225	141
	15	S-11	Al Hesn-Al Abyad	2,372	2.07	2,911	40	25	116	73
	16	S-12	Mahdah	196	2.07	241	40	25	10	6
	17	S-13	Al Ga'ra	2,047	2.07	2,512	40	25	100	63
	18	S-14	Al Ghail	1,000	2.07	1,227	40	25	49	31
Dahmar	19	D-01	Elow Al Mikhlaf	926	3.04	1,249	40	25	50	31
	20	D-02	Hamal-Bait Al Jabar	2,475	3.04	3,339	40	25	134	83
	21	D-03	Hegrat Al A'asham	1,592	3.04	2,148	40	25	86	54
	22	D-04	Al Kuob	3,256	3.04	4,393	40	25	176	110
	23	D-05	Mayfa'at Yaer	1,515	3.04	2,044	40	25	82	51
	24	D-06	Wardasan	2,146	3.04	2,895	40	25	116	72
	25	D-07	Al Asakera	1,944	3.04	2,623	40	25	105	66
	26	D-08	Masneat Abdul Aziz	406	3.04	548	40	25	22	14
Ibb	27	I-01	Asfal Bani Saba	9,311	2.47	11,884	40	25	475	297
	28	I-02	Al Sana	6,026	2.47	7,691	40	25	308	192
	29	I-03	Mamsa Al Marqab	2,810	2.47	3,587	40	25	143	90
	30	I-04	Al Jahlah & Al Meshraq	10,467	2.47	13,359	40	25	534	334
Taiz	31	T-01	Al Muayteeb	2,432	2.47	3,104	40	25	124	78
	32	T-02	Bani Al Suror	9,385	2.47	11,978	40	25	479	299
	33	T-03	Sheb Humran	23,732	2.47	30,290	40	25	1,212	757
	34	T-04	Yafiq Bani Hamad	6,844	2.47	8,735	40	25	349	218
	35	T-05	Al Azaez	11,784	2.47	15,040	40	25	602	376
	36	T-06	Al Khunha	1,579	2.47	2,015	40	25	81	50
<b>Total</b>				163,394		209,851			<b>8,393</b>	<b>5,245</b>

(5) Site Screening and Ranking

Data and information on present conditions of socio-economic activities, water sources, water supply facilities and community awareness of the candidate sites collected and compiled in the First Fiscal Year survey, as well as results of the groundwater survey conducted in the Second Fiscal Year were used to screen the 36 candidate sites for selection of sites to formulate a rural water supply improvement plan. The concept and criteria for selection as listed below were discussed and agreed with GARWSP.

- Availability of water source
- Water source situation
- Contribution from beneficiary
- Similar projects
- Land use and water rights
- Accessibility

As a result of the screening using the above criteria, 23 sites were retained as candidates for formulation of the rural water supply improvement plan. Then the sites were ranked using the following ranking parameters.

- Difficulty to receive water
- Needs for water supply improvement
- Water source potential
- Capacity for payment of operation and maintenance fees

The ranking of screened sites is shown in the table below.

Table 1-3 List of Screened Sites with Ranking

No.	Governorate	Code	Site Name	Ranking	
1	Al Mawheet	A-02	Jabal Al Taraf	19	
2		A-03	Ozlat Al Jaradi	16	
3	Sana'a	S-02	Jarban	20	
4		S-03	Al Kharaba	17	
5		S-04	Qamlan-Bait Al Najrani	10	
6		S-05	Afesh	12	
7		S-07	Bait Al Hadrami	9	
8		S-09	Ruhm	21	
9		S-11	Al Hesn-Al Abyad	13	
10		Dahmar	D-01	Elow Al Mikhlaf	1
11	D-02		Hamal Bait Al Jabar	7	
12	D-03		Hegrat Al A'asham	4	
13	D-05		Mayfa'at Yaer	3	
14	D-07		Al Asakera	6	
15	D-08		Masneat Abdul Aziz	2	
16	Ibb		I-01	Asfal Bani Saba	5
17			I-02	Al Sana	11
18		I-04	Al Jahlah & Al Meshraq	15	
19	Taiz	T-02	Bani Al Suror	22	
20		T-03	Sheb Humran	18	
21		T-04	Yafiq Bani Hamad	14	
22		T-05	Al Azaez	23	
23		T-06	Al Khunha	8	

(6) Assistance for IEE

Based on “JICA Guidelines for Environmental-Social Consideration”, an initial environmental examination (IEE) was made for this study. As a result of this study, approval was given by the Environmental Protection Authority (EPA) of Yemen for implementation of the screened sites without requiring procedures for further environmental impact assessment (EIA).

(7) Topographic Surveying and Other Complementary Surveys

Complementary field surveys were conducted at the screened sites to support formulation of the water supply improvement plan.

a. Topographic Surveying

The topographic surveying was carried for the following 2 methods.

- Route (profile) surveying for pipeline route design
- Plane surveying for planning of water supply facilities layout drawing

b. Confirmation of Land and Accessibility for Construction of Water Supply Facilities

Land plots necessary for construction of water supply facilities and accessibility to construction areas were confirmed at the screened sites to prepare the preliminary facilities design of water supply facilities. As a result, all targeted water sources and land planned for construction of water supply facilities were confirmed to be available for project implementation. Accessibilities for construction equipment into construction areas were also confirmed.

c. Survey on Procurement of Construction Equipment and Materials

The possibilities for local procurement and third country procurement of materials and equipment as well as use of local contractors were surveyed. Materials for civil works such as cement, concrete blocks and aggregates are locally produced, and imported steel and metallic products can be procured. In Yemen, diesel engine driven vertical (borehole) pumps are most popular, but submersible motor pumps are also being used. Market conditions of consumables and spare parts, and guarantees and repair system of suppliers and manufacturers were considered so that operation and maintenance of water supply facilities can be handled easily by local management.

(8) Supplementary Socio-Economic Survey

The main purpose of the supplementary socio-economic survey is to confirm the present difficulties for procuring reliable water, coverage area, service level, and other parameters

necessary for ranking of screened sites. Since water demand forecasts, water potential evaluation and preliminary design of water supply facilities have been conducted for the screened sites, reflecting on the needs of the residents in consideration of options determined to be appropriate for each site, a rural water supply improvement plan was formulated.

#### (9) Rural Water Supply Improvement Plan

Using survey results on socio-economic situation, water sources, existing water supply facilities and water supply activities, the following items were prepared for the screened sites as a rural water supply improvement plan.

- Rough preliminary design of water supply facilities
- Implementation plan
- Operation and maintenance plan
- Rough initial cost estimations

Furthermore, the rural water supply improvement plan was evaluated on economics, financial aspects, institutional aspects, appropriate technology, as well as natural and social environment. Refer to Chapter 6 of the Main Report for details.

#### (10) Draft Action Plan for Capacity Development

The capacities of GARWSP headquarters and branch offices were identified and assessed in the first fiscal year study. Also in the first fiscal year study, a participatory workshop was held to conduct a needs assessment on capacity building. As a result, capacity requirements necessary for planning, implementation and monitoring of rural water supply improvement projects and policy for their achievement were considered in order to prepare a draft action plan for capacity development.

Strengthening of capacity for planning and implementation of GARWSP headquarters and branch offices, in terms of implementation of water supply projects under sector reform calling for decentralization and transfer of authority to rural bodies, is the most important issue for consideration. Formulating a development policy and details of development needs for capacity building of GARWSP headquarters and branch offices is one of the main components of this study, and the important issues are listed below. Moreover, these issues become important policies for the pilot project scheduled for implementation in the third fiscal year and formulation of an action plan for capacity development of GARWSP.

- Adoption of Demand Responsive Approach
- Strengthening of Project Implementation System under Decentralization
- Introduction of Method for Community Based Operation and Maintenance and Capacity Building
- Method of Increasing Awareness of Residents on Water and Sanitation



## **1.2 Phase II: Assistance for Formulation of Action Plan on Capacity Development**

### 1.2.1 Second Fiscal Year Activities

#### (1) Submission of Interim Report

To conclude Phase I, an Interim Report was prepared to explain the study activities conducted during the First and Second Fiscal Years. At the beginning of Phase II, in February 2007, the Interim Report was submitted to the Yemeni side for discussions with GARWSP and other relevant organizations.

#### (2) Holding First Seminar

After submission of the Interim Report to the Yemeni side, a seminar was held in the capital city of Sana'a on 13 February 2007 to explain the results of Phase I activities, and to exchange knowledge and experience between the participants. The participants included members from GARWSP headquarters, GARWSP branch offices, donors, and local councils.

#### (3) Preparation for Pilot Project

At the end of the second fiscal year, the concepts and implementation procedures for the pilot project were discussed with GARWSP and other relevant concerns in preparation for the next stage. This activity was essential to avoid any unnecessary problems and delays so that the pilot project can be ready to commence at the beginning of the next fiscal year.

## 1.2.2 Third Fiscal Year Activities

### (1) Implementation of Pilot Project

A pilot project was implemented during the Fourth Study in Yemen. Three sites were selected from the screened sites according to the concept discussed with GARWSP. The pilot project included technology transfer on supervision of construction works, and the residents made contributions such as distribution of pipes and other materials from the stock yard to the construction areas, and pipe connections to individual households. GARWSP branch offices in the governorates of Al Mawheet, Sana'a and Dahmar were targeted for capacity development since sites appropriate for pilot project were available in the governorate and the branch office was sufficiently prepared for implementing the pilot project. The pilot project sites were selected in accordance with the conditions discussed and agreed with GARWSP. The results of pilot project implementation are explained in Chapter 7 of the Main Report.

### (2) Action Plan for Capacity Development of GARWSP

During Phase I, a draft action plan for capacity development was prepared from results of capacity assessment, field surveys and analyses of collected information. Subsequently, additionally reflecting on results of capacity building assistance given during the pilot project, an action plan for capacity development of GARWSP headquarters and branch offices was formulated. See Chapter 8 of the Main Report for details of the action plan for capacity development.

### (3) Preparation and Submission of Progress Report

The study activities being conducted during the Fourth Study in Yemen, especially the implementation of the pilot project, were organised and compiled as the Progress Report. Upon submission of this report, the contents of the report were discussed with GARWSP and other relevant agencies.

### (4) Preparation and Submission of Draft Final Report

At the end of the Fifth Study in Yemen, a Draft Final Report was prepared to report the results of the Study from Phase I to Phase II including rural water supply facilities improvement plan for screened sites and capacity development plan.

(5) Holding Second Seminar

After submission of the Draft Final Report, a second seminar was held on 1<sup>st</sup> October 2007 to explain the contents of the Draft Final Report and to exchange views and experiences between the participants. Stakeholders who participated in the seminar were representatives from GARWSP headquarters, GARWSP branch offices, relevant governmental organizations, donors, NGOs, local councils, water committees and others similar to the first seminar. Comments on the Draft Final Report as well as the Study itself were accepted from the participants to be reflected in the Final Report.

(6) Finalization of Study

As the final step of the Study, the Draft Final Report will be revised into the Final Report in consideration of the comments and remarks made by GARWSP, relevant organizations and other participants during the second seminar. JICA will send the Final Report to Yemen through official channels. Submission of the Final Report for “Rural Water Supply Component of the Study for Water Resources Management and Rural Water Supply Improvement in the Republic of Yemen” finalizes the Study in hopes of contributing to the improvement of rural water supply conditions and development of capacity in GARWSP organization.

## **2. SOCIO-ECONOMIC SURVEY**

## **2. SOCIO-ECONOMIC SURVEY**

### **2.1 Objective and Scope of Socio-Economic Survey**

#### 2.1.1 Objective of the Survey

The objective of the socio-economic survey is to comprehend the socio-economic conditions of the target villages of the study, present situation in water use and sanitation, perceptions of the community members on needs and valuation of the improved water supply and its operation and maintenance. Results of the survey and analysis will be utilized as a part of the baseline data for selection of priority projects and for formulation of the water supply plan.

#### 2.1.2 Scope of the Survey

The survey was conducted in 36 sites of 25 districts in five governorates by a local consultant subcontracted by the JICA Study Team. In each targeted site a sampled household survey was conducted from targeted villages, and an inventory survey was conducted at the village level as well as at district/sub-district level under the supervision of the Study Team.

### **2.2 Survey Methodologies**

#### 2.2.1 Fieldwork Organization

Three teams of five enumerators headed by a team leader in each team were responsible for data collection in the field. Each team was composed of two male and three female to enable the team to split along gender lines when and where necessary. At household level, four of the five team members worked in pairs (one male and one female), while the fifth member - being female - worked on her own. Female enumerators were able to administer the interview with a female household member and could also interview the male household head. However, for cultural reasons male enumerators were only restricted to do interviews with the male head of household. The team was small enough for the team leader to manage and to check the quality of the information collected by team members on a daily basis. The three teams were

supervised by a field supervisor who was moving from one team to another. The three team leaders and the field supervisors were all male. This gave them the advantage of being able to communicate effectively in a male dominated society, and enabled them to have easier access to the overwhelming male local authorities and local council members.

The survey areas were divided at governorate level into three sections based on their proximity to one another, number of questionnaires required from each governorate, and to the extent possible an equal distribution of questionnaires among the three teams.

1. Team I : For Sana'a with a total sample size of 541 households (hhs)
2. Team II : For Taiz and Ibb with a total sample size of 475 hhs (315 and 160 respectively)
3. Team III: For Al Mahweet & Dahmar with a total sample size of 484 hhs (170 and 314 respectively)

#### 2.2.2 Fieldwork Schedule

Prior to the commencement of the actual fieldwork at the target sites, training of enumerators and pre-test of questionnaires were conducted. The questionnaires were prepared by the JICA Study Team in English and translated into Arabic by the Survey Manager of the Interaction team after confirmation and clarification of the contents. A four-day training workshop was organized to train the enumerators during 21<sup>st</sup> – 24<sup>th</sup> January 2006 in Sana'a. After the survey team conducted the pre-test of the questionnaires in Al Hesn – Al Abyad, one of the target sites of the survey, as a part of the training program, the JICA Study Team and the field survey team finalized the questionnaires to be used in the survey.

The fieldwork for the three data collection teams started simultaneously on the 25<sup>th</sup> January 2006, and each team completed its fieldwork within the planned period. On average each site took around two days of fieldwork.

1. Team I : For Sana'a, took 24 days to complete fieldwork.
2. Team II : For Taiz and Ibb, took 23 days including travelling time
3. Team III : For Al Mahweet and Dahmar, took 23 days to complete fieldwork

**(1) Fieldwork Schedule for Team I in Sana'a:**

	Name of the Site	District	Day	Date
1	Al Hesn Al Abyad	Jehana	Wednesday	25/1/06
2			Thursday	26/1/06
3	Mahdah	Jehana	Friday	27/1
4			Saturday	28/1
5	Tawa'r	Al Hisn	Sunday	29/1/06
6			Monday	30/1/06
7	Al Lejam	Sanhan&Bani Bahlol	Tuesday	31/1/06
8	Bait Al Hadrami	Sanhan&Bani Bahlol	Wednesday	1/2/06
9			Thursday	2/2/06
10			Friday	3/2/06
11	Al Ga'ra	Al Teyal	Saturday	4/2
12	Afesh	Bilad Al Rous	Sunday	5/2
13			Monday	6/2
14	Ruhm	Sanhan & Bani Bahlol	Tuesday	7/2
15			Wednesday	8/2
16	Kharabah	Bani Matar	Thursday	9/2
17	Qamlan	Bani Matar	Friday	10/2
18	Jarban	Hamadan	Saturday	11/2
19	Jarban	Hamadan	Sunday	12/2
20	Al Ghail	Nehm	Monday	13/2
21	Al Ghail	Nehm	Tuesday	14/2
22	Bani Waleed Asboor	Al Hyma Kharjia	Wednesday	15/2
23	Bani Waleed Asboor	Al Hyma Kharjia	Thursday	16/2
24	Return to Sana'a City		Friday	17/2

**(2) Fieldwork Schedule for Team II in Taiz and Ibb:**

	Name of the Site	District	Day	Date
1	A trip to Taiz		Wednesday	25/1/06
2	Bani Al Suror	Al Maf'afar	Thursday	26/1/06
3			Friday	27/1/06
4			Saturday	28/1/06
5			Sunday	29/1/06
6	Sheb Humran	Al Maf'afar	Monday	30/1/06
7	Yafoq Bani Hamad	Al Mawaset	Tuesday	31/1/06
8			Wednesday	1/2/06
9			Thursday	2/2/06
10	Al Azaez	Al Shamayten	Friday	3/2/06
11			Saturday	4/2/06
12	Al Khunah	Al Wazieyah	Sunday	5/2/06
13			Monday	6/2/06
14	Al Muayteeb	Mawiyah	Tuesday	7/2/06
15	Traveling to Ibb & making arrangements with local council		Wednesday	8/2/06
16	Al Jahlah Al Meshraq	Ibb	Thursday	9/2/06
17			Friday	10/2/06
18	Al Marqab	Al-Makhader	Saturday	11/2/06
19	Al Sana	Al Makhader	Sunday	12/2/06
20	Asfal Bani Saba	Al Qafir	Monday	13/2/06
21	Asfal Bani Saba	Al Qafir	Tuesday	14/2/06
22	Asfal Bani Saba	Al Qafir	Wednesday	15/2/06
23	Traveling to Sana'a			

**(3) Fieldwork Schedule for Team III in Al-Mahweet and Dahmar:**

	<b>Name of the Site</b>	<b>District</b>	<b>Day</b>	<b>Date</b>
1	Traveling to Al Mahweet			25/1/06
2	Al Jaradi	Al Rujum	Thursday	26/1/06
3	Al Jaradi		Friday	27/1/06
4	Jabal Al Taraf	Al Mahweet	Saturday	28/1/06
5			Sunday	29/1/06
6	Al Sha'afel Al Olya	Al Khabt	Monday	30/1/06
7	Al Sha'afel Al Sofla		Tuesday	31/1/06
8	Jabal Bani Ali	Khamis Bani Sa'ad	Wednesday	1/2/06
9			Thursday	2/2/06
	Traveling to Dahmar			
10	Al Kuoab	Dhuran	Friday	3/2/06
11			Saturday	4/2/06
12	Hegrat Al Asham	Jabal Al Sharq	Sunday	5/2/06
13			Monday	6/2
14	Hamal Bait Al Jabar		Tuesday	7/2
15			Wednesday	8/2
16	Mayfa'at Year		Ans	Thursday
17	Al Asakerah	Mayfa'a	Friday	10/2
18	Masneat Abdulaziz		Saturday	11/2
19	Wardsan	Ans	Sunday	12/2
20			Monday	13/2
21	Elow Al Mikhlaf	Jabal Al Sharq	Tuesday	14/2
22			Tuesday	14/2
23	Return to Sana'a			

**2.2.3 Methodologies and Tools Applied for Data Collection**

The survey employed the following data collection methods and tools:

**Table 2-1 Data Collection Method and Tools**

<b>Data collection methods</b>	<b>Data collection tools</b>
Household interviews with the head of households	Structured interview with questionnaire
Household interviews with a female household member	Structured interview with questionnaire
Interview with the head district of LC and community figures	Semi-structured interview
Interview with the village leader at village level	Structured interview with questionnaire



#### 2.2.4 Sample Size and Sampling Methodology for Household Survey

The sample for the household socio-economic survey was designed to provide independent reliable estimates of social, health and economic indicators mainly livelihood, needs of the improved water supply and willingness and affordability for the water supply service at a household level to pay and sanitation for each of the 36 proposed sites (cluster of several villages) chosen for implementation of water supply projects.

The survey universe comprise of 36 sites that are designated from 25 districts of Al Mahweet, Sana'a, Dahmar, Ibb and Taiz. The overall sample size was determined to be 1500 households (approximately 10% of the households of the 36 sites). The overall sample allocation was done proportionately to each site by the JICA Study Team.

In each site, households were stratified by their geographical location in order to ensure a representative sample. The sample was randomly selected in one stage in each site area, The sampling frame of households was developed in the field during the village inventory survey by the team leader.

The interviewees of the household survey were mainly heads of households who controls the budget. Besides, adult women were interviewed for survey items related to present condition of water use, sanitations, and health as well as their needs for improved water supply. For this purpose, in addition to the main household's questionnaire, other questionnaire was administrated to female respondents in case the main respondent is male.

### **2.3 Results of Sample Household Survey**

#### 2.3.1 Characteristics of Respondents

1,500 samples were distributed to 36 target sites as shown in the table below.

Table 2-2 Distribution of Sample Households

Governorate	District	Site No.	Site Name	No. of Samples
Al Mahweet	Al Khabt	A-01	Al Sha'afel Al Olyah & Al Sufla	45
	Al Mahwit	A-02	Jabal Al Taraf	40
	Al Rujum	A-03	Ozlat Al Jaradi	45
	Bani Sa'ad	A-04	Al Khamis-Bani Ali	40
Sana'a	Al Haymah al Kharijyah	S-01	Bani Waleed-Al Asboor	40
	Hamdan	S-02	Jarban	40
	Bani Matar	S-03	Al Kharaba	40
	Bani Matar	S-04	Qamlan-Bait Al Najrani	40
	Belad Al Rous	S-05	Afesh	40
	Sanhan & Bany Bahloul	S-06	Al Lejam	40
	Sanhan & Bany Bahloul	S-07	Bait Al Hadrami	40
	Sanhan & Bany Bahloul	S-08	Dajah & Sarfah	40
	Sanhan & Bany Bahloul	S-09	Ruhm	40
	Al Hisn	S-10	Tawa'ar	40
	Jehana	S-11	Al Hesn-Al Abyad	40
	Jehana	S-12	Mahdah	21
	Al Teyal	S-13	Al Ga'ra	40
	Nehm	S-14	Al Ghail	40
Dahmar	Jabal Al Sharq	D-01	Elow Al Mikhlaf	48
	Jabal Al Sharq	D-02	Hamal-Bait Al Jabar	40
	Jabal Al Sharq	D-03	Hegrat Al A'asham	40
	Duran	D-04	Al Kuob	40
	Ans	D-05	Mayfa'at Yaer	40
	Ans	D-06	Wardasan	40
	Mayfa'a	D-07	Al Asakera	40
	Mayfa'a	D-08	Masneat Abdul Aziz	26
Ibb	Al Qafr	I-01	Asfal Bani Saba	40
	Al Makhader	I-02	Al Sana	40
	Al Makhader	I-03	Mamsa Al Marqab	40
	Ibb	I-04	Al Jahlah & Al Meshraq	40
Taiz	Mawiyah	T-01	Al Muayteeb	40
	Al Ma'afer	T-02	Bani Al Suror	75
	Al Ma'afer	T-03	Sheb Humran	40
	Al Mawaset	T-04	Yafiq Bani Hamad	45
	Al Shamayaten	T-05	Al Azaez	75
	Al Wazieyah	T-06	Al Khunha	40
Total				1,500

75% of the respondents for the questionnaire for the household head are male. Around 60% of the respondents are household heads themselves. In case that the male household head has been absent from the house for working in town or abroad for years, his spouse or other family members answered the questionnaire instead of him.

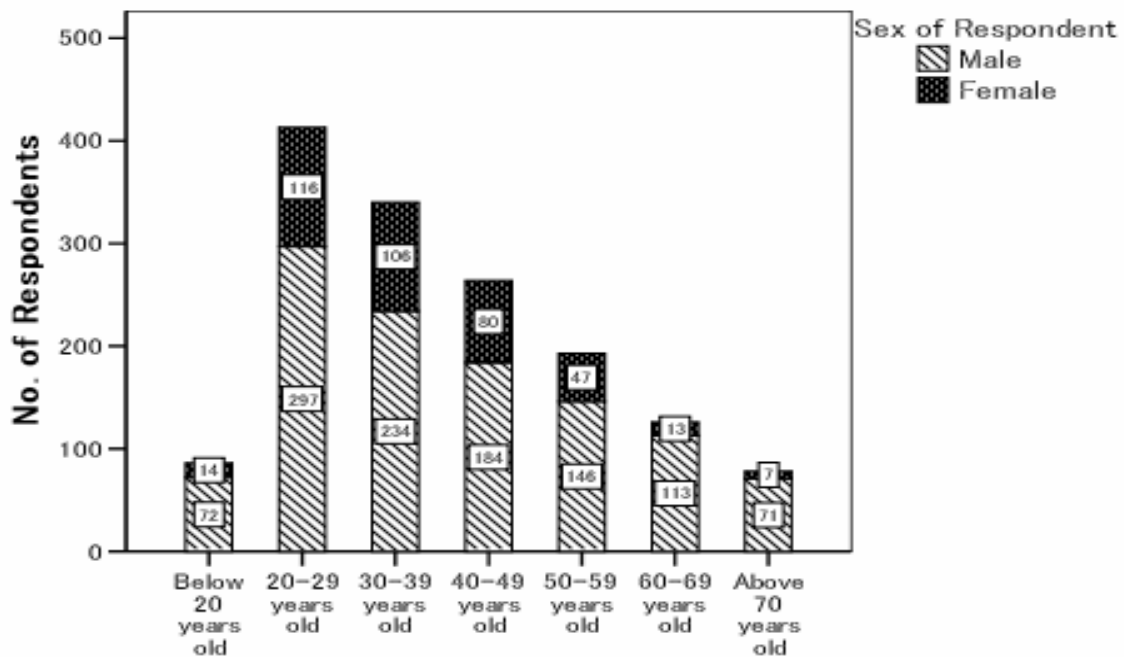


Figure 2-1 Distribution of Respondents by Sex and Age Group

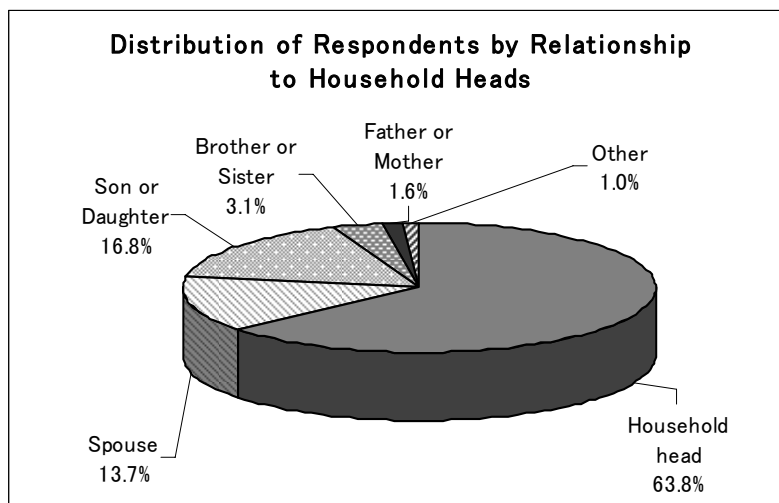


Figure 2-2 Distribution of Respondents by Relationship to Household Heads

### 2.3.2 Characteristics of Sample Households

Number of family members in a household is eight on average and half of the members are 14 years old and below according to the results of the sample household survey. Around 90% of the sample households are male-headed in their early forties. Marital status of the household heads is monogamous at more than 80% of the households interviewed in the survey.

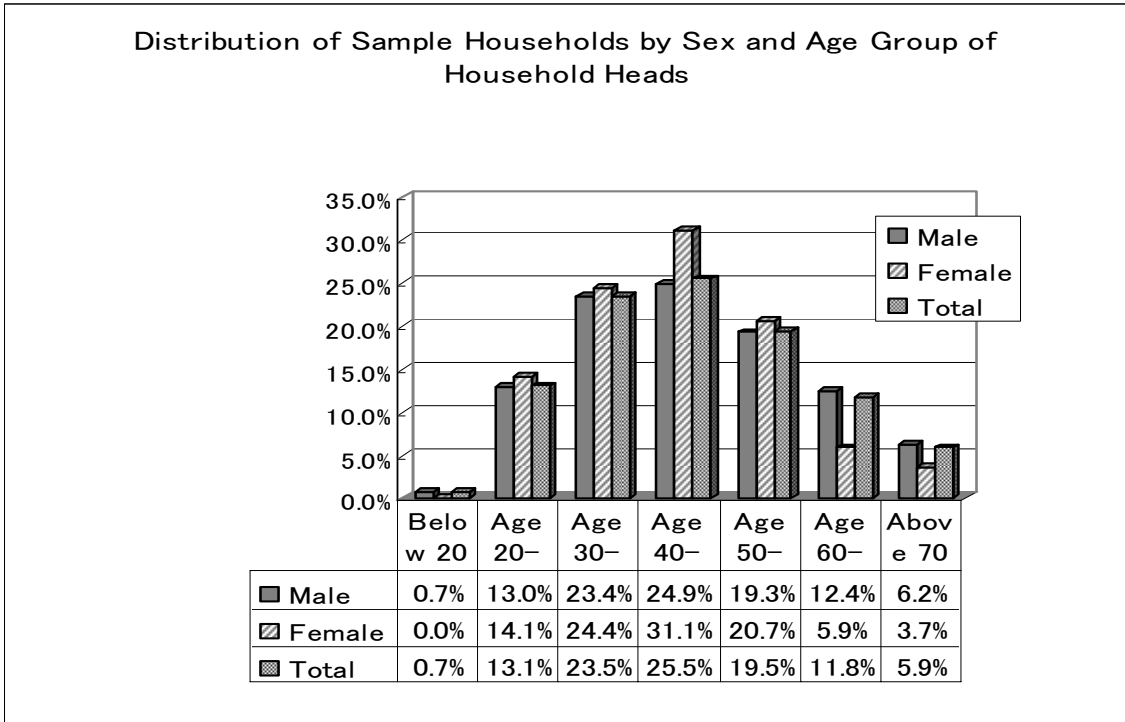


Figure 2-3 Distribution of Sample Households by Sex and Age Group

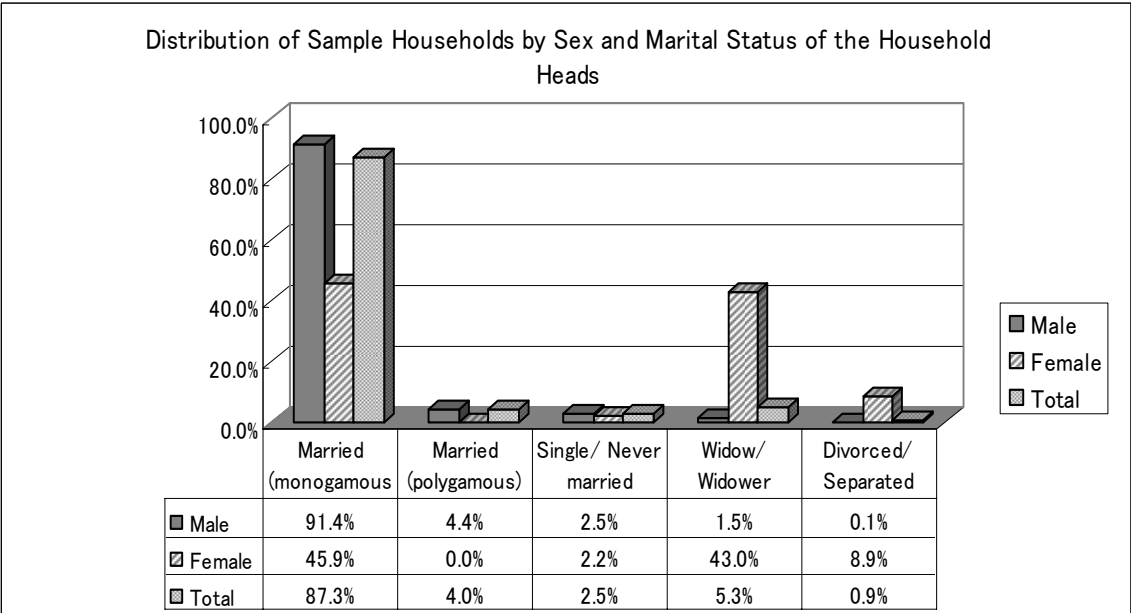


Figure 2-4 Distribution of Sample Households by Sex and Marital Status

### 2.3.3 Education Attainment of Household Members

Approximately 1,800 boys and 1,550 girls at basic school-age (6-14) were confirmed in the sample households. Among them, around 90% of boys and 70% of girls are attending the basic school. Enrolment rate of the basic school-aged children is shown in the figure below by governorate. Enrolment rate of boys in the sites in Sana'a is highest among five governorate while the highest rate of the girl's enrolment is shown in Taiz. Difference of the enrolment rates of boys and girls is also small in Taiz. On the other hand, the girl's enrolment rate in Dahmar has big gap with the one for boys in the same governorate.

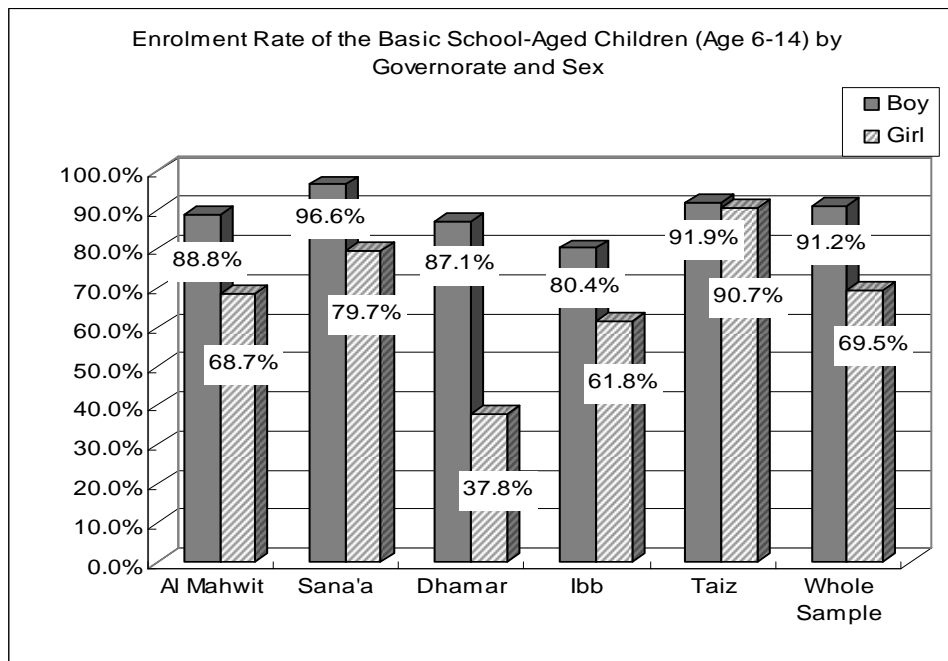


Figure 2-5 Enrolment Rate of Basic School-Aged Children

Figures below show critical reasons of non-enrolment of the school-aged children at the sample households. Common reason of non enrolment of school-aged boys and girls is difficulty for the household to afford the education costs. In addition, boys cannot attend school to help families earn their living. On the other hand, in case of girl child, parents regard that their child is still young to send school even though she is at the school-age and keep her at home. Also, girls are, in most cases, busy to help mothers in household chore including water fetching for their families. Other main factors to hinder girls to attend the school are long distance from the house to school and no female teachers at the school.

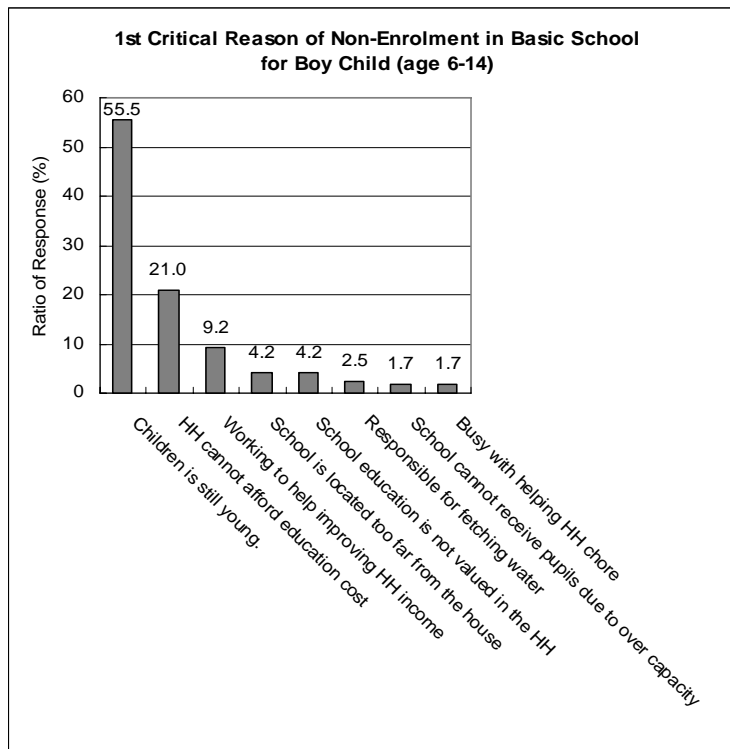


Figure 2-6 Reason for Non-Enrolment in Basic School of Boy Child

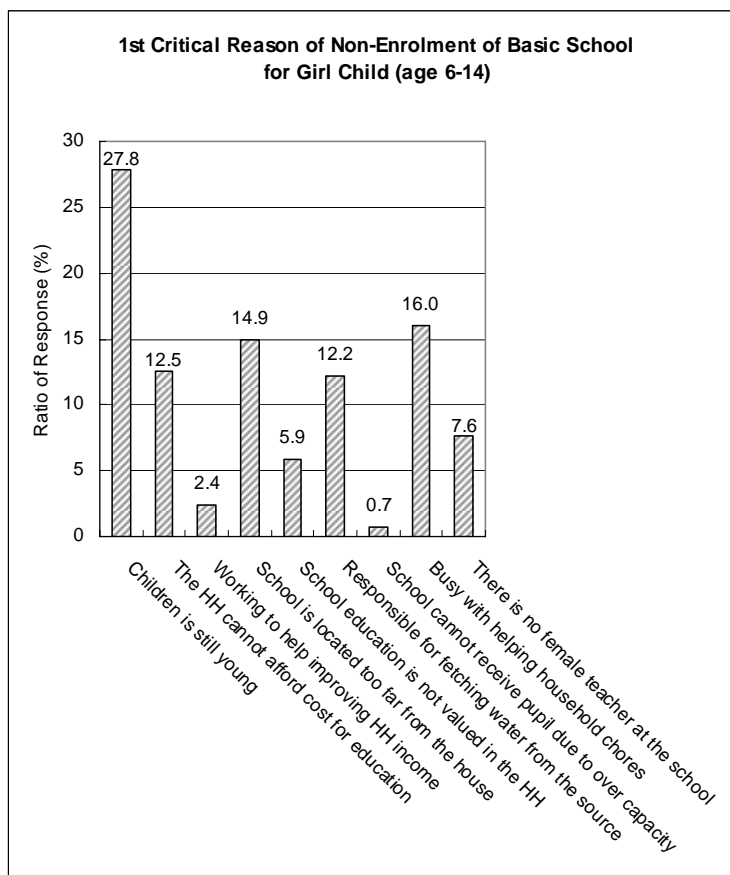


Figure 2-7 Reason for Non-Enrolment in Basic School of Girl Child

With regard to the literacy level of the family members at age 15 and above in the sample households, illiteracy rate of women is higher (70%) than the one for men (30%) as shown in the figure below.

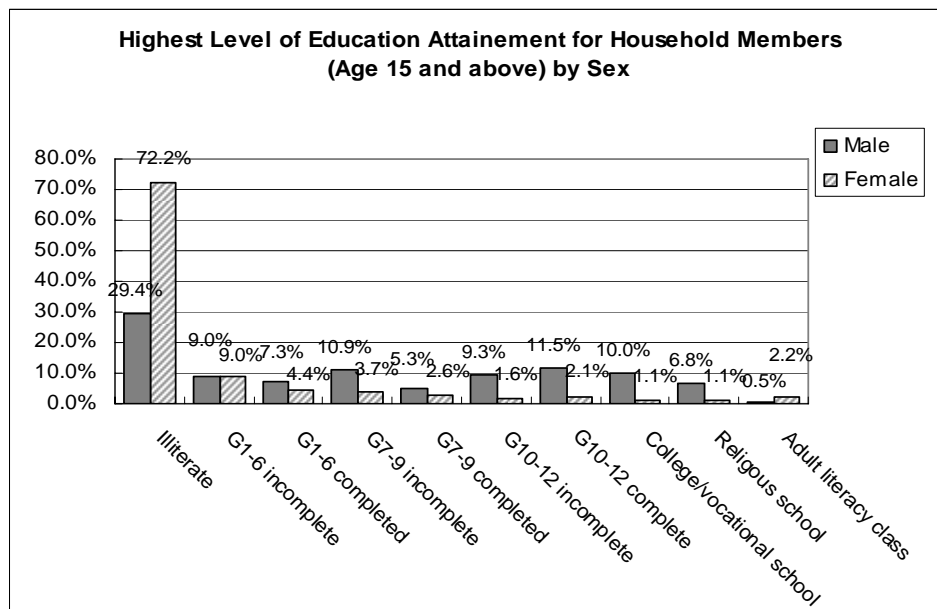


Figure 2-8 Highest Level of Education Attainment for Household Members

#### 2.3.4 Household Income and Expenditure

Main income sources for the communities in the screened sites is shown in a table and the percentage distribution of the sample households by the income sources is also indicated in a figure by governorate. In addition to agriculture which is the main income source for around 60% of the sample households, livestock rearing and employment in the army are also part of the income source for many households. Most of the sample households interviewed have more than one income sources.

Table 2-3 Type of Income Source for Sample Households

Type of Income Source	No. of Response		Ratio of Case
	N	Ratio	
Agriculture	883	31.9%	58.9%
Day labor	660	23.8%	44.0%
Livestock rearing	387	14.0%	25.8%
In the army	337	12.2%	22.5%
Civil servant	176	6.4%	11.7%
Retail (running shops)	85	3.1%	5.7%
Money transfers from abroad	75	2.7%	5.0%
Employee of private company	23	0.8%	1.5%
Other	142	5.1%	9.5%
Total	2,768	100.0%	184.5%

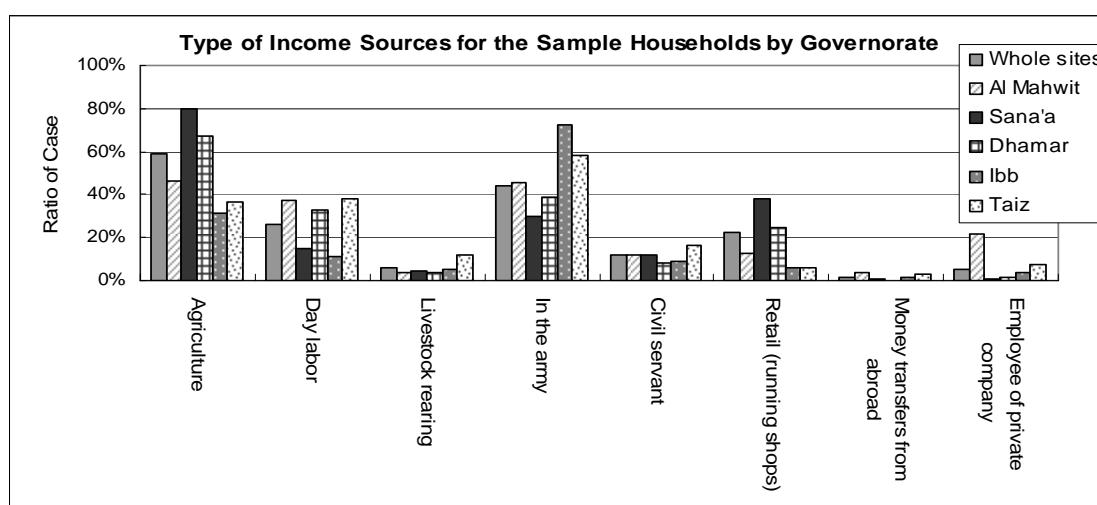


Figure 2-9 Type of Income Source for Sample Households by Governorate

Mean monthly income is YR42,000/household and median is YR30,000. For the monthly expenditure, average figure is YR39,000/household while median is YR31,000.

As shown in the table below, the household income for the sample households in Sana'a is the highest in five governorates while the one in Ibb is the lowest.

Table 2-4  
Monthly Household Income by Governorate

Governorate	Mean	Median
Al Mahweet	39,845	30,000
Sana'a	53,454	36,667
Dahmar	41,195	30,000
Ibb	27,459	20,000
Taiz	31,841	26,750
All Sites	42,062	30,000

Divided the samples by percentile at 25%, 50% and 75%, per capita monthly income is further compared by the income level and governorate. Difference among the income groups is biggest in Sana'a as shown in the figure below.



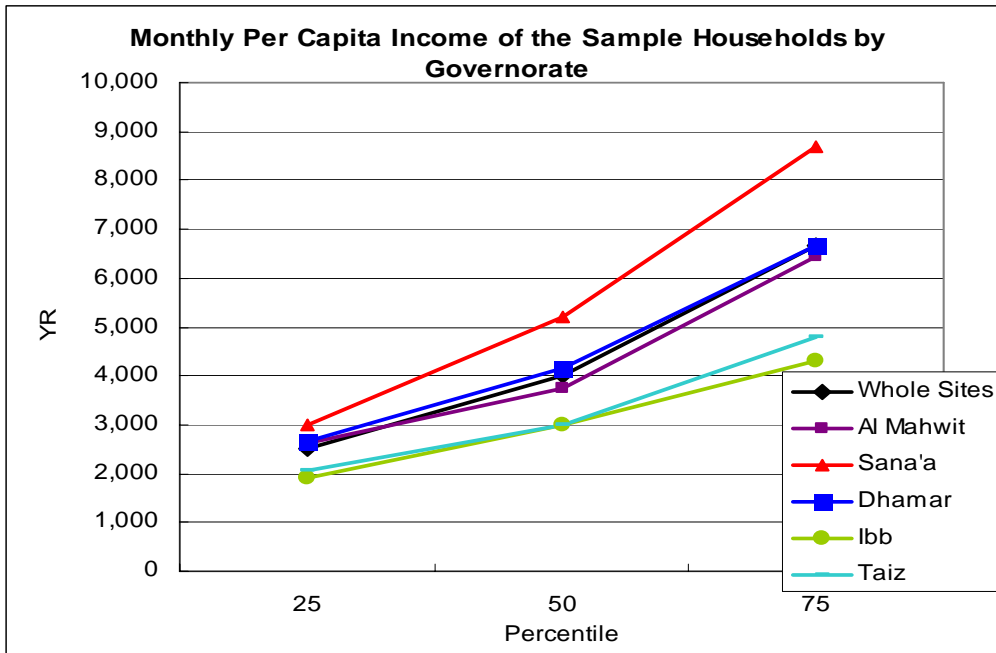


Figure 2-10 Monthly Per Capita Income of Sample Households by Governorate

Expenditure for food occupies around 59% of the total monthly household expenditure. Expenditure for water including domestic and other purposes is around 7%. Also, 14% of the monthly expenditure is spent for nonessential grocery such as tobacco and qat.

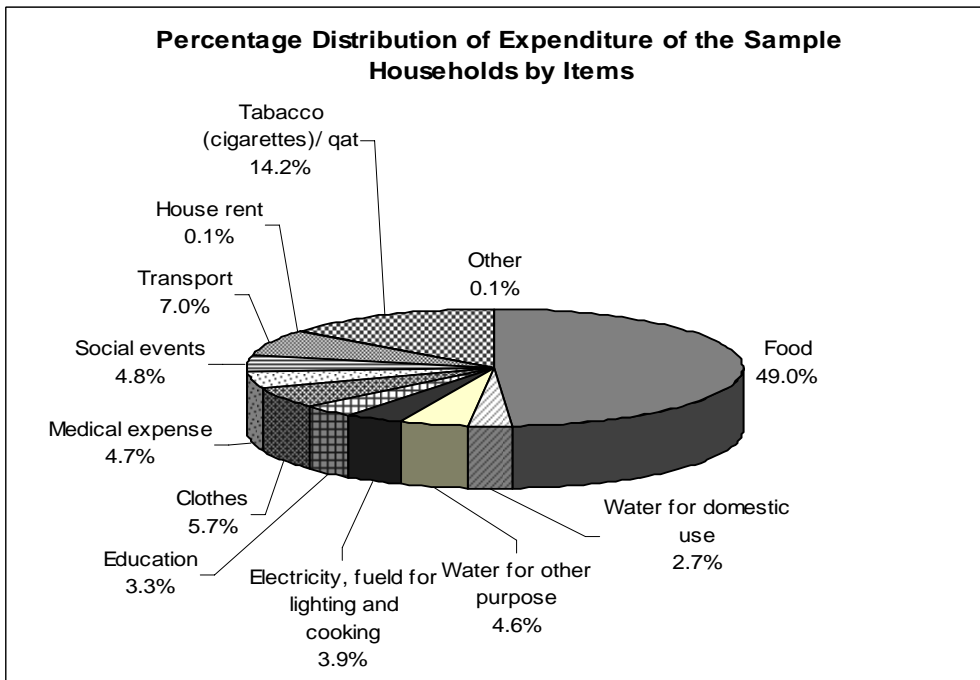


Figure 2-11 Percentage Distribution of Expenditure of Sample Households

### 2.3.5 Water Use Patterns

The figure below shows type of water sources used by the sample households for domestic use. For the sites where they do not have access to the piped water scheme, most of the households rely on the private boreholes and unprotected spring/ wells. Even in case that they have a communal piped water scheme, supply conditions are erratic due to the limited supply capacity against the demand as well as break down of the facilities.

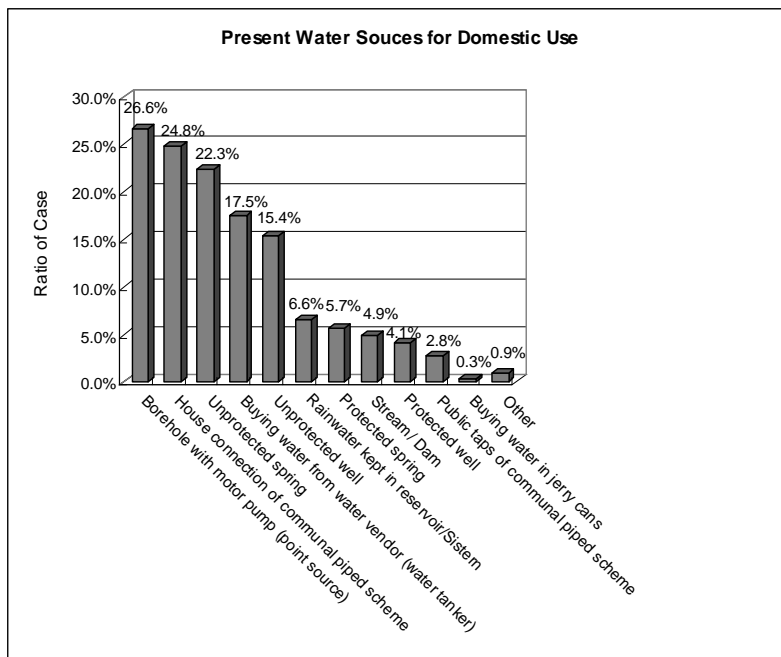


Figure 2-12 Present Water Sources for Domestic Use

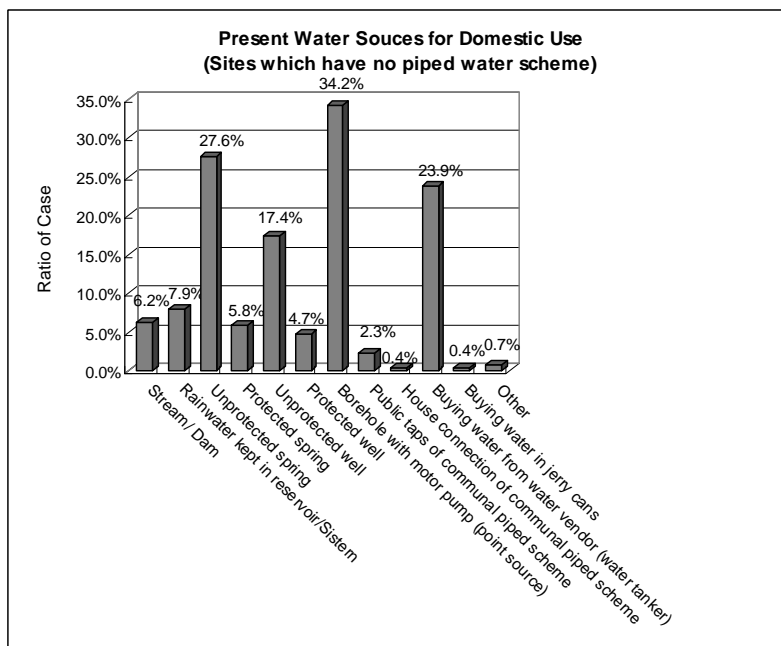


Figure 2-13 Present Water Sources for Domestic Use (Sites with No Piped Water)

Boreholes and springs are perceived safe for drinking while rainwater kept in cisterns is mainly used for washing and animal watering. Water for irrigation is mainly from rainwater apart from the households which have their own private boreholes or shallow wells.

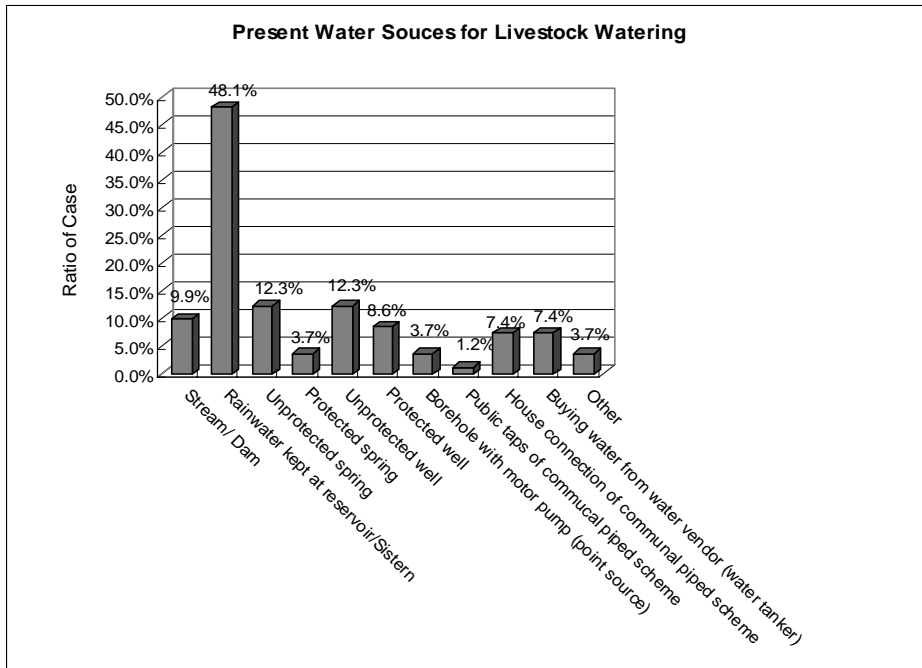


Figure 2-14 Present Water Sources for Livestock Watering

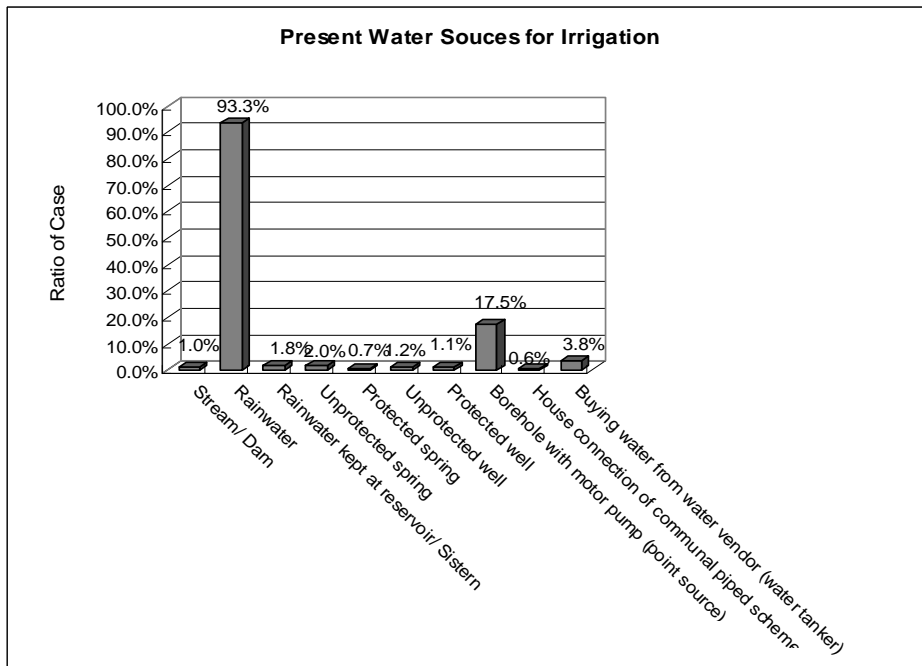


Figure 2-15 Present Water Sources for Irrigation

The volume of daily water consumption for domestic use is approximately 165 liters/household/day (l/hh/d) and 20 liters/person/day (l/pers/d) at the median level. In order to obtain water for domestic use, 48% of the sample households spend money at a median amount of YR1,400/household/day which accounts for about 4.5-5% of the monthly household income. Other households get water for domestic use free of charge.

Table 2-4 Volume of Water Consumption for Domestic Use

Parameter		l/hh/d	l/pers/d
Frequency	Valid Number	1497	1494
	Missing Number	3	6
Mean		191.723	26.648
Median		166.667	20

Table 2-5 Cost Spent for Domestic Water by Sample Households

	Unprotected spring	Protected spring	Unprotected well	Protected well	Borehole with motor pump	Public taps of communal piped scheme	House connection of communal piped scheme	Buying water from water vendor	Buying water in jerry cans
Valid Number	11	4	7	9	55	16	367	269	7
Missing N (N/A)	1489	1496	1493	1491	1445	1484	1133	1231	1493
Mean	304.55	240	661.43	3040	2403.64	1379.38	1112.97	3938.85	2525.71
Median	300	240	500	3000	1500	1000	850	3000	1500

Water fetching is primarily one of the responsibilities of adult women in the household and girl child often help her mother collect water as shown in the figure below.

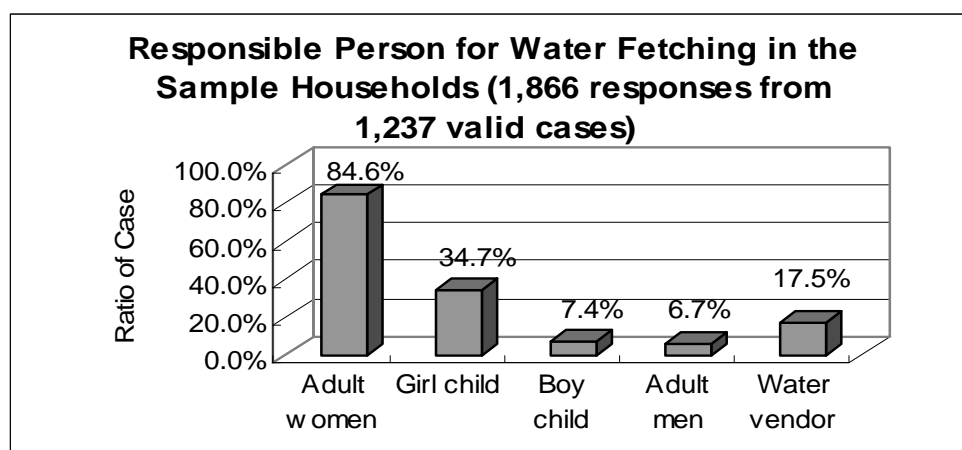


Figure 2-16 Responsible Person for Water Fetching in Sample Households

At the households which are not connected to a piped water scheme, they rely on donkeys to carry water kept in plastic container from the source to their houses. As it is difficult for them to carry water at once enough for the daily consumption, they need to fetch water four times a day on average with approximately 30 minutes to one hour for one trip including the time to wait at the water point. Therefore households require two to four hours a day for water collection.

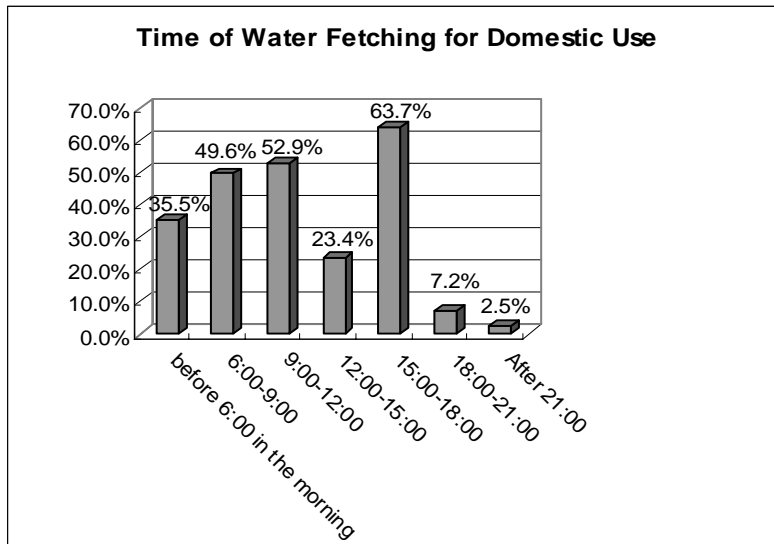


Figure 2-17 Time Period of Water Fetching for Domestic Use

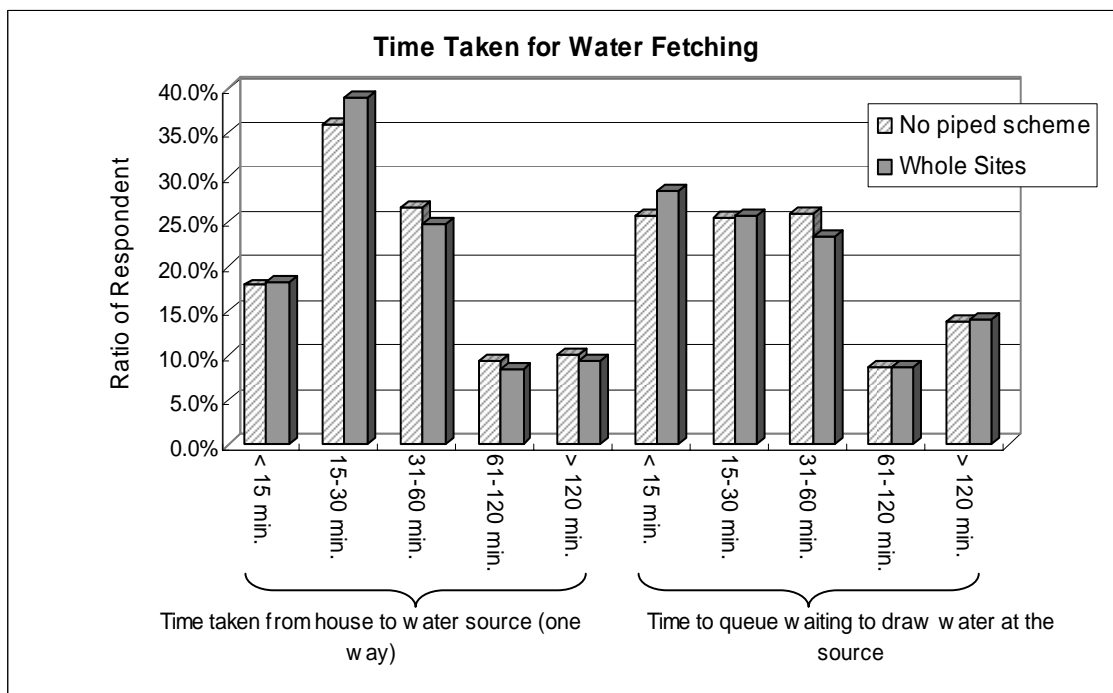


Figure 2-18 Time Taken for Water Fetching

### 2.3.6 Health and Sanitation Conditions

Main diseases for the community members in the screened sites are malaria, respiratory diseases and kidney diseases for adult men and women, and diarrhoea for children. As measures to prevent diarrhoea, half of the sample households practice hand washing before eating, drinking clean water, and protecting food from contamination, respectively. On the other hand, hand washing after using the toilet is not common to the households surveyed. Treatment of drinking water is hardly practiced in the screened sites. 90% of the sample households answered that they drink water as it is while those who treat water normally boil or filter it with cloth.

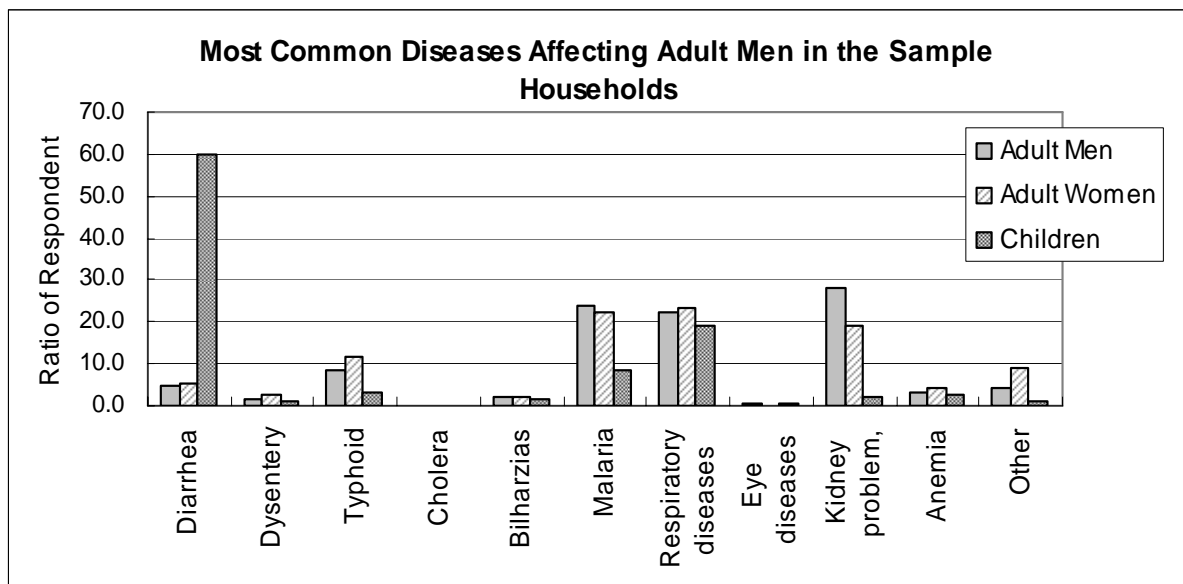


Figure 2-19 Common Diseases Affecting Adult Men in Sample Households

With regard to sanitation environment, the table below shows distribution of sample households by type of toilet which are owned by them. Nearly 75% of the households surveyed have toilets of the pour flush type which is discharged to open land or soaked in a pit in most cases. The remaining households do not have latrines as they cannot afford the construction cost or enough water is not available for them. If the household does not have a latrine, family members usually defecate outside their compound while children sometimes use the yard for defecation.

Table 2-6 Type of Toilet Owned by Sample Households

Type of Toilet	Number	%	Valid %
Flush discharging to open land	450	30.0%	40.1%
Flush connected to pit	405	27.0%	36.1%
Dry pit latrine	120	8.0%	10.7%
Uncovered pit	82	5.5%	7.3%
Covered pit	54	3.6%	4.8%
Flush connected to sewage network	6	0.4%	0.5%
Other	4	0.3%	0.4%
Total	1,121	74.7%	100%
N/A (no toilet at the house)	379	25.3%	
Grand Total	1,500	100%	

2.3.7 Valuation for Improved Water Supply

All of the screened sites where protected water sources are not available ranked water supply as the highest priority to improve their living conditions. Meanwhile, other needs such as job opportunity and power supply are higher than the one for water supply in the sites where public water schemes are currently operational.

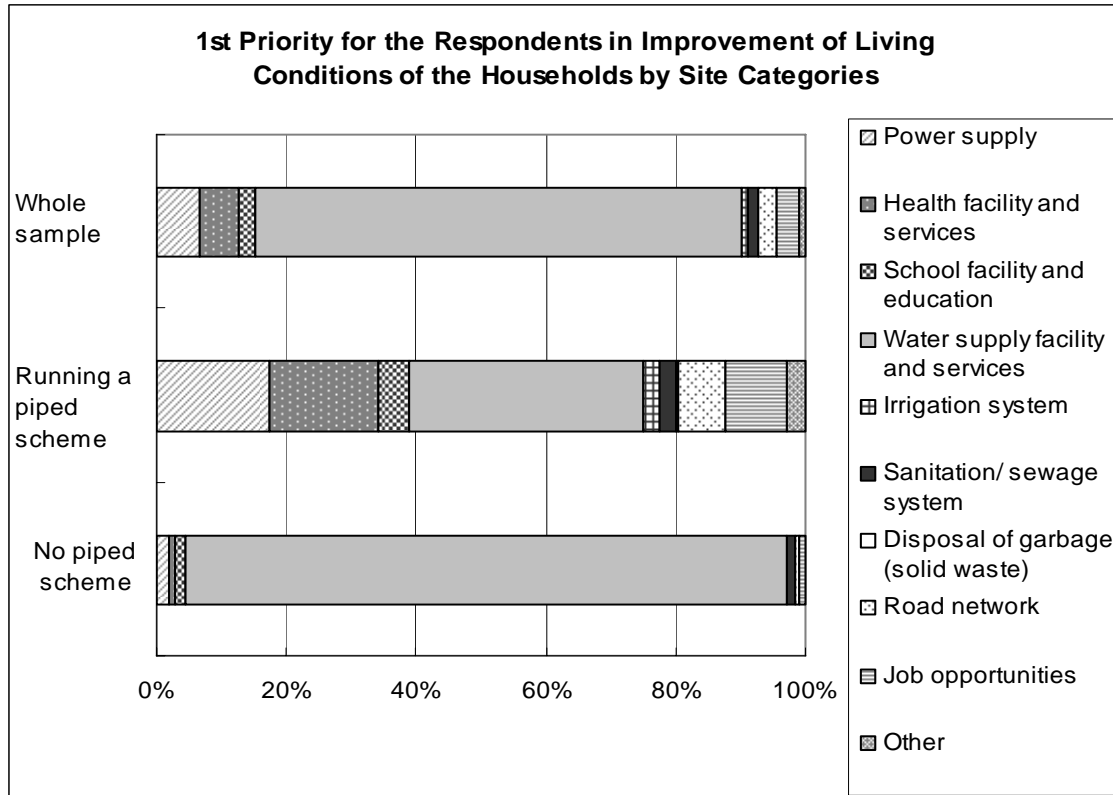


Figure 2-20 First Priority of Respondents for Improved Living Conditions

Females have higher interest on improvement of sanitation rather than male though water supply is common priority area for both male and female in the target sites.

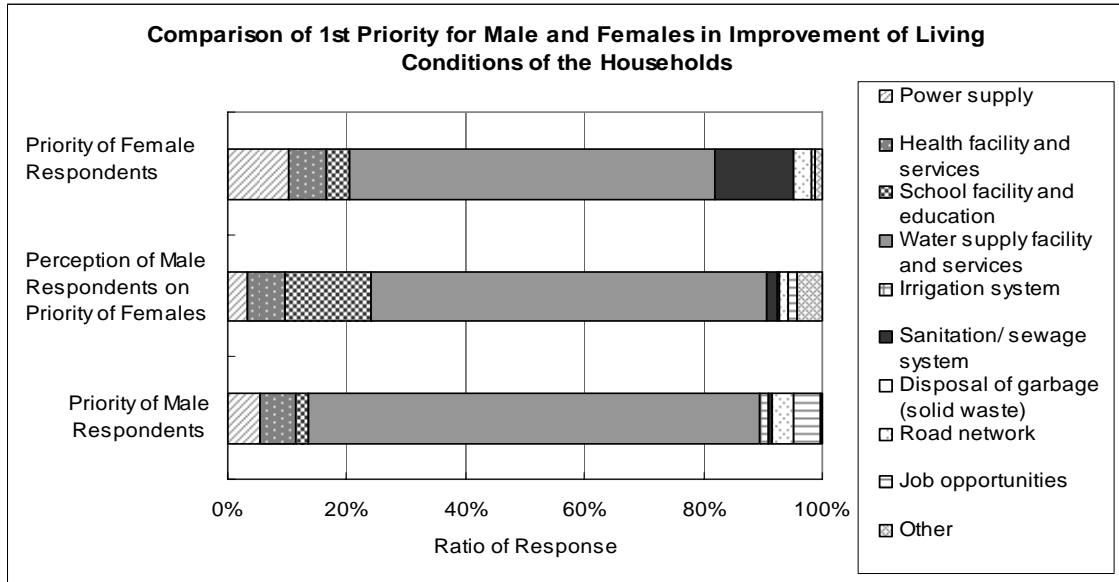


Figure 2-21 Comparison of First Priority between Male and Female for Improved Living Conditions

In the sample household survey, around 90% of the sample households expressed their needs for improvement of existing water supply conditions as they perceive that they cannot get enough quantity of water at present. Priority in usage of water is put on drinking and cooking. Also, needs of water for livestock watering is relatively high for the households which own domestic animals.

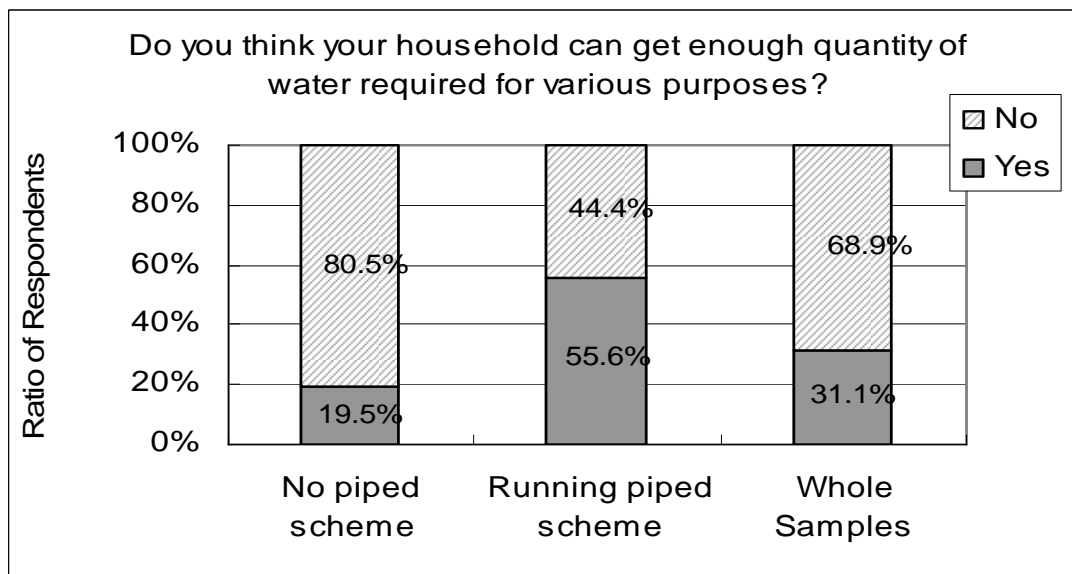


Figure 2-22 Response to Sufficiency of Water



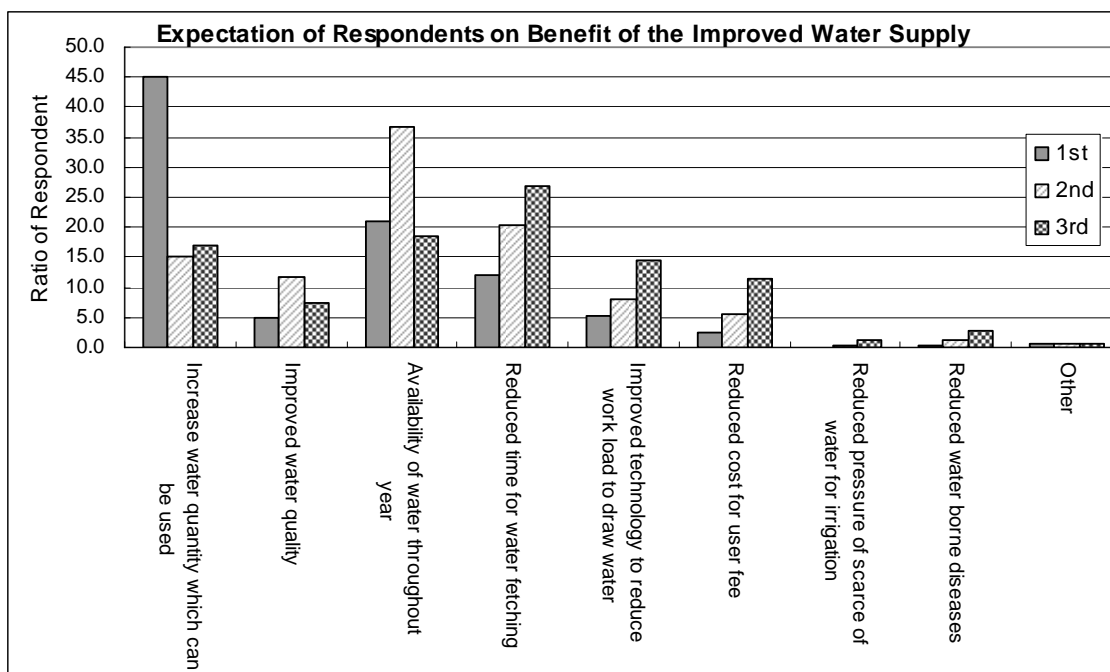


Figure 2-23 Expectation of Respondents on Benefit of Improved Water Supply

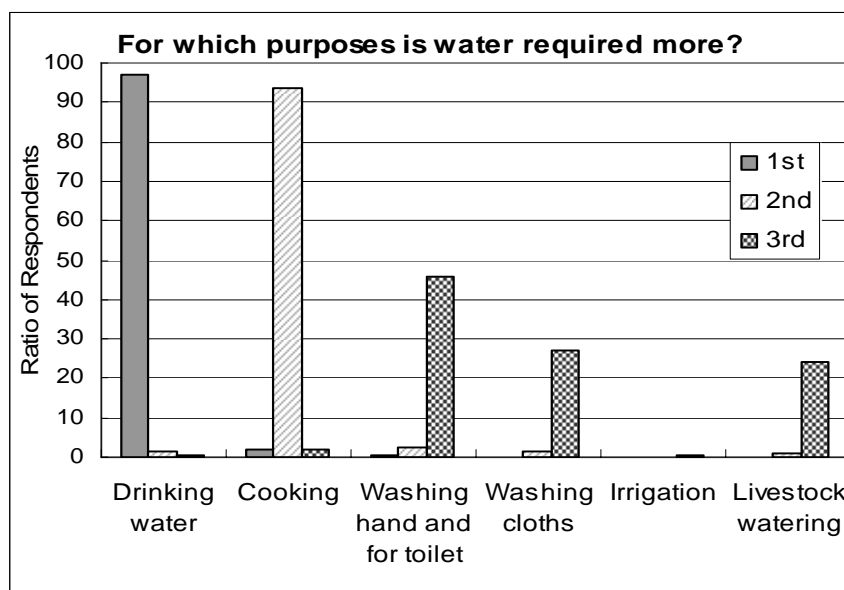


Figure 2-24 Water Use Purposes

Most respondents expect increase in water quantity which can be used, availability of water perennially, and reduction of time for water fetching. Further, 95% of them are willing to pay at a median amount of RY150/m<sup>3</sup> as user fee for operation and maintenance cost and 82% also showed willingness to contribute to part of the construction cost of the facilities. Contribution to part of the construction cost of the facilities can mainly be done in a manner through provision of labour force or payment in cash at YR2,000/household.

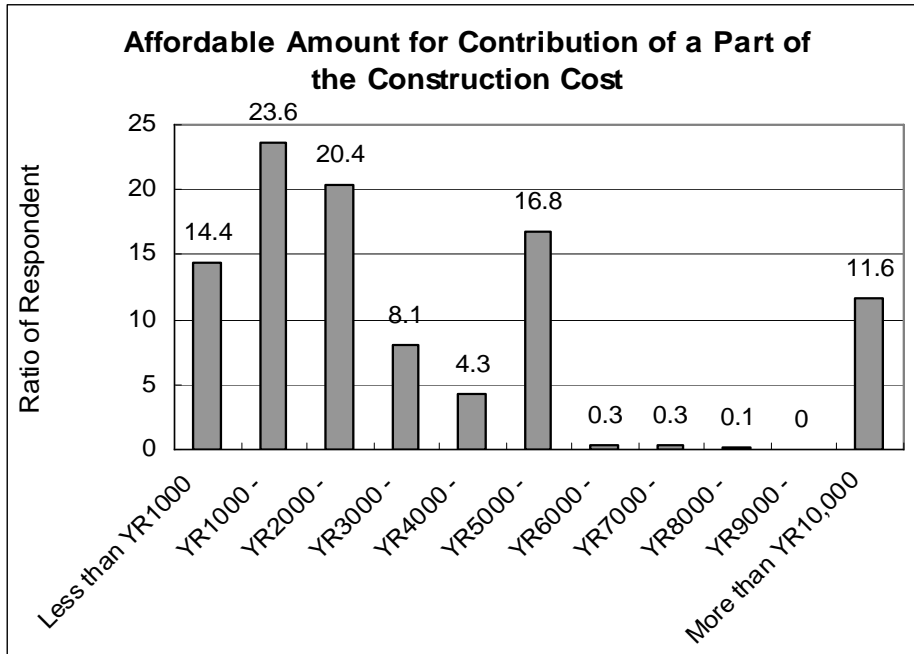


Figure 2-25 Affordable Amount of Contribution to Construction Cost

Additional water demand for domestic use averages 160 lit/household/day (100 lit/household/day at median level) and 23 lit/person/day (16 lit/person/day at median level) in the case where the water supply condition is improved through construction or rehabilitation of piped water schemes.

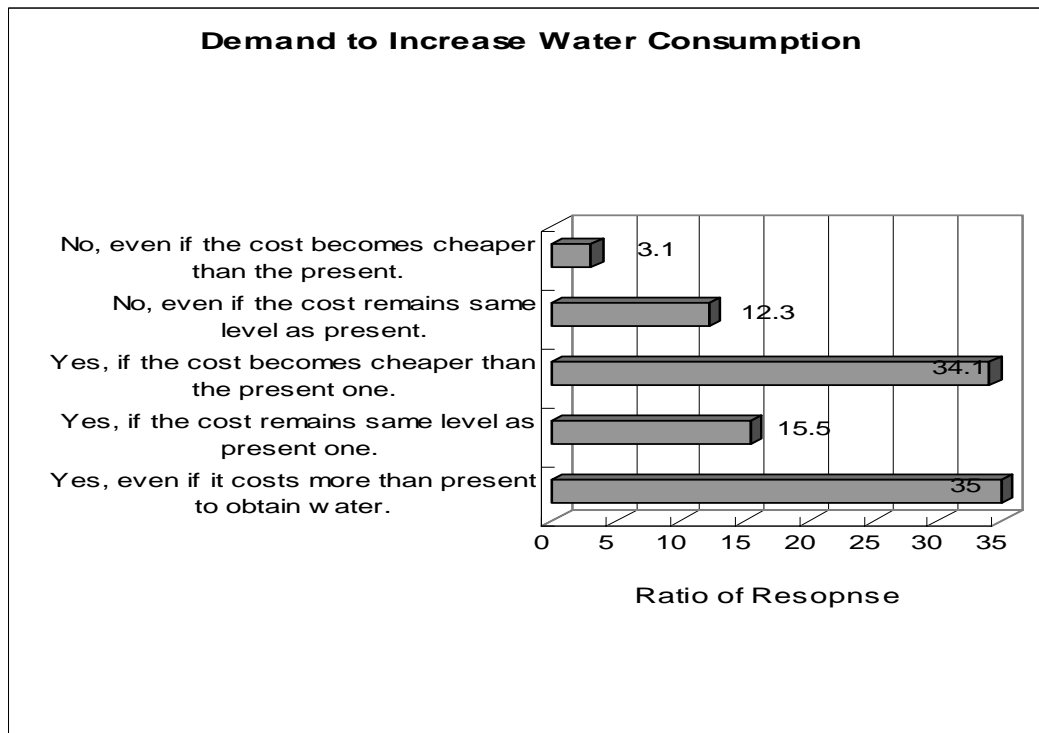


Figure 2-26 Response to Increase in Water Consumption

### 2.3.8 Awareness on Management of Water Supply

The table below shows the awareness of respondents on existence of a water committee in the site. In communities which presently run communal piped water schemes, majority of the respondents understand that the water committee is responsible for daily management of the water scheme. Around 85% of the respondents are satisfied with the management of the present water committee in the sites where the water scheme is under operation.

Table 2-7 Awareness of Respondents on Existence of Water Committee in the Site

Site No.	Yes	No	Total	Valid N	Don't Know	Condition of Existing Public Scheme	Mode of Management Entity
A-01	0.0%	100.0%	100%	45	0	No existing scheme	-
A-02	100.0%	0.0%	100%	38	2	Working	CBO (registered)
A-03	90.9%	9.1%	100%	44	1	Working	CBO
A-04	2.6%	97.4%	100%	38	2	No existing scheme	-
S-01	0.0%	100.0%	100%	40	0	No existing scheme	-
S-02	17.5%	82.5%	100%	40	0	Not working	CBO
S-03	0.0%	100.0%	100%	40	0	Not working	Traditional Authority
S-04	0.0%	100.0%	100%	40	0	Not working	-
S-05	0.0%	100.0%	100%	40	0	Not working	-
S-06	100.0%	0.0%	100%	40	0	Working	CBO
S-07	5.0%	95.0%	100%	40	0	No existing scheme	-
S-08	2.5%	97.5%	100%	40	0	No existing scheme	-
S-09	0.0%	100.0%	100%	35	5	No existing scheme	-
S-10	60.5%	39.5%	100%	38	2	Working	Traditional Authority
S-11	95.0%	5.0%	100%	40	0	Working	CBO
S-12	0.0%	100.0%	100%	21	0	Not working	-
S-13	0.0%	100.0%	100%	40	0	No existing scheme	-
S-14	2.5%	97.5%	100%	40	0	Not working	-
D-01	0.0%	100.0%	100%	48	0	No existing scheme	-
D-02	2.5%	97.5%	100%	40	0	No existing scheme	-
D-03	0.0%	100.0%	100%	40	0	No existing scheme	-
D-04	0.0%	100.0%	100%	40	0	No existing scheme	-
D-05	15.4%	84.6%	100%	39	1	Working	Traditional Authority
D-06	0.0%	100.0%	100%	39	1	No existing scheme	-
D-07	0.0%	100.0%	100%	40	0	No existing scheme	-
D-08	3.8%	96.2%	100%	26	0	No existing scheme	-
I-01	7.5%	92.5%	100%	40	0	No existing scheme	-
I-02	2.5%	97.5%	100%	40	0	No existing scheme	-
I-03	6.1%	93.9%	100%	33	7	No existing scheme	-
I-04	2.5%	97.5%	100%	40	0	No existing scheme	-
T-01	0.0%	100.0%	100%	40	0	Not working	-
T-02	96.0%	4.0%	100%	75	0	Working	CBO (registered)
T-03	92.5%	7.5%	100%	40	0	Working	CBO (registered)
T-04	77.3%	22.7%	100%	44	1	Working	CBO
T-05	100.0%	0.0%	100%	74	1	Working	CBO (registered)
T-06	0.0%	100.0%	100%	40	0	No existing scheme	-
<b>Total</b>	<b>28.6%</b>	<b>71.4%</b>	<b>100%</b>	<b>1,477</b>	<b>23</b>		

\*CBO (registered): Management body of the water scheme is registered under the Ministry of Social Affairs and has legal status.

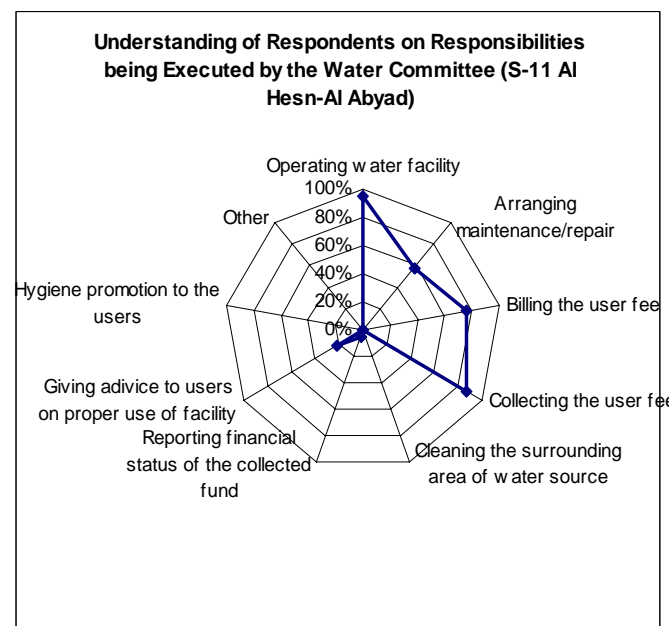
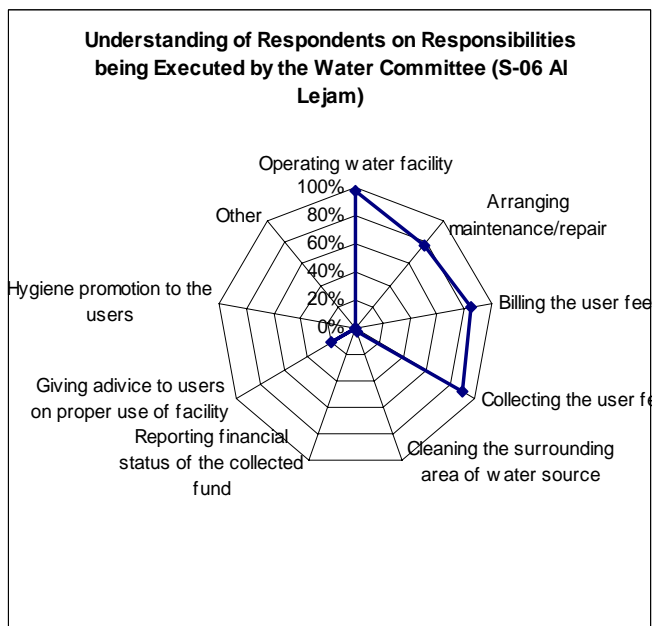
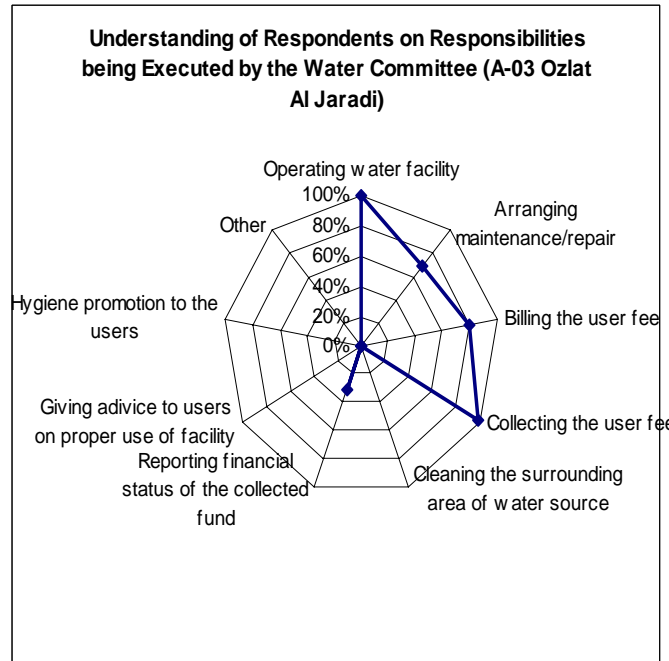
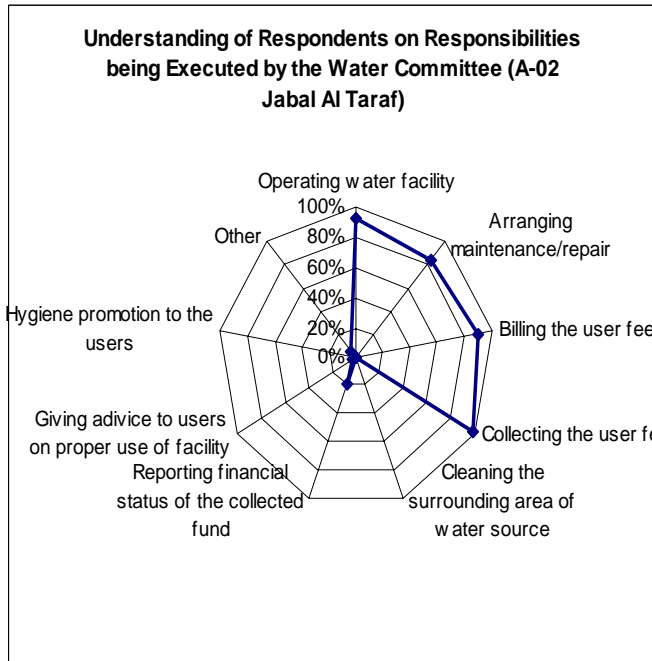


Figure 2-27 Understanding of Respondents on Responsibilities of Water Committee (Sites in Al-Mawheet and Sana'a Governorates)

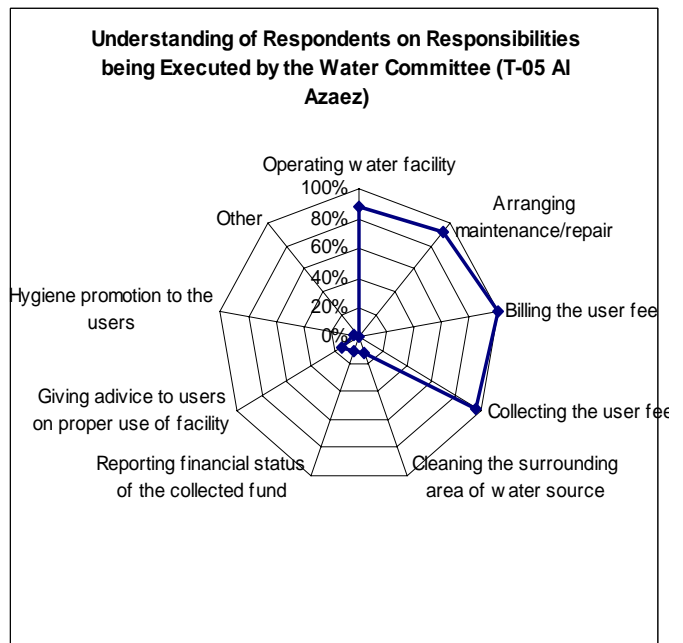
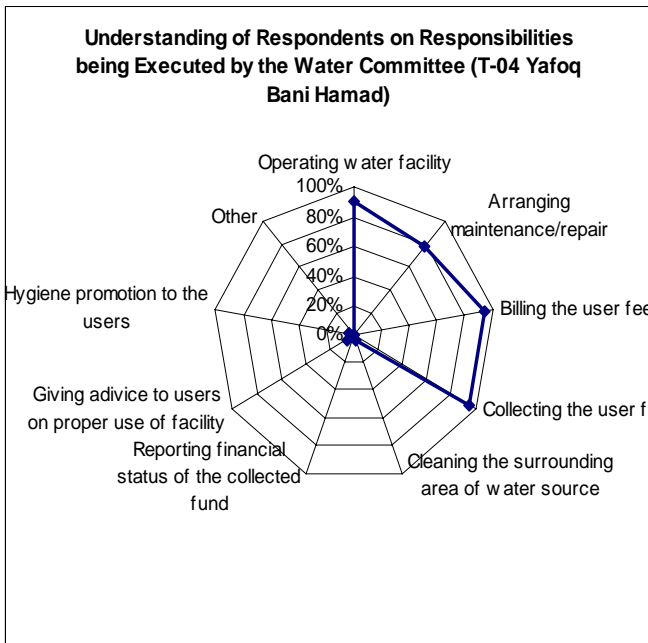
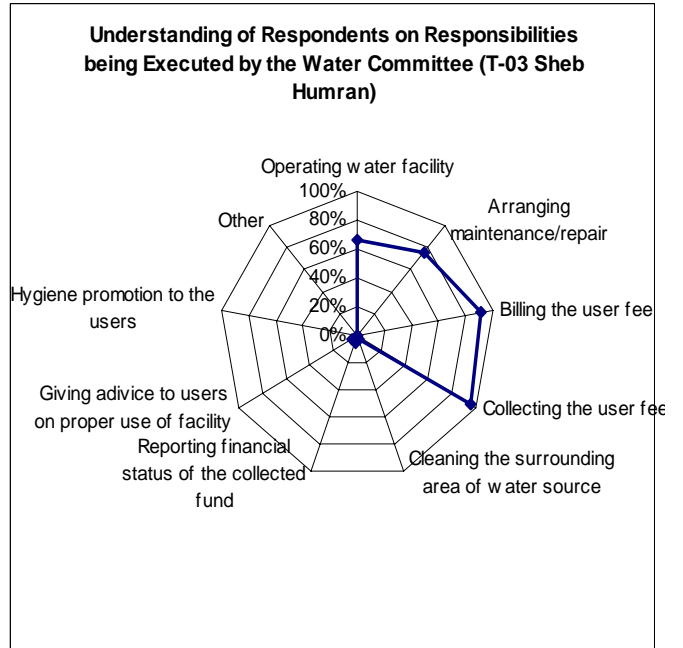
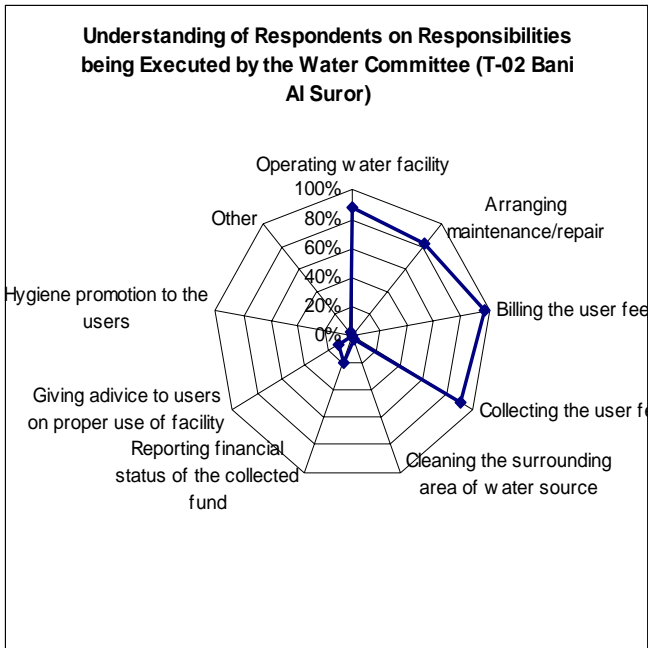


Figure 2-28 Understanding of Respondents on Responsibilities of Water Committee (Sites in Taiz Governorate)

## 2.4 Socio-Economic Situation of Screened Sites

### (1) Demography

According to the population census of 2004, the national population of Yemen is approximately 19.6 million with an annual average growth rate of 3.0% from 1994 to 2004. Table 2-8 shows the distribution of population at the governorates covered in this study.

Table 2-8 Distribution of Governorate Population

Governorate	Population		Average Annual Growth Rate (1994-2004)	Ratio of Population Distribution (2004)
	1994	2004		
Al-Mawheet	371,595	495,045	2.87%	2.5%
Sana'a	746,812	918,727	2.07%	4.7%
Dahmar	981,674	1,330,108	3.04%	6.8%
Ibb	1,665,054	2,131,861	2.47%	10.8%
Taiz	1,870,057	2,393,425	2.47%	12.2%
<b>Total, Yemen</b>	<b>14,587,807</b>	<b>19,685,161</b>	<b>3.00%</b>	

Source:

- Website for the Central Statistical Organization, Final Results of the General Census for 2004 at Governorate Level
- Central Statistical Organization (2004), 2004 Statistical Year Book, Sana'a

From results of socio-economic surveys and reference to the population census of 2004 as well as other information, the populations of screened sites for 2006 are listed in Table 2-9. The population size varies from a minimum of 400 to a maximum of almost 24,000. The average population of the screened sites is about 5,600 while the median population is 2,550. Based on the population for 2006, a projection was made to estimate the population of each site at 2016 with applying the annual average growth rate of 1994-2004 at the governorate level from the latest census. This information will be used as basis to formulate the rural water supply improvement plan.

Table 2-9 Population of Screened Sites

Governorate	No.	Code No.	Site Name	Present Population (2006)	Population Growth Rate (%)	Population Forecast (2016)
Al Mawheet	1	A-02	Jabal Al Taraf	2,727	2.87	3,619
	2	A-03	Ozlat Al Jaradi	20,786	2.87	27,584
Sana'a	3	S-02	Jarban	1,611	2.07	1,977
	4	S-03	Al Kharaba	1,361	2.07	1,670
	5	S-04	Qamlan-Bait Al Najrani	629	2.07	772
	6	S-05	Afesh	3,680	2.07	4,517
	7	S-07	Bait Al Hadrami	2,550	2.07	3,130
	8	S-09	Ruhm	4,567	2.07	5,605
	9	S-11	Al Hesn-Al Abyad	2,372	2.07	2,911
Dahmar	10	D-01	Elow Al Mikhlaf	926	3.04	1,249
	11	D-02	Hamal-Bait Al Jabar	2,475	3.04	3,339
	12	D-03	Hegrat Al A'asham	1,592	3.04	2,148
	13	D-05	Mayfa'at Yaer	1,515	3.04	2,044
	14	D-07	Al Asakera	1,944	3.04	2,623
	15	D-08	Masneat Abdul Aziz	406	3.04	548
Ibb	16	I-01	Asfal Bani Saba	9,311	2.47	11,884
	17	I-02	Al Sana	6,026	2.47	7,691
	18	I-04	Al Jahlah & Al Meshraq	10,467	2.47	13,359
Taiz	19	T-02	Bani Al Suror	9,385	2.47	11,978
	20	T-03	Sheb Humran	23,732	2.47	30,290
	21	T-04	Yafiq Bani Hamad	6,844	2.47	8,735
	22	T-05	Al Azaez	11,784	2.47	15,040
	23	T-06	Al Khunha	1,579	2.47	2,015
Total				128,269		164,728

## (2) Social Structure

Each governorate is administratively divided into districts (moderiah). A district consists of numbers of sub-districts (ozlah) which contain groups of villages (qaryah) and their attachments (mahallah). Sub-districts, villages and hamlets are group of communities which usually share common tribal identity. Therefore, most of the project sites are formed by the homogeneous group based on the traditional tribal structure with the extended family system. Villages were originated with one family and extended to the surrounding areas by their family members as the population increased. An exception is the sites located near to Sana'a City such as Bait Al Hadrami and Ruhm where people from different places migrate and settle in the villages for ease of accessibility to Sana'a for work.

One third of the screened sites cover the entire area of a single village with several hamlets while others are supposed to extend the service area of the water scheme to cover more than one village or entire sub-district. The project area of Ozlah Al Jaradi and Sheb Humran cover part of neighbouring sub-districts as well as its own sub-district, which results into increase of the population to be served by the project scheme as mentioned in Table 2-9. Composition of the villages forming each project site is listed in Annex. Many cases were found in the project area that villages and hamlets are not clearly distinguished by the residents.

Communities are traditionally led by head (sheikh) of the village or sub-district while the local council members elected from the respective constituencies represent the community members to form the district council. The sheikhs have strong influence to the community members through taking the initiative in development of the community including contribution of necessary resources, settling conflicts, and acting as an interface with the local authority and government. Under the leadership of the sheikhs, Aqil or Adel usually appointed in each village or hamlet serves for the community members for notarization of documents and collection of tax. In case that there is no sheikh at village or sub-district level, they also play as the mediator of conflicts in the community and interface with the external organizations. While the traditional leadership structure is maintained in most part of the project sites in Al Mawheet, Sana'a, Dahmar and Ibb as it characterizes the society of the northern part of Yemen, local council members play more vital role in facilitation of the development projects in the communities in Taiz rather than the sheikhs are directly involved in the process of the projects.

### (3) Village Settings and Infrastructure

Since the proposed water supply area of the screened sites are very different from each other such as covering only one village or targeting the entire sub-district, area of the sites also varies from less than 2 km<sup>2</sup> to around 50 km<sup>2</sup>. Most of the project sites are located in steep mountainous areas. Clusters of settlements are scattered along a ridge and slope of mountains or hills. Old settlements which originated the village are usually located at the top of the mountain or hill and other houses form a number of hamlets downwards to the bottom of mountains. Due to its geographical features, the road network within the sites is poorly connected with narrow dirt roads. The approach roads from the governorate capital to the sites is paved with asphalt apart from Elow al Mikhlaf, Hamal-Bait Al Jabar, Hegrat Al A'asham and Al Asakera where dirt roads stretch from the branch of the main road to the sites for approximately two to two and a half hours by vehicle.



Infrastructure and social services available in the project sites is indicated in Table 2-10. Even if the site is indicated as that the power supply and telecommunication network are available, several small villages or hamlets without accessibility to those infrastructure are dotted at the remote areas from the centre of the communities in the sites. For the households which cannot have access to power supply from public networks or generators, their alternative for lighting is kerosene or gas lamp.

Table 2-10 Infrastructure and Social Services in Screened Sites

Code No.	Site Name	Power Supply			Telecommunication		Public Facilities				Banking Service	Place to Buy Diesel Fuel
		Public Network	Generator by Community Project	Private Generator	Land phone line	Mobile	School	Health Facility	Mosque	Market		
A-02	Jabal Al Taraf	-	-	-	x	x	5	2	16	-	Mawheet	Mawheet
A-03	Ozlat Al Jaradi	-	x	-	x	x	10	1	22	-	Mawheet	Al Rujum
S-02	Jarban	x	-	-	x	x	2	0	7	-	Sana'a	Matrah Jerban
S-03	Al Kharaba	x	-	-	-	x	1	0	4	-	Sana'a	Matnah
S-04	Qamlan-Bait Al Najrani	x	-	-	-	x	0	0	4	-	Sana'a	Souq Al Amal
S-05	Afesh	x	-	-	x	x	1	1	7	-	Sana'a	Walan
S-07	Bait Al Hadrami	x	-	-	x	x	2	0	4	-	Sana'a	Souq Dar Salam
S-09	Ruhm	x	-	-	x	x	4	0	9	-	Sana'a	
S-11	Al Hesn-Al Abyad	x	-	-	x	x	5	0	3	-	Sana'a	Asfan
D-01	Elow Al Mikhlaf	-	-	-	x	x	1	0	13	-	Dahmar	Sayhan
D-02	Hamal-Bait Al Jabar	-	-	-	x	x	1	0	10	Weekly	Dahmar	Within the site
D-03	Hegrat Al A'asham	-	-	-	-	x	1	0	7	-	Medina Al Sharq	
D-05	Mayfa'at Yaer	x	-	-	-	x	1	0	2	-	Dahmar	
D-07	Al Asakera	-	-	x	x	x	2	0	12	-	Dhamar	Allasy
D-08	Masneat Abdul Aziz	x	-	-	x	x	1	0	3	-	Dahmar	Qa Samah
I-01	Asfal Bani Saba	-	-	-	-	x	4	0	10	-	Ibb	Rehab
I-02	Al Sana	-	-	-	-	x	2	0	13	-	Ibb	Sumarah, Rehab
I-04	Al Jahlah & Al Meshraq	x	-	-	x	x	3	1	26	Permanent x 2	Ibb	Within the site
T-02	Bani Al Suror	x	-	-	x	x	6	1	20	Permanent x 1	Taiz	Within the site
T-03	Sheb Humran	-	x	-	x	x	14	3	29	Permanent x 1, Weekly	Taiz	Within the site, Souq Al Nashamah
T-04	Yafiq Bani Hamad	-	x	-	x	x	6	1	15	Permanent x 1	Taiz	Within site
T-05	Al Azaez	x	-	-	x	x	4	1	30	Weekly	Taiz, Al Turbah	Al Maralaz
T-06	Al Khunha	-	-	-	-	x	1	0	2	-	Taiz	Al Barah

With regard to the social services, there is at least one primary school in the site except for Qamlan-Bait Al Najrani. Meanwhile, the number of health facilities is very few in the sites. The sites located in the centre of district or sub-district such as Bani Al Suror, Sheb Humran

and Yafiq Bani Hamad have a government's rural district hospital. Public health centers are available in Jabal Al Taraf, Ozlat Al Jaradi, Sheb Humran, and Al Azaez, and others have private clinics. At the center of Al Ma'afer District, there is a district council office as well as in Bani Al Suror.

### (3) Community Based Organizations

There are existing community based organizations in two thirds of the screened sites. These committees were established to manage specific development issues common to the residents in the villages such as water committee, parents council for school, farmers cooperative and others as shown in Table 2-11.

Table 2-11 Type of Existing Community Based Organizations in Screened Sites

Code No.	Site Name	Village Development Committee	Water Committee	Women's Group/ Mothers' Group	Farmers' Cooperative	School Committee (Parents Council)	Cultural/ social group	Others	None
A-02	Jabal Al Taraf	M	M			M			
A-03	Ozlat Al Jaradi		M						
S-02	Jarban		M			M			
S-03	Al Kharaba								x
S-04	Qamlan-Bait Al Najrani								x
S-05	Afesh				B	M			
S-07	Bait Al Hadrami					M			
S-09	Ruhm				B	M			
S-11	Al Hesn-Al Abyad		M						
D-01	Elow Al Mikhlaf								x
D-02	Hamal Bait Al Jabar				M	M			
D-03	Hegrat Al Asham								x
D-05	Mayfa'at Yaer			F					
D-07	Al Asakera					M			
D-08	Masneat Abdul Aziz								x
I-01	Asfal Bani Saba								x
I-02	Al Sana								x
I-04	Al Jahlah-Al Meshraq					B	M		
T-02	Bani Al Suror	M	M						
T-03	Sheb Humran	B	B	F		B			
T-04	Yafiq Bani Hamad		M			M		M (Solidarity fund committee)	
T-05	Al Azaez		M			M			
T-06	Al Khunah								x

M: formed by male members only, F: Formed by female members only,  
B: formed by both male and female members

The village development committees in Jabal Al Taraf, Bani Al Suror and Sheb Humran are responsible to coordinate the development projects planned and implemented within the community in conjunction with other groups organized for specific issues such as water supply and school education.

Membership of these existing community based organizations is mostly male dominated with a few exceptions. Due to the values of Islamic culture, women cannot be a part of meetings together with men. Community members also traditionally regard that participation in the communal activities and decision making in such occasions are supposed to be done by men. With these cultural and traditional backgrounds, there are few cases that the community based organizations are formed jointly by male and female members or women organize women's group or mothers' group to exchange information and mutual cooperation for improvement of their living conditions.

Development projects ever been conducted in the sites are construction of schools, water supply facilities, road, mosques and health facilities. Households in the villages contributed for part of the construction costs in cash and/or provision of labour force in most cases. They contributed YR 2,700/ household on average for the construction costs.

#### (4) Household Characteristics

Number of family members in a household is eight on average and half of the members are 14 years old and below according to the results of the sample household survey. One house is often shared with more than one generation when a son of the household head gets married to have a separate household. Around 90% of the sample households are male-headed in their early forties. Marital status of the household heads is monogamous at more than 80% of the households interviewed in the survey.

Approximately 1,800 boys and 1,550 girls at basic school-age (6-14) were confirmed in the sample households. Among them, around 90% of boys and 70% of girls are attending the basic school. The enrolment rate of boys is higher than the one for girls in all the target governorates. Enrolment rate of girls in Dahmar is less than 40% while the one for boys is 87%, which shows the biggest gap among five governorates. Meanwhile, there is the smallest gap of the enrolment rate of boys and girls in Taiz.

Common reason for non enrolment of school-aged boys and girls is the difficulty of the household to afford the education costs. In addition, boys cannot attend school to help families earn their living. On the other hand, in case of girl child, parents regard that their child is still young to send school even though she is at the school-age and keep her at home. Also, girls are, in most cases, busy to help mothers in household chore including water fetching for their families. Other main factors to hinder girls to attend the school are long distance from the house to school and no female teachers at the school.

With regard to the literacy level of the family members at age 15 and above in the sample households, illiteracy rate of women is higher (70%) than the one for men (30%). 11% of women completed the primary education up to grade 6 of the basic school, of which 58% graduated the basic school (up to grade 9) and proceeded to the secondary school. For men, 43% completed the grade 6, of which 78% finished the basic school and proceeded to the secondary school. While 10% of men have attainment of higher education or technical/vocational institution, only 1% of women do.

#### (5) Economic Conditions

Main income sources for the communities in the screened sites are farming and day labour according to results of the socio-economic survey as shown in Table 2-12. Livestock rearing and employment in the army are also part of the income source for many households. Most of the sample households interviewed have more than one income sources.

Table 2-12 Type of Income Source for Sample Households

Type of Income Source	No. of Response		Ratio of Cases
	No.	Ratio	
Agriculture	883	31.9%	58.9%
Day labor	660	23.8%	44.0%
Livestock rearing	387	14.0%	25.8%
In the army	337	12.2%	22.5%
Civil servant	176	6.4%	11.7%
Retail (running shops)	85	3.1%	5.7%
Money transfers from abroad	75	2.7%	5.0%
Employee of private company	23	0.8%	1.5%
Other	142	5.1%	9.5%
Total	2,768	100.0%	184.5%

N.B.: As multiple answers were applied, the total number of responses above is not consistent with the total number of interviewed households, which was 1,500.

Mean monthly income is YR42,000/household and median is YR30,000. For monthly expenditure, the average figure is YR39,000/household while median is YR31,000.

Type of agriculture dominated in the target areas is subsistence farming with growing food crops such as sorghum, millet, wheat and barley. Qat is the source of cash income for mainly the sites in Sana'a and Dahmar. Vegetables and fruits are also planted in the communities in Sana'a for cash income while coffee plantation is found in a few sites in Dahmar and Ibb. Around 75% of the sample households own agricultural land.

#### (6) Water Use Patterns

Types of existing water sources in each screened site are shown in the next page. Residents in the sites where they have no public piped water scheme rely on unprotected water sources such as cistern to keep rainwater, unprotected hand dug well and spring to obtain water for domestic use. These sources are usually seasonal and water is mostly available during rainy season of around April-May and August-September though it varies between governorates. When these seasonal water sources have dried up, they are forced to seek water from other sources located outside the village or buy water from water vendors if they can afford the cost.

Even in case that they have a communal piped water scheme, supply conditions is erratic due to the limited supply capacity against the demand as well as break down of the facilities. Currently, restriction of water supply is executed through water rationing according to the schedule in all the sites where they run the public scheme.

Other water sources available in the target communities are private motorized boreholes for irrigation of qat. The owner of the boreholes allows other community members to draw water from the source while the pump is operated to irrigate the field. Though these boreholes can supply water perennially, the owner of the facility normally run the pump in dry season and use rainwater during the rainy season to save running costs of the motor pump.

Where they can access to more than one type of water sources, the residents separate the water source for domestic use from other purposes such as animal watering and irrigation. Boreholes and springs are perceived safe for drinking while hand dug wells and rainwater kept in cisterns are mainly used for washing and animal watering. Water for irrigation is mainly from rainwater apart from the households which have their own private boreholes or shallow wells.

Table 2-13 Type of Existing Water Sources in Use at Screened Sites

Code	Site Name	a) Located in the Site										b) Located outside the Site				Operational Condition of Existing Public Water Scheme
		Stream/Dam	Rainwater Stored in Reservoir/Cistern	Unprotected Spring	Protected Spring	Unprotected Well	Borehole with Motor Pump (point source)	Piped Water Scheme with Connection to Public Taps	Piped Water Scheme with House Connections	Buying Water from Water Vendor (water tanker)	Other	Stream/Dam	Unprotected Spring	Borehole with Motor Pump (point source)	Buying Water from Water Vendor (water tanker)	
A-02	Jabal Al Taraf		H, A, I			H, A, I				D						Working
A-03	Ozlat Al Jaradi		A, I	D, H, A, I						D, H						Working
S-02	Jarban		D, H, A					D, I						D, H		Not working
S-03	Al Kharaba		H, A, P	D				D, I								Not working
S-04	Qamlan-Bait Al Najrani			D, H, A	H									D, H		Not working
S-05	Afesh		H	D, A, I												Not working
S-07	Bait Al Hadrami		A					D, H, I								No existing scheme
S-09	Ruhm		P, A			D, H, A		D, H, A, I								No existing scheme
S-11	Al Hesn-Al Abyad					D, H, A		D, H, A		D, H				D, H		Working
D-01	Elow Al Mikhlaf		D, H, A	D, H, A									H, A		D	No existing scheme
D-02	Hamal-Bait Al Jabar		A	H, A				D, H, I								Not working
D-03	Hegrat Al A'sham		A		D, H, A										D, H, A	No existing scheme
D-05	Mayfa at Yaer		A							D, H, A			H, A			Working
D-07	Al Asakera		D, H, A					D, H, I								No existing scheme
D-08	Masneat Abdul Aziz		H, A												D, H	No existing scheme
I-01	Asfal Bani Saba		I	3				I								No existing scheme
I-02	Al Sana		H, A	D, I												No existing scheme
I-04	Al Jahlah & Al Meshraq	D, H	P	D, H				D, H, A, I	D, H, A, I						D	No existing scheme
T-02	Bani Al Suror		A	D, H, A				H, A	I							No existing scheme
T-03	Sheb Humran		A	D				D, H, A, I								Working
T-04	Yafoq Bani Hamad		D, H, A, I	D, H, A, I				D, I	D, A, I							Working
T-05	Al Azaez		A						D, H, I							Working
T-06	Al Khunha							D, H, A, I	D, H, A							No existing scheme

Keys for Usages of the Water Sources:

D: Drinking, cooking, H: Other usage for household chores such as washing and cleaning,

A: Animal watering, I: Irrigation, P: Ablution for prayer

Volume of daily water consumption for the domestic use is approximately 165 l/hh/d and 20 l/pers/d at the median level. In order to obtain water for the domestic use, 48% of the sample households spend money at a median amount of YR1,400/household/day which accounts for about 4.5-5% of the monthly household income. Other households receive water for domestic use free of charge.

Water fetching is primarily one of the responsibilities of adult women in the household and girl child often help her mother collect water. They rely on donkeys to carry water kept in the plastic container from the source to their houses at the households which are not connected to the piped water scheme. As it is difficult for them to carry water at once enough for the daily consumption, they need to fetch water four times a day on average with approximately 30 minutes to one hour for one trip including the time to wait at the water point. It therefore becomes two to four hours a day for the household to take for water collection.

#### (7) Sanitation and Health Conditions

Main diseases for the community members in the screened sites are malaria, respiratory diseases and kidney diseases for adult men and women and diarrhoea for children. As the measures to prevent diarrhoea, half of the sample households practice hand washing before eating, drinking clean water, and protecting food from contamination, respectively. On the other hand, hand washing after using toilet is not common to the households surveyed. Treatment of drinking water is hardly practiced in the project sites. 90% of the sample households answered that they drink water as it is while those who treat water normally boil or filter it with cloth.

With regard to the sanitation environment, Table 2-6 shows distribution of sample households by type of toilet which are owned by them. Nearly 75% of the households surveyed have toilet which is pour flush type to discharge to open land or soak in a pit in most cases. Remaining households do not have latrine as they cannot afford construction cost or enough water is not available for them. If the household does not have latrine, family members usually defecate outside their compound while children sometimes use yard for defecation.

#### (8) Valuation for Improved Water Supply

All the screened sites where they do not have protected water source ranked the water supply as the highest priority to improve their living conditions. Meanwhile, other needs such as job opportunity and power supply are higher than the one for water supply in the sites where the public water scheme is relatively well managed and operational such as Jabal Al Taraf, Bani Al Suror and Al Azaez.

In the sample household survey, around 90% of the sample households expressed their needs for improvement of existing water supply conditions. They mostly expect increase of water quantity which can be used, availability of water perennially, and reduction of time for water fetching. Further, 95% of them are willing to pay at a median amount of RY150/m<sup>3</sup> for user fee for operation and maintenance cost and 82% also showed willingness to contribute for part of the construction cost of the facility. Contribution for part of the construction cost of the facility can mainly be done in manner of provision of labour force or payment in cash at YR2,000/household.

Additional water demand for domestic use averages 160 l/hh/d (100 l/hh/d at median level) and 23 l/pers/d (16 l/pers/d at median level) in case the water supply condition is improved through construction or rehabilitation of piped water schemes.



### **3. GROUNDWATER SURVEY**

### 3. GROUNDWATER SURVEY

In the design of water supply facilities, the water source is the most important factor. To identify the continuous potential and quality assurance of the water sources planned for the candidate sites, pumping tests and water quality analyses were conducted. Then, based on water potential evaluation and water balance analysis, an overall evaluation of candidate water sources was made from viewpoints of quantity and quality.

#### 3.1 Pumping Test

##### 3.1.1 Execution of Pumping Test

Pumping tests were carried out on 42 boreholes selected as candidate water sources for the 36 candidate sites. The pumping tests were contracted out to local sub-contractors selected through tendering by evaluation of proposals submitted from short listed local contractors registered under GARWSP for work which was divided into 4 lots. The selected sub-contractors for each lot and their work allocation are listed below.

Table 3-1 Sub-contracted Work on Pumping Tests

Lot No.	Allocated Area (Governorate)	No. of Sites	No. of Wells Contracted	Name of Sub-contractor
1	Al-Mawheet and Sana'a	9	10	Mabkhout Kayed Al Abraki
2	Sana'a	9	11	Abdulkhaleq M. Al Gholi
3	Dahmar and Ibb	12	12	Mabkhout Kayed Al Abraki
4	Taiz	6	9	Abdulkhaleq M. Al Gholi
Total		36	42	

However, in the course of carrying out the pumping tests, some tests could not be completely carried out due to several factors as listed below.

Table 3-2 Non-executable Pumping Tests

Code	Site Name	Situation	Reason
S-02	Jarban	Constant and Recovery tests only	Able to make only partial water level measurements due to low water level
S-08	Dajah & Sarfah	Could not conduct test	Too deep to make water level measurements
S-11/2	Al Hesn-Al Abyad	Cancelled	Due to small diameter of well casing, residents refused test for fear of damage to well
S-13	Al Ga'ra	Could not conduct test	Too deep to make water level measurements
S-14	Al Ghail	Provisional test only	Well collapsed and filled well with mud
T-01	Al Muayteeb	Step test only	High water temperature damaged testing equipment and therefore, could not continue test

### 3.1.2 Procedure

The pumping tests were conducted through the following three tests.

#### Step Drawdown Test

The step drawdown test is important to determine the safe yield of the well. Tests for a minimum of five (5) steps were carried out to identify fluctuation points in the s-Q curve. Each step was carried out for 120 minutes.

#### Constant Discharge Test

Upon continuous pumping at the safe yield determined in the step drawdown test, the drawdown was measured. The duration of the test was at least 24 hours until the water level stabilized.

#### Time Recovery Test

The time recovery test was started immediately after completion of the constant discharge test. The test was carried out for a minimum period of 24 hours until the water level stabilized. Recovery measurements were recorded with the same frequency as those taken during the constant discharge test.

### 3.1.3 Results

The results of the pumping tests are shown in Table 3-3 and summarized as follows.

- 42 Boreholes Contracted: Divided into 4 lots
- 38 Pumping Tests Conducted: Could not test 4 wells due to reasons such as well collapse, low water table and small diameter casing
- 31 Boreholes Recommended for Safe Use: 7 wells are not recommended for use due to reasons such as low yield, slow recovery and uncertainty from incomplete pumping test

Table 3-3 Results of Pumping Tests

Governorate	Site Code	Site Name	Source Code	Targeted Deep Well for Testing	Const. Year	Well Depth (m)	Static Water Level (GL-m)	Aquifer Thickness (m)	Pump Setting Depth (GL-m)	Dynamic Water Level (GL-m)	Draw down (m)	Safe Yield (l/sec)	Remarks	
Al Mahweet	A-01	Al Sha'afel Al Olyah & Al Sufia	A-01	New	2005	192	20.12	85.9	138	66.21	46.09	4.4		
	A-02	Jabal Al Taraf	A-02	Existing	1997	165	26.00	69.5	117	33.76	7.76	4.4		
	A-03	Ozlat Al Jaradi	A-03	Existing	1990	150	50.80	49.6	107	55.86	5.06	10.4		
	A-04	Al Khamis-Bani Ali	A-04	New	2001	92	6.66	42.7	66	42.50	35.84	4.4		
	Sana'a	S-01	Bani Waleed - Al Asboor	S-01/1	New (Bani Waleed)	2005	348	115.79	116.1	247	142.93	27.14	1.6	Recovery is very slow
		S-01/2		S-01/2	New (Al Asboor)	2005	300	52.78	123.6	213	106.18	53.40	3.4	Recovery is very slow
	S-02	Jarban	S-02	New	2005	450	345.31	52.3	370	345.37	0.06	2.0	No step drawdown test due to low water level	
	S-03	Al Kharaba	S-03	Existing	1982	150	44.93	52.5	111	80.82	35.89	3.5		
	S-04	Gamlan-Bait Al Najrani	S-04	Existing	1988	145	10.01	67.5	105	10.92	10.92	0.91	5.6	
	S-05	Afesh	S-05	Existing	1996	300	212.97	43.5	270	231.21	18.24	3.2		
	S-06	Al Lejam	S-06	Existing	1993	300	148.09	76.0	265	149.59	1.50	4.2		
	S-07	Bait Al Hadrami	S-07	New	2005	410	193.22	108.4	291	197.12	3.90	3.2		
	S-08	Dajah & Sarfah	S-08	New	2006	(665)*	(500)*	(98.3)*	(600)*	(620)*	(120)*	(6.0)*	2.2	Test cancelled (could not make test due to low water table)
	S-09	Ruhm	S-09	New	2003	470	192.45	138.8	291	227.90	35.45	3.0		
S-10/1	Tawa'ar	S-10/1	Existing	1994	280	134.78	72.6	220	180.62	45.84	2.2			
S-10/2		S-10/2	Existing	2004	310	144.83	82.6	220	155.96	11.13	4.1			
S-11/1	Al Hesn-Al Abyad	S-11/1	New	2005	350	154.11	97.9	248	219.12	66.01	3.8	Test cancelled (residents refused for fear of damage to well because well casing diameter is small)		
S-11/2		S-11/2	Existing	1980	180	---	---	---	---	---	---	---		
S-12	Mahdah	S-12	New	2005	350	57.78	146.1	246	76.52	18.74	18.74	2.2	Test cancelled (could not make test due to low water table)	
S-13	Al Ga'ra	S-13	New	2006	(840)*	(520)*	(420)*	(668)*	(600)*	(80)*	(80)*	(5.4)*	Test cancelled (could not make test due to low water table)	
S-14	Al Ghail	S-14	Existing	1985	185(?)	---	---	---	---	---	---	---	Test cancelled (well collapsed, filled with mud)	
Dahmar	D-01	Elow Al Mikhlaif	D-01	New	2000	273	184.13	44.4	207	185.83	1.70	2.4		
	D-02	Hamal Bait Al Jabar	D-02	Existing	1985	310	185.80	62.1	220	209.30	23.50	3.5		
	D-03	Hegrat Al A'sham	D-03	New	1999	320	163.05	78.5	249	183.95	20.90	5.0		
	D-04	Al Kuob	D-04	New	1999	152	84.90	33.6	123	91.42	6.52	0.3		
	D-05	Mayfa'at Yaer	D-05	Existing	1984	127	59.56	33.7	96	62.78	3.22	2.6		
	D-06	Wardasan	D-06	Existing	1998	220	89.65	65.2	165	131.90	42.25	0.5		
	D-07	Al Asakera	D-07	New	1999	304	193.63	55.2	250	195.18	1.55	4.5		
	D-08	Masneat Abdul Aziz	D-08	New	2004	268	61.98	103.0	192	123.68	61.70	4.5		
	I-01	Asfal Bani Saba	I-01	New	2005	305	106.40	99.3	216	112.70	6.30	4.5		
	I-02	Al Sana	I-02	New	2005	272	35.58	118.2	210	140.48	104.90	3.9		
	I-03	Mamasa Al Marqab	I-03	New	2005	78	47.78	15.1	69	54.35	6.57	1.6		
	I-04	Al Jahlah & Al Meshraq	I-04	New	2005	305	14.85	145.1	219	110.15	95.30	4.1		
	T-01	Al Muayteeb	T-01	New	2005	300	140.09	80.0	213	169.33	29.24	3.0	Step drawdown test only due to high temperature	
	T-02/1	Bani Al Suror	T-02/1	Existing (Bir 1)	1982	230	183.88	23.1	200	186.42	2.54	5.1		
T-02/3		T-02/3	Existing (Bir 3)	2001	251	118.55	66.2	178	139.66	21.11	2.6			
T-02/4		T-02/4	New (Bir 4)	1998	190	137.23	26.4	154	139.44	2.21	5.4			
T-03/1	Sheb Hurman	T-03/1	New (Al Jah)	2005	400	22.53	188.7	284	44.82	22.29	4.0			
T-03/4		T-03/4	Existing (Al Meashaar)	1998	260	24.42	117.8	184	28.46	4.04	4.2			
T-04	Yafiq Bani Hamad	T-04	Existing	1982	220	124.80	47.6	156	126.71	1.91	3.0			
T-05/1	Al Azaez	T-05/1	Existing (Marda'a Alhomya)	1985	120	8.41	55.8	94	53.60	45.19	2.0			
T-06	Al Khunha	T-06	New	2004	200	-0.05	100.0	142	5.62	5.67	8.8			

\*GARWSP Data

## **3.2 Water Quality Analysis**

### **3.2.1 Sampling**

To analyze the quality of water, samples were taken from the boreholes where pumping tests were carried out as well as other water sources. Water samples from candidate water sources were collected to determine their acceptance for drinking. Samples from other water sources were analyzed to identify the present conditions of water used for various purposes (not only for drinking, but also for irrigation, animal watering and other purposes) by residents of the candidate sites. The list of water samples from various sources for analyses is shown in Table 3-5.

### **3.2.2 Analysis**

Water quality analyses were conducted at the sampling site using equipment procured for this study and at an authorized water quality analysis laboratory in Sana'a. The analysis locations for each parameter are listed in Table 2-5.

Using equipment procured in this study, methods of handling water quality analysis equipment and making analyses were transferred to GARWSP branch office staff during the course of the pumping tests as part of the on-the-job training activities for capacity strengthening. The equipment will be handed over to GARWSP upon completion of the study.

Any results of analyses which were determined to be doubtful were retested until the results were confirmed to be satisfactorily reliable and correct. Especially, careful attention was given to analyses at the site and retesting was carried out for reconfirmation. For analyses on Coliform group count, each of the target GARWSP branch offices made further retesting and confirmed that coliform bacteria were not found in the target water sources at the screened sites.

Table 3-5 List of Water Sources Sampled for Quality Analyses

No.	Governorate	Site Code	Site Name	Source Code	Sampled Water Source		
					Type of Sample	Type of Source	
1	Al Mahweet	A-01	Al Sha'afel Al Olyah & Al Sufla	A-01	Target water source	Deep Well	
2				A-01/2	Other water source	Dug Well (Lower)	
3				A-01/3	Other water source	Rain Water (Upper)	
4		A-02	Jabal Al Taraf	A-02	Target water source	Deep Well	
5		A-03	Ozlat Al Jaradi	A-03	Target water source	Deep Well	
6		A-04	Al Khamis-Bani Ali	A-04	Target water source	Deep Well	
7				A-04/2	Other water source	River	
8	Sana'a	S-01	Bani Waleed - Al Asboor	S-01/1	Target water source	Deep Well	
9				S-01/2	Target water source	Deep Well	
10				S-01/3	Other water source	Dug Well	
11		S-02	Jarban	S-02	Target water source	Deep Well	
12				S-02/2	Other water source	Rain Water (Cistern)	
13		S-03	Al Kharaba	S-03	Target water source	Deep Well	
14				S-03/2	Other water source	Rain Water (Cistern)	
15		S-04	Qamlan-Bait Al Najrani	S-04	Target water source	Deep Well	
16		S-05	Afesh	S-05	Target water source	Deep Well	
17				S-05/2	Other water source	Spring	
18		S-06	Al Lejam	S-06	Target water source	Deep Well	
19		S-07	Bait Al Hadrami	S-07	Target water source	Deep Well	
20				S-07/2	Other water source	Private well	
21		S-08	Dajah & Sarfah	S-08	Target water source	Deep Well	
22				S-08/2	Other water source	Private well	
23		S-09	Ruhm	S-09	Target water source	Deep Well	
24				S-09/2	Other water source	Vendor	
25		S-10	Tawa'ar	S-10/1	Target water source	Deep Well	
26				S-10/2	Target water source	Deep Well	
27		S-11	Al Hesn-Al Abyad	S-11/1	Target water source	Deep Well	
28				S-11/2	Target water source	Deep Well	
29		S-12	Mahdah	S-12	Target water source	Deep Well	
30				S-12/2	Other water source	Dug well	
31		S-13	Al Ga'ra	S-13	Target water source	Deep Well	
32				S-13/2	Other water source	Private well	
33		S-14	Al Ghail	S-14	Target water source	Deep Well	
34				S-14/2	Other water source	Vendor	
35		Dahmar	D-01	Elow Al Mikhlaf	D-01	Target water source	Deep Well
36					D-01/2	Other water source	Rain Water (Cistern)
37			D-02	Hamal Bait Al Jabar	D-02	Target water source	Deep Well
38					D-02/2	Other water source	Vendor
39			D-03	Hegrat Al A'asham	D-03	Target water source	Deep Well
40					D-03/2	Other water source	Spring
41			D-04	Al Kuob	D-04	Target water source	Deep Well
42	D-04/2				Other water source	Vendor	
43	D-05		Mayfa'at Yaer	D-05	Target water source	Deep Well	
44	D-06		Wardasan	D-06	Target water source	Deep Well	
45				D-06/2	Other water source	Private well	
46	D-07		Al Asakera	D-07	Target water source	Deep Well	
47				D-07/2	Other water source	Private well	
48	D-08	Masneat Abdul Aziz	D-08	Target water source	Deep Well		
49			D-08/2	Other water source	Vendor		
50	Ibb	I-01	Asfal Bani Saba	I-01	Target water source	Deep Well	
51				I-01/2	Other water source	Private Well*	
52		I-02	Al Sana	I-02	Target water source	Deep Well	
53		I-03	Mamsa Al Marqab	I-03	Target water source	Deep Well	
54		I-04	Al Jahlah & Al Meshraq	I-04	Target water source	Deep Well	
55	I-04/2			Other water source	Spring		
56	Taiz	T-01	Al Muayteeb	T-01	Target water source	Deep Well	
57				T-01/3	Other water source	Private well	
58		T-02	Bani Al Suror	T-02/1	Target water source	Deep Well	
59				T-02/2	Other water source	Deep Well (Seasonal)	
60				T-02/3	Target water source	Deep Well	
61				T-02/4	Target water source	Deep Well	
62		T-03	Sheb Humran	T-03/1	Target water source	Deep Well	
63				T-03/2	Other water source	Deep Well (Seasonal)	
64				T-03/4	Target water source	Deep Well	
65		T-04	Yafoq Bani Hamad	T-04	Target water source	Deep Well	
66		T-05	Al Azaez	T-05/1	Target water source	Deep Well	
67				T-05/2	Target water source	Deep Well	
68				T-05/4	Target water source	Spring	
69		T-06	Al Khunha	T-06	Target water source	Deep Well	
70				T-06/2	Other water source	Dug Well	

\*Also source for Al Sana

### 3.2.3 Adopted Water Quality Standards

As agreed in the “Note of Agreement 2”, maximum values of accepted limits of Yemeni drinking water quality standards based on “WHO Guidelines for Drinking Water Quality” will be adopted as criteria for determination of the appropriateness in water quality. The analyzed parameters are listed in Table 3-6 along with the water quality standards adopted for this study.

Table 3-6 Water Quality Parameters Analyzed and Standards Adopted for this Study

Parameter	Quality Standard		Analysis Location
	Value	Reference Source	
pH	6.5-9.0	Yemeni max.	Sampling Site
Temperature	—		Sampling Site
Electric Conductivity	—		Sampling Site
Coliform Group Count	0/100 ml	Yemeni max.	Sampling Site
TDS (Total Dissolved Solids)	1,500 mg/l	Yemeni max.	Laboratory
Sodium Na <sup>+</sup>	400 mg/l	Yemeni max.	Laboratory
Potassium K <sup>+</sup>	12 mg/l	Yemeni max.	Laboratory
Magnesium Mg <sup>+2</sup>	150 mg/l	Yemeni max.	Laboratory
Calcium Ca <sup>+2</sup>	200 mg/l	Yemeni max.	Laboratory
Iron Fe <sup>+2</sup>	1.0 mg/l	Yemeni max.	Laboratory
Manganese Mn <sup>+2</sup>	0.2 mg/l	Yemeni max.	Laboratory
Bicarbonates HCO <sub>3</sub> <sup>-</sup>	600 mg/l	Yemeni max.	Laboratory
Chloride Cl <sup>-</sup>	600 mg/l	Yemeni max.	Laboratory
Sulphate SO <sub>4</sub> <sup>-2</sup>	600 mg/l	Yemeni max.	Laboratory
Fluoride F <sup>-</sup>	1.5 mg/l	Yemeni max.	Laboratory
Phosphate P <sub>2</sub> O <sub>5</sub>	5.0 mg/l	Yemeni max.	Laboratory
Ammonium NH <sub>4</sub> <sup>+</sup>	0.5 mg/l	Yemeni max.	Laboratory
Nitrate NO <sub>3</sub> <sup>-</sup>	50 mg/l	Yemeni max.	Laboratory
Nitrite NO <sub>2</sub> <sup>-</sup>	2.0 mg/l	Yemeni max.	Laboratory

### 3.2.4 Results

The results of analyses after confirmation on their reliability are shown in Table 3-7. Evaluation results of target water sources are shown in Table 3-8 along with the items of poor quality.

**Table 3-7 Results of Water Quality Analyses**

Code	Site Name	pH	Temp. (°C)	Conductivity (µS/cm)	Coliform Count	Ca <sup>2+</sup> mg/l	Mg <sup>2+</sup> mg/l	Fe <sup>2+</sup> mg/l	Mn <sup>2+</sup> mg/l	Na <sup>+</sup> mg/l	K <sup>+</sup> mg/l	HCO <sub>3</sub> <sup>-</sup> mg/l	Cl <sup>-</sup> mg/l	F <sup>-</sup> mg/l	SO <sub>4</sub> <sup>2-</sup> mg/l	P <sub>2</sub> O <sub>5</sub> mg/l	NO <sub>3</sub> <sup>-</sup> mg/l	NO <sub>2</sub> <sup>-</sup> mg/l	NH <sub>4</sub> <sup>+</sup> mg/l	TDS mg/l
	Yemeni Standard	6.5-9.0			-	200	150	1.0	0.2	400	12	600	600	1.5	600	5.0	50	2.0	0.5	1,500
A-01	Al Sha'afel Al Olyah & Al Sufia	6.61	34.7	1,809	Negative	180.00	54.00	0.0218	0.1793	174.14	2.92	486.78	309.00	0.131	134.90	0.663	0.269	0.045	0.103	1,201.77
A-01/2		7.26	32.9	852	Positive	108.00	28.80	0.0178	0.0155	56.58	2.81	324.52	72.50	0.098	30.60	0.480	0.119	0.014	0.051	531.20
A-01/3		8.10	30.0	257	Positive	44.00	6.00	0.0369	0.0005	9.27	8.05	102.48	16.00	0.096	16.00	0.614	0.086	0.015	0.026	174.80
A-02	Jabal Al Taraf	7.27	29.1	710	Negative	86.00	29.28	0.2843	0.0783	21.95	1.78	292.08	52.50	0.089	54.80	0.631	0.175	0.008	0.071	377.93
A-03	Ozlat Al Jaradi	6.70	24.7	312	Negative	36.00	20.40	0.0677	0.0309	8.29	5.03	146.40	20.50	0.122	<10.00	0.377	0.113	0.011	0.012	151.90
A-04	Al Khamis-Bani Ali	6.99	33.4	2,830	Negative	188.40	61.00	0.3716	<b>0.2469</b>	63.79	2.75	314.76	481.00	<b>1.780</b>	360.12	0.831	0.271	0.029	0.063	<b>1,741.96</b>
A-04/2		7.60	29.3	639	Positive	76.15	26.84	0.0351	<b>0.2469</b>	66.09	2.75	207.90	45.00	0.139	82.44	0.491	0.115	0.031	0.031	399.90
S-01/1	Bani Waleed-Al Asboo	7.04	30.7	1,208	Negative	98.00	46.80	0.1573	0.1137	90.20	2.90	441.60	126.00	0.130	93.60	0.615	0.145	0.009	0.050	599.30
S-01/2		6.70	29.4	1,139	Negative	116.00	38.40	0.1049	<b>0.2356</b>	70.70	2.86	361.10	112.00	0.120	118.00	0.255	0.140	0.009	0.001	592.65
S-01/3		7.40	23.9	546	Negative	84.17	26.84	0.0190	0.0131	56.90	4.75	270.84	32.00	0.206	36.60	0.440	0.081	0.055	0.010	395.66
S-02	Jarban	8.08	25.4	288	Negative	34.00	15.60	0.0392	0.0323	14.10	2.80	117.12	22.00	0.101	<10.00	0.220	0.071	0.022	0.462	141.89
S-02/2		8.40	18.3	135	Positive	28.00	2.40	0.0303	0.0061	<1.00	1.46	61.00	14.50	0.137	17.06	0.162	0.036	0.102	0.041	31.89
S-03	Al Kharaba	7.64	18.1	615	Negative	92.00	14.40	0.0451	0.0005	23.90	1.56	234.24	59.00	0.116	31.00	0.911	0.115	0.010	0.008	273.14
S-03/2		8.14	18.8	204	Positive	34.00	13.20	<b>1.5338</b>	0.0024	6.34	5.78	102.48	16.50	0.240	24.00	0.740	0.131	0.040	0.002	467.15
S-04	Gamlan-Bait Al Najrani	7.36	19.9	338	Negative	50.00	8.40	0.0408	0.0062	11.70	1.90	161.04	23.50	0.109	22.00	0.265	0.164	0.021	0.004	108.60
S-05	Afesh	7.48	32.7	1,256	Negative	104.20	53.60	0.6953	0.0392	153.45	6.25	268.40	168.00	0.122	148.00	0.232	0.230	0.061	0.011	785.90
S-05/2		7.83	23.2	682	Positive	76.15	46.36	0.0051	0.0026	345.40	4.75	180.56	64.00	0.069	50.63	0.141	0.109	0.022	0.040	399.18
S-06	Al Legam	<b>9.30</b>	31.9	577	Negative	4.00	3.60	0.2383	0.0127	154.10	0.90	162.26	72.00	0.140	28.90	0.662	0.216	0.035	0.039	266.74
S-07	Bait Al Hadrami	8.54	31.3	385	Negative	40.00	2.44	0.3750	0.0035	99.40	1.00	53.78	37.00	0.109	98.44	0.161	0.200	0.016	0.004	199.60
S-07/2		<b>9.23</b>	24.2	426	Positive	20.00	9.76	0.0246	0.0099	118.90	4.50	97.60	42.00	0.311	102.30	0.321	0.109	0.009	0.006	199.30
S-08	Dajah & Sarfah	8.69	48.5	1,439	Negative	20.00	6.72	0.7365	0.0637	148.00	8.86	158.60	348.00	<b>4.460</b>	56.60	0.881	0.240	0.062	0.003	627.65
S-08/2		7.92	45.5	945	Negative	12.00	9.60	0.0654	0.0094	121.40	5.50	341.60	83.50	0.196	53.70	0.440	0.183	0.032	0.071	384.50
S-09	Ruhm	7.94	28.3	385	Negative	34.00	3.60	0.1987	0.0633	50.70	1.14	136.04	41.00	0.108	15.70	0.387	0.085	0.015	0.003	262.81
S-09/2		7.60	24.1	510	Positive	15.00	10.80	0.0122	0.0314	64.87	1.50	129.32	53.00	0.195	41.20	0.280	0.207	0.032	0.018	267.39
S-10/1	Tawa'ar	<b>9.40</b>	28.8	1,127	Negative	8.00	2.40	0.3688	0.0040	139.00	1.13	95.16	261.00	0.106	115.00	0.411	0.122	0.070	0.017	592.56
S-10/2		8.80	30.4	1,033	Negative	10.00	10.80	0.6912	0.0011	129.00	1.56	129.32	170.00	0.120	127.60	0.114	0.105	0.001	0.010	398.02
S-11/1	Al Hesn-Al Abyad	8.37	32.9	1,195	Negative	14.00	13.20	0.4804	0.0271	142.90	2.20	209.80	177.00	0.140	122.60	0.661	0.084	0.021	0.011	599.11
S-11/2		8.09	31.5	1,018	Positive	39.00	18.00	0.2340	0.0716	104.39	2.16	163.48	132.00	0.450	145.90	0.114	0.022	0.021	0.025	399.50
S-12	Mahdah	<b>9.50</b>	24.6	397	Negative	38.70	13.20	0.1266	0.0042	55.00	1.50	104.92	107.00	0.056	33.10	0.231	0.164	0.036	0.031	95.61
S-12/2		7.95	20.6	731	Positive	92.00	14.40	0.3610	0.0150	38.50	2.20	297.68	91.00	0.269	57.90	0.317	0.144	0.007	0.073	396.27
S-13	Al Ga'ra	8.20	54.3	806	Negative	10.00	6.00	0.2327	0.0703	78.04	3.51	179.34	132.00	0.154	67.30	0.641	0.203	0.006	0.062	410.37
S-13/2		<b>9.30</b>	42.7	509	Negative	2.00	1.20	0.0111	0.0102	62.40	0.86	156.16	61.50	0.162	35.00	0.326	0.112	0.016	0.021	272.42
S-14	Al Ghail	7.79	28.3	1,332	Negative	40.00	20.40	0.0230	0.1339	191.22	4.91	385.50	87.50	0.371	121.40	0.721	0.169	0.011	0.081	719.86
S-14/2		7.31	27.7	2,520	Negative	94.00	42.00	0.0884	0.0234	179.50	8.30	<b>614.00</b>	102.00	0.416	152.20	0.862	0.194	0.030	0.059	<b>1,777.46</b>



Code	Site Name	pH	Temp. (°C)	Conductivity (µS/cm)	Coliform Count	Ca <sup>2+</sup> mg/l	Mg <sup>2+</sup> mg/l	Fe <sup>2+</sup> mg/l	Mn <sup>2+</sup> mg/l	Na <sup>+</sup> mg/l	K <sup>+</sup> mg/l	HCO <sub>3</sub> <sup>-</sup> mg/l	Cl <sup>-</sup> mg/l	F <sup>-</sup> mg/l	SO <sub>4</sub> <sup>2-</sup> mg/l	P <sub>2</sub> O <sub>5</sub> mg/l	NO <sub>3</sub> <sup>-</sup> mg/l	NO <sub>2</sub> <sup>-</sup> mg/l	NH <sub>4</sub> <sup>+</sup> mg/l	TDS mg/l
	Yemeni Standard	6.5-9.0			-	200	150	1.0	0.2	400	12	600	600	1.5	600	5.0	50	2.0	0.5	1,500
<b>D-01</b>	Elow Al Mikhlaf	7.48	30.2	894	Negative	96.14	14.64	0.3319	0.0146	118.97	2.00	112.24	53.00	0.010	67.15	0.820	0.210	0.040	0.002	589.39
D-01/2		<b>9.68</b>	22.4	114	Negative	32.16	7.32	<b>1.5136</b>	0.0331	1.72	4.25	48.80	10.00	0.030	48.52	1.030	0.110	0.006	0.021	198.78
<b>D-02</b>	Hamal-Bait Al Jabar	7.83	31.7	503	Negative	60.12	12.20	0.0180	0.0267	109.77	4.75	239.12	20.00	0.104	29.72	0.161	0.091	0.021	0.141	197.43
D-02/2		7.68	28.1	459	Negative	32.06	36.60	0.0596	0.0094	67.24	4.00	185.44	34.00	0.093	28.78	0.111	1.030	0.008	0.020	197.30
<b>D-03</b>	Hegrat Al Aasham	7.12	29.2	445	Negative	72.14	12.20	0.1584	0.0329	41.95	6.00	180.56	29.00	0.010	31.12	0.106	0.361	0.021	0.006	199.60
D-03/2		7.48	21.7	414	Positive	68.14	21.96	0.0176	0.0044	24.71	6.50	183.00	30.00	0.031	25.85	0.113	0.611	0.020	0.001	198.39
<b>D-04</b>	Al Kuob	7.23	28.6	455	Negative	72.00	16.80	0.0972	0.0761	38.50	3.25	226.92	20.00	0.011	14.80	0.205	0.145	0.015	0.009	183.83
D-04/2		7.99	27.8	486	Positive	66.00	16.80	0.0372	0.0025	59.40	4.50	137.86	43.00	0.107	22.34	0.146	0.037	0.019	0.126	217.00
<b>D-05</b>	Mayfat Yaer	7.28	30.4	532	Negative	74.00	27.60	0.0656	0.0046	56.89	8.00	202.52	30.00	0.091	15.30	0.662	0.240	0.010	0.003	530.00
<b>D-06</b>	Wardasan	8.18	32.5	1,431	Negative	20.04	9.76	0.0059	0.0039	321.26	3.25	575.84	78.00	0.083	79.89	0.030	0.220	0.021	0.001	793.34
D-06/2		8.30	42.1	1,830	Negative	12.00	10.80	0.0211	0.0084	388.80	2.50	878.40	52.00	0.063	57.50	0.231	0.066	0.012	0.051	1,004.20
<b>D-07</b>	Al Asakera	7.97	37.7	1,004	Negative	104.00	21.60	0.0301	0.0073	106.40	9.90	322.80	115.00	0.103	24.97	0.130	0.220	0.031	0.001	662.50
D-07/2		7.07	34.1	959	Positive	102.00	34.80	0.1402	0.0075	92.30	<b>12.00</b>	326.96	103.00	0.133	30.07	0.041	0.450	0.017	0.021	573.20
<b>D-08</b>	Masneat Abdul Aziz	8.25	33.5	342	Negative	26.00	8.40	0.0884	0.0070	78.73	2.50	102.48	22.00	0.076	<10.00	0.094	0.007	0.011	0.039	162.00
D-08/2		8.21	30.6	398	Positive	62.00	15.60	0.0032	0.0069	30.46	5.25	139.08	22.00	0.810	18.11	0.192	0.166	0.003	0.013	825.90
<b>I-01</b>	Asfal Bani Saba	8.40	30.1	434	Negative	22.00	8.40	0.2580	0.0001	61.50	0.50	208.80	25.00	0.122	32.18	0.230	0.110	0.004	0.005	198.00
I-01/2		<b>9.41</b>	32.0	384	Negative	8.00	4.88	0.0228	0.0001	48.29	0.50	185.44	35.45	0.131	21.46	0.215	0.460	0.001	0.002	131.34
<b>I-02</b>	Al Sana	7.99	31.2	496	Negative	26.00	20.70	0.1045	0.0168	67.20	0.75	273.28	26.00	0.120	30.07	0.211	0.320	0.008	0.003	198.04
<b>I-03</b>	Mamsa Al Marqab	7.12	30.6	694	Negative	100.00	31.20	0.0258	0.0079	38.20	1.50	290.36	30.00	<b>1.864</b>	19.70	0.031	0.810	0.004	0.009	408.95
<b>I-04</b>	Al Jahlah & Al Meshrad	8.32	27.0	646	Negative	40.00	16.80	0.0193	0.0020	107.60	0.50	104.92	61.00	0.095	125.80	0.021	0.030	0.016	0.010	386.80
I-04/2		7.39	21.4	836	Negative	100.00	40.80	0.0222	0.0025	6.40	0.50	336.72	58.00	0.039	34.99	0.064	0.160	0.051	0.006	484.86
<b>T-01</b>	Al Muayteeb	7.22	61.1	2,520	Negative	170.00	12.00	0.7517	<b>0.2002</b>	<b>407.00</b>	<b>24.75</b>	196.42	<b>600.00</b>	0.115	193.00	0.921	0.411	0.025	0.016	1,341.30
T-01/3		7.30	55.0	2,350	Negative	82.00	8.40	0.7360	0.1316	313.50	<b>15.00</b>	158.60	458.00	0.110	339.00	0.800	0.680	0.003	0.014	1,410.20
<b>T-02/1</b>	Bani Al Suror	7.05	37.5	1,133	Negative	80.00	40.80	0.0008	0.0048	127.60	2.75	324.50	94.00	0.041	140.60	0.130	1.160	0.001	0.006	688.10
T-02/2		7.19	28.8	1,002	Positive	102.00	56.40	0.0138	0.0060	52.30	0.75	419.60	70.00	0.056	86.30	1.200	0.201	0.010	0.026	594.56
<b>T-02/3</b>		7.42	39.2	1,224	Negative	50.00	73.00	0.0005	0.0027	171.00	2.70	419.68	78.00	0.113	152.00	0.164	0.103	0.010	0.001	232.70
<b>T-02/4</b>		6.96	29.5	988	Negative	86.00	33.60	0.0359	0.0176	112.40	2.25	379.42	52.00	0.131	86.13	0.011	1.400	0.017	0.011	566.80
<b>T-03/1</b>	Sheb Humran	6.97	27.0	1,025	Negative	110.22	46.36	0.0519	0.0096	29.00	1.60	441.70	100.00	0.133	102.62	0.600	1.150	0.020	0.006	719.27
T-03/2		7.14	28.5	1,121	Negative	116.23	48.80	0.0284	0.0070	29.00	1.60	463.60	70.00	0.061	86.80	0.300	0.360	0.001	0.091	650.12
<b>T-03/4</b>		7.37	26.3	939	Negative	70.54	30.04	0.3660	0.1374	72.90	1.75	397.72	70.00	0.032	110.00	0.520	1.220	0.022	0.023	547.79
<b>T-04</b>	Yafiq Bani Hamad	7.27	28.1	877	Negative	96.19	35.38	0.0840	0.0352	31.70	0.25	326.90	80.00	0.121	71.50	0.073	0.720	0.004	0.003	393.15
<b>T-05/1</b>	Al Azaez	7.03	27.0	1,675	Negative	158.00	43.68	0.1460	0.0318	39.70	0.75	509.96	190.00	0.126	220.90	0.368	1.650	0.016	0.018	951.65
<b>T-05/2</b>		6.90	28.1	1,017	Negative	110.22	40.26	0.1844	0.0460	36.60	1.25	287.90	125.00	0.131	89.67	0.086	1.360	0.005	0.011	577.72
<b>T-05/4</b>		7.12	24.3	1,093	Negative	112.22	54.65	0.0077	0.0019	38.70	0.25	283.04	115.00	0.203	90.00	0.391	1.020	0.012	0.026	579.23
<b>T-06</b>	Al Khunha	7.21	39.5	1,233	Negative	68.14	8.54	0.5530	0.0343	84.00	1.70	348.90	160.00	0.091	128.30	0.540	0.430	0.081	0.001	722.05
T-06/2		7.74	28.7	1,400	Positive	56.11	43.92	0.0910	0.0111	97.00	1.60	287.90	210.00	0.051	150.60	0.511	1.310	0.011	0.040	862.30

N.B.: Code in Bold/Italic : Target Water Source Value in Bold : Not satisfy standard

Table 3-8 Evaluation on Quality of Target Water Sources

Governorate	Site Code	Site Name	Source Code	Evaluation	Poor Quality Items
Al Mahweet	A-01	Al Sha'afel Al Olyah & Al Sufla	A-01	Good	
	A-02	Jabal Al Taraf	A-02	Good	
	A-03	Ozlat Al Jaradi	A-03	Good	
	A-04	Al Khamis-Bani Ali	A-04	Poor	TDS=1,742 mg/l, Mn=0.25 mg/l, F=1.78 mg/l, Conductivity=2,830 $\mu$ S/cm
Sana'a	S-01	Bani Waleed - Al Asboor	S-01/1	Good	
			S-01/2	Poor	Mn=0.24 mg/l
	S-02	Jarban	S-02	Good	
	S-03	Al Kharaba	S-03	Good	
	S-04	Qamlan-Bait Al Najrani	S-04	Good	
	S-05	Afesh	S-05	Good	
	S-06	Al Lejam	S-06	Poor	pH=9.3
	S-07	Bait Al Hadrami	S-07	Good	
	S-08	Dajah & Sarfah	S-08	Poor	F=4.46 mg/l
	S-09	Ruhm	S-09	Good	
	S-10	Tawa'ar	S-10/1	Poor	pH=9.4
			S-10/2	Good	
	S-11	Al Hesn-Al Abyad	S-11/1	Good	
			S-11/2	Good	
S-12	Mahdah	S-12	Poor	pH=9.5	
S-13	Al Ga'ra	S-13	Good		
S-14	Al Ghail	S-14	Good		
Dahmar	D-01	Elow Al Mikhlaf	D-01	Good	
	D-02	Hamal Bait Al Jabar	D-02	Good	
	D-03	Hegrat Al A'asham	D-03	Good	
	D-04	Al Kuob	D-04	Good	
	D-05	Mayfa'at Yaer	D-05	Good	
	D-06	Wardasan	D-06	Good	
	D-07	Al Asakera	D-07	Good	
	D-08	Masneat Abdul Aziz	D-08	Good	
Ibb	I-01	Asfal Bani Saba	I-01	Good	
	I-02	Al Sana	I-02	Good	
	I-03	Mamsa Al Marqab	I-03	Poor	F=1.86 mg/l
	I-04	Al Jahlah & Al Meshraq	I-04	Good	
Taiz	T-01	Al Muayteeb	T-01	Poor	Na=407 mg/l, K=24.75 mg/l, Mn=0.2002 mg/l, Cl=600 mg/l, Temperature=61.1°C
	T-02	Bani Al Suror	T-02/1	Good	
			T-02/3	Good	
			T-02/4	Good	
	T-03	Sheb Humran	T-03/1	Good	
			T-03/4	Good	
	T-04	Yafiq Bani Hamad	T-04	Good	
	T-05	Al Azaez	T-05/1	Good	
T-05/2			Good		
T-05/4			Good		
T-06	Al Khunha	T-06	Good		

Water from cisterns, dug wells, streams and other unprotected sources usually contain high levels of coliform bacteria due to contamination from the surface, and therefore, boiling is highly recommended before drinking these waters. However, properly constructed deep wells are protected from contamination and water taken from these wells does not contain bacteria and is basically safe for drinking.

### 3.3 Groundwater Potential and Water Balance Analysis

Using results of the inventory survey and field reconnaissance, and from evaluation on pumping test results, the water resources potential was evaluated. The following two methods of evaluation of water sources were conducted.

1. Evaluation of each production well based on results of pumping tests by using values such as transmissivity, specific capacity and recovery time.
2. Evaluation on the basis of water balance calculations by evaluating the exploitable potential of the groundwater basin in a catchment.

#### 3.3.1 Evaluation of Pumping Test Results

From results of pumping tests, the hydraulic characteristics of the aquifer in the candidate sites were calculated and effects of abstraction on the water level in the production well were revealed. In this section, the production wells are classified on the basis of values of transmissivity, specific capacity, drawdown and recovery during the pumping tests.

##### (1) Transmissivity and Specific Capacity

Transmissivity ( $T$ ) is the flow in  $\text{m}^3/\text{day}$  through a section of aquifer 1m wide under a unit hydraulic gradient. Specific capacity ( $Sc$ ) is the discharge of a well per unit of drawdown.

Table 3-9 shows the general guidelines for evaluation of well potential by transmissivity and specific capacity. In the table, a transmissivity of  $10 \text{ m}^2/\text{day}$  suggests good potential for domestic water supply. Withdrawals, or productivity, of this level are expected to be sufficient for water supply systems of the candidate sites of the Study.

The level indicating infeasible, or imperceptible, is below the transmissivity of  $0.1 \text{ m}^2/\text{day}$ , and this means that groundwater cannot be practically extracted. Poor to fair, or very low to low, indicates that groundwater can possibly be pumped up by a hand pump or a mechanical pump in some cases. Good, or intermediate, means that groundwater may be withdrawn using a submersible or vertical pump for water supply.

**Table 3-9 Comparison of Transmissivity and Specific Capacity for Well Potential**

Transmissivity (m <sup>2</sup> /day)		Specific Capacity (liters/sec/m)	Groundwater Supply Potential		
1000	Irrigation	Good	100	Very high	Withdrawals of great regional importance
		Fair	10	High	Withdrawals of lesser regional importance
		Poor	1	Intermediate	Withdrawals for local water supply
100	Domestic	Good	0.1	Low	Smaller withdrawals for local water supply
		Fair	0.01	Very low	Withdrawals for local water supply with limited consumption
		Poor	0.001	Imperceptible	Sources for local water supply are difficult (if possible) to ensure
10					
1					
0.1					

*after U.S. Bureau of Reclamation, Ground Water Manual, U.S. Department of Interior, Washington, 1977. (Kashef, A. Ismail, Groundwater Engineering, p.366)*

*after Krasny, Jiri. 1993. GROUND WATER. vol.31, no.2, pp.231*

Based on the above table, the production wells in the candidate sites were divided into four (4) classes, as follows.

- A:  $T \geq 10$  Very good (intermediate to high potential)
- B:  $5 < T < 10$  Good (low to intermediate potential)
- C:  $1 < T < 5$  Fair (low potential)
- D:  $T < 1$  Poor to infeasible (very low to imperceptible potential)

The results of classification are shown in Table 3-10. No wells were categorized as Class D, poor or very low potential.

The well targeted for S-02 has the highest values of transmissivity and specific capacity of all target wells. The pumping test was conducted with a pumping rate of 2 l/s, and drawdown was only 0.06m after 24 hours pumping. The result suggests that the yield of the well may be twice or more than the conducted rate.

## (2) Drawdown and Recovery

Drawdown and recovery of a production well are also important factors for evaluation of the well. Depth to groundwater table naturally relates to pumping cost, or operation cost, of a production well. The pumping water level in a well should be recovered to the static water level as early as possible after the pump is stopped. Otherwise, the water level of the well will fall continually and eventually cause a drain of the aquifer.

Table 3-10 Evaluation of Well and Aquifer Potential

Gov.	Site Name	Well Code	Pumping Rate in Test (l/s)	Water Level Before Test (G.L.-m)	Pumping Water Level (G.L.-m)	Draw down (m)	Water Level Grade	Specific Capacity ( l/s/m)	Transmissivity (T)		Time for Recovery		
									m <sup>2</sup> /day	Grade	(min.)	t <sub>r</sub> (day)	Grade
Al MAhweet	Al Sha'afel Al Olyah & Al Sufia	A-01	4.4	20.12	66.21	46.09	A	0.095	9.8	B	2340	1.63	C
	Jabal Al Taraf	A-02	4.4	26.00	33.76	7.76	A	0.567	68.8	A	240	0.17	A
	Ozlat Al Jaradi	A-03	10.4	50.80	55.86	5.06	A	2.055	153.8	A	1200	0.83	A
	Al Khamis-Bani Ali	A-04	4.4	6.66	42.50	35.84	A	0.123	6.3	B	240	0.17	A
Sana'a	Bani Waleed - Al Asboor	S-01/1	1.6	115.79	142.93	27.14	B	0.059	5.1	B	>4680	>3.25	D
		S-01/2	3.4	52.78	106.18	53.4	B	0.064	4.5	C	>6000	>4.2	D
	Jarban	S-02	2.0	345.31	345.37	0.06	D	33.333	1526.4	A	200	0.14	A
	Al Kharaba	S-03	3.5	44.93	80.82	35.89	A	0.098	6.0	B	1800	1.25	B
	Qamlan-Bait Al Najrani	S-04	5.6	10.01	10.92	0.91	A	6.154	590.7	A	720 <sup>(1)</sup>	0.50	A-
	Afesh	S-05	3.2	212.97	231.21	18.24	C	0.175	10.5	A	720	0.50	A
	Al Lejam	S-06	4.2	148.09	149.59	1.5	B	2.800	332.6	A	540 <sup>(2)</sup>	0.38	A-
	Bait Al Hadrami	S-07	3.2	193.22	197.12	3.9	B	0.821	118.6	A	220	0.15	A
	Dajah & Sarfah	S-08	(6.0)*	(500)*	(620)*	(120)	(D)	(0.050)	—	—	—	—	—
	Ruhm	S-09	3.0	192.45	227.90	35.45	C	0.085	4.6	C	420	0.29	A
	Tawa'ar	S-10/1	2.2	134.78	180.62	45.84	B	0.048	2.6	C	160	0.11	A
		S-10/2	4.1	144.83	155.96	11.13	B	0.368	36.6	A	480	0.33	A-
	Al Hesn-Al Abyad	S-11/1	3.8	154.11	219.12	65.01	C	0.058	3.3	C	1560	1.08	B
	Mahdah	S-12	2.2	57.78	76.52	18.74	A	0.117	8.0	B	420	0.29	A
Al Ga'ra	S-13	(5.4)*	(520)*	(600)*	(80)	(D)	(0.068)	—	—	—	—	—	
Al Ghail	S-14	—	—	—	—	—	—	—	—	—	—	—	
Dahmar	Elow Al Mikhlaf	D-01	2.4	184.13	185.83	1.70	B	1.412	131.3	A	1200	0.83	A
	Hamal Bait Al Jabar	D-02	3.5	185.80	209.30	23.50	C	0.149	15.8	A	600	0.42	A
	Hegrat Al A'asham	D-03	5.0	163.05	183.95	20.90	B	0.239	20.0	A	1500	1.04	B
	Al Kuob	D-04	0.3	84.90	91.42	6.52	A	0.046	4.1	C	660	0.46	A
	Mayfa'at Yaer	D-05	2.6	59.56	62.78	3.22	A	0.807	89.8	A	660	0.46	A
	Wardasan	D-06	0.5	89.65	131.90	42.25	B	0.012	1.3	C	1740	1.21	B
	Al Asakera	D-07	4.5	193.63	195.18	1.55	B	2.903	387.9	A	420	0.29	A
	Masneat Abdul Aziz	D-08	4.5	61.98	123.68	61.70	B	0.073	4.6	C	1320	0.92	A
Ibb	Asfal Bani Saba	I-01	4.5	106.40	112.70	6.30	B	0.714	118.7	A	90	0.06	A
	Al Sana	I-02	3.9	35.58	140.48	104.90	B	0.037	1.7	C	1680	1.17	B
	Mamasa Al Marqab	I-03	1.6	47.78	54.35	6.57	A	0.244	30.9	A	2400	1.67	C
	Al Jahlah & Al Meshraq	I-04	4.1	14.85	110.15	95.30	B	0.043	2.3	C	1560	1.08	B
Taiz	Al Muayteeb	T-01	3.0 <sup>**</sup>	140.09	169.33 <sup>**</sup>	29.24 <sup>**</sup>	B	0.103 <sup>**</sup>	—	(B)	680 <sup>**</sup>	0.47 <sup>**</sup>	A
	Bani Al Suror	T-02/1	5.1	183.88	186.42	2.54	B	2.008	312.5	A	100	0.07	A
		T-02/3	2.6	118.55	139.66	21.11	B	0.123	8.4	B	960	0.67	A
		T-02/4	5.4	137.23	139.48	2.25	B	2.400	20.0	A	80	0.06	A
		T-03/1	4.0	22.53	44.82	22.29	A	0.179	8.9	B	480	0.33	A
	Sheb Humran	T-03/4	4.2	24.42	28.46	4.04	A	1.040	85.5	A	1440 <sup>(1)</sup>	1.00	B
		Yafoq Bani Hamad	T-04	3.0	124.80	126.71	1.91	B	1.571	121.0	A	180 <sup>(3)</sup>	0.13
	Al Azaez	T-05/1	2.0	8.41	53.60	45.19	A	0.044	2.4	C	1200	0.83	A
Al Khunha	T-06	8.8	-0.05	5.62	5.67	A	1.552	150.0	A	1200	0.83	A	

\*) GARWSP data

\*\*) Estimated by step draw-down test

1) 0.02m residual drawdown

2) 0.01m residual drawdown

3) 0.05m residual drawdown

Based on pumping water levels (PWLs) from the pumping tests, the production wells were classified as below.

- A:  $0 < \text{PWL} \leq 100\text{m}$  (below ground level)
- B:  $100 < \text{PWL} \leq 200\text{m}$
- C:  $200 < \text{PWL} \leq 300\text{m}$
- D:  $\text{PWL} > 300\text{m}$

The value obtained from the recovery time divided by the pumping duration time,  $t_R$ , was used to classify the production wells.

- A:  $t_R \leq 1.0$
- B:  $1.0 < t_R \leq 1.5$
- C:  $1.5 < t_R \leq 2.0$
- D:  $t_R > 2.0$

If  $t_R \leq 1.0$ , this indicates that the recovery time is shorter than the pumping duration time, but  $t_R > 1$  shows that the recovery of water level takes longer than the duration of pumping.

As an example, two wells (S-01/1 and S-01/2) of Bani Waleed-Al Asboor were categorized as Class D, with  $t_R=3.25$  and  $4.2$ , respectively. This implies that the time for recovery takes 3 to 4 times as long as the pump operation time, where for example, 24 to 32 hours after 8 hours pumping, which is not practical for continual use as production wells for a water supply system.

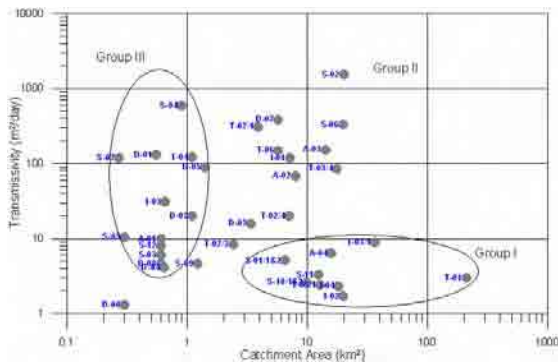
Table 3-10 shows the classification of the production wells in the candidate sites based on pumping test results.

### 3.3.2 Water Balance Analysis

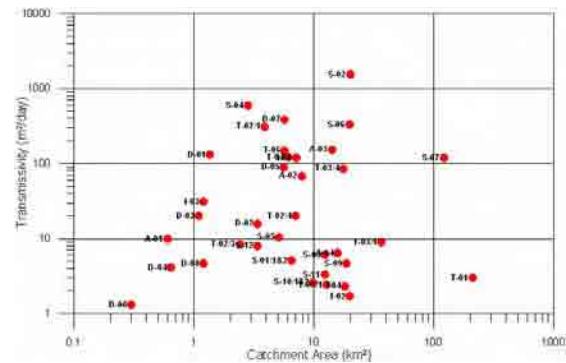
#### (1) Estimation of Catchment Area

With assumption that surface and groundwater watersheds of the catchment coincide, topographic maps of 1:50,000 were used to estimate the catchment area of wells. This assumption may be reasonable for large areas, but it is unlikely to be valid with small catchments, particularly for a fractured aquifer. Therefore, for catchments likely to have areas too small as compared with the value of transmissivity ( $T$ ), they were modified to a higher order segment of a river system, as described below.

Figure 3-1 shows the area of catchment ( $A$ ), obtained directly from a topographic map, in relation to transmissivity ( $T$ ), from results of pumping tests. The figure shows that they can be combined into three groups. Group I is the group with low transmissivities, less than  $10\text{m}^2/\text{day}$ , and catchments showing wide variations. The second Group II is the group with transmissivities generally proportional to the catchments. The third Group III is the group with transmissivities varying widely for small catchments of less than about  $1\text{ km}^2$ .



**Figure 3-1**  
**Catchment-Transmissivity**  
**Relationship Graph**



**Figure 3-2**  
**Modified Catchment-Transmissivity**  
**Relationship Graph**

Group I may suggest that the water bearing fractures are not developed sufficiently in the area or a limited-scale water bearing fracture has been penetrated by the production well. The proportional relation between transmissivities and catchments seen in Group II is thought to be reasonable. The wide variations of transmissivities within small catchments in Group III indicate that the actual catchments of groundwater may not coincide with surface watersheds. Therefore, in Group III, the planimetered catchments of the higher order segment of the river system were presumptively plotted in relation to the transmissivities as shown in Figure 3-2. Since the figure shows that this presumption may be applicable, the modified catchment areas were used for evaluation.

## (2) Natural Recharge

The hydrological balance in a catchment can be represented by the following equation:

$$\text{Recharge} = \text{Discharge} + \text{Change in storage}$$

This can be expressed as:

$$P = (Et + R) + dSg$$

where,  $P$  is precipitation,  $Et$  is evapotranspiration,  $R$  is total run-off, and  $dSg$  is change in groundwater storage.

This equation can be used to estimate annual groundwater recharge in catchments of the candidate sites. However,  $R$  cannot be obtained for each small catchment, and also  $P$  and  $Et$  can only be estimated roughly on the basis of limited data. Therefore, a more feasible way to evaluate the groundwater recharge of the catchments is considered to be by using the recharge coefficient, 3-5% of rainfall, obtained by an empirical approach of the High Water Council (*Groundwater Resources, TS-HWC, 1992*). Rainfall in the catchments was estimated based on the isohyet map (refer to Figure 3-3), from the report WRAY-35 (*The Water resources of Yemen, MOMR and TNO Institute of Applied Geo-science, 1995*), after examination of meteorological data collected during the Study. See Table 3-11 for areas of the catchments and the estimated recharge using the recharge coefficient of 3 - 5%.

### (3) Analysis of Water Balance

Calculation of the present water balance for each catchment was attempted. In addition to natural discharge, human activities induce another significant discharge, which is groundwater consumption for irrigation, domestic use and industrial use, in the catchment. And then, some of these consumptions may return to the ground through infiltration. These recharge and discharge induced by human activities are considerable for a very large area such as the Sana'a basin, but it is likely to be negligible for a small rural area such as the candidate sites of the Study, with the exception of consumption for irrigation and domestic uses.

In the case of irrigation, groundwater use is practically limited to qat and other cash crops. Cereals like sorghum and millet have been mostly cultivated in rain-fed (and base-flow) fields in the sites. Water resource survey and socio-economic survey conducted by the Study Team show that most of the sites in Sana'a governorate and some sites in Dahmar governorate have irrigation zones for qat and other cash crops. In other sites, large catchment areas of more than 10km<sup>2</sup> were considered to have possible irrigation zones for qat and other cash crops. The irrigated area in a site was estimated on the basis of the ratio of cultivated areas for cash crops in each governorate as shown below.

Al Mahweet:	3.65%
Sana'a:	2.17%
Dahmar:	1.60%
Ibb:	2.27%
Taiz:	1.03%



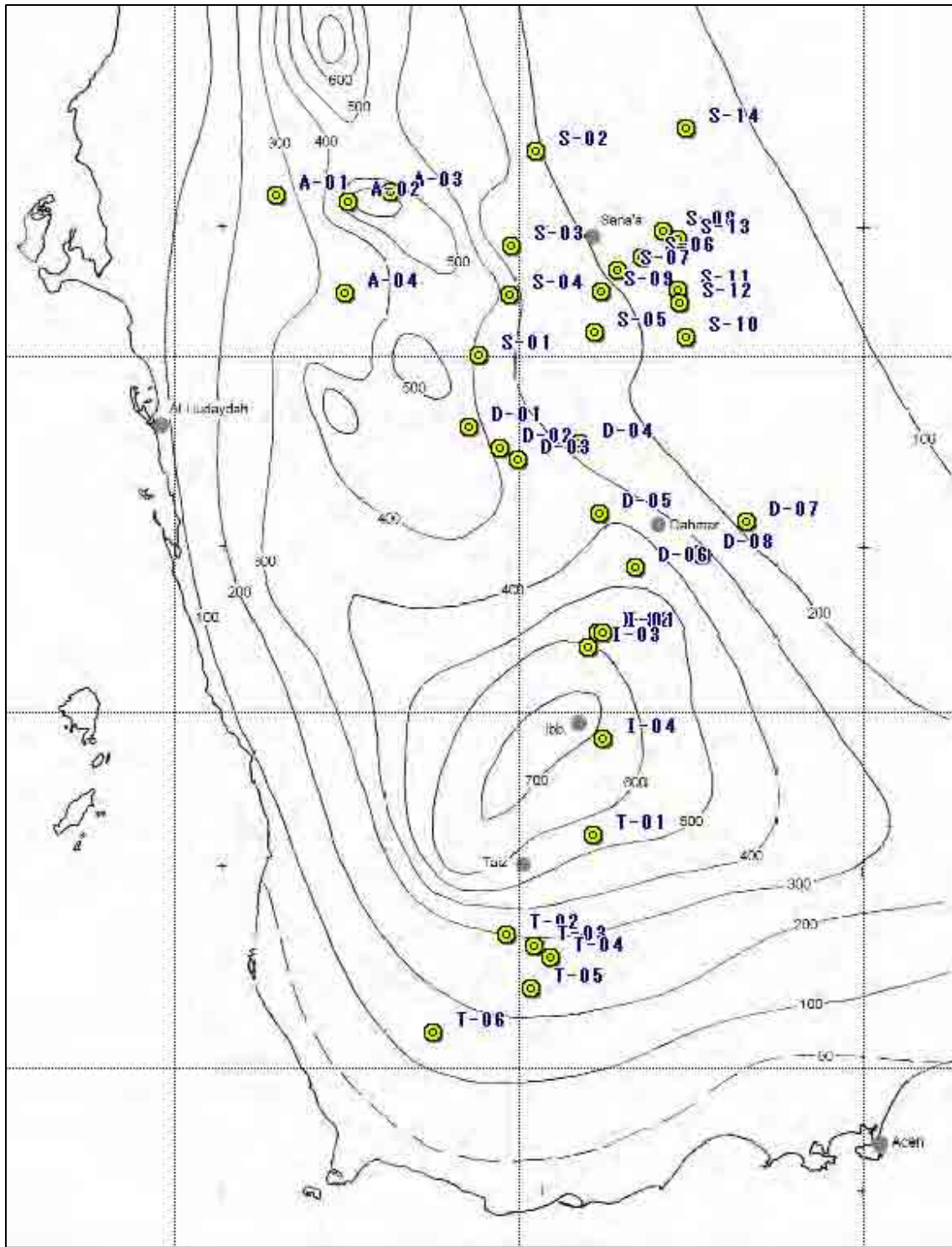


Figure 3-3 Isohyet Map in the Study Area

Consumption of groundwater for irrigation was estimated for sites cultivating qat using the value of irrigation water requirement, 8,000m<sup>3</sup>/ha, obtained from the report of Sana'a Basin Water Management Study (*Basin Characterization and Selection of Pilot Study Areas, Volume II, 2001*). The seasonal proportion of the crop growing term was estimated as 0.4. Then, the consumption volume of groundwater was calculated as:

$$\text{Groundwater Consumption} = (\text{Area of catchment}) \times (\text{Cash crop area ratio}) \times (\text{water requirement}) \times (\text{crop growing seasonal proportion})$$

In addition to the above consideration, groundwater consumption was estimated for some catchments where one or more deep wells for grain fields were observed in the catchments through the site survey. The estimated consumption volume for irrigation is based on present conditions, and the volume will probably change if the conditions change, for instance, if the irrigation area expands. However, further consumption for irrigation should be restrained to conserve the groundwater resources.

The present domestic water consumption is calculated by average household water consumption, 20 l/capita/day, obtained by the socio economic survey, and the number of residents in the site estimated by population density of the district.

### 3.3.3 Water Balance Prediction and Evaluation of Water Source

In addition to the above present water balance calculation, water balance after start of operation of the project water supply system is estimated in this section. This future balance was calculated by the present recharge against the present and future discharge, which is the pumping rate planned for the project. Based on the estimated results, each site was categorized into four groups as follows.

- A: Ratio (Discharge/Recharge)  $\leq$  50%
- B: 50% < Ratio  $\leq$  100%
- C: 100% < Ratio  $\leq$  200%
- D: Ratio > 200%

Table 3-11 shows the results of water balance calculations and the categorization. A ratio of 100% means that discharge is equal to recharge in the area. A value less than 100% means that discharge is less than recharge. So, the design pumping rate is acceptable for Groups A and B. A discharge ratio above 100% means possibly that the discharge volume is over the recharge volume and that groundwater storage is unlikely to be sustainable in a long term. At sites showing more than 200% discharge ratio, the design pumping rate may cause critical conditions to the aquifer within a short period.

Table 3-11 Evaluation of Water Balance

No.	Gov.	Site Name	Source Code	Pumping Rate from Test		Projected Pumping Rate	Catchment	Rain-fall	Recharge <sup>(**)</sup>	Domestic Water Consumption	Irrigation Consumption	Total Discharge	Present Balance		Water Balance after abstraction for water supply system	Expected Discharge Ratio per Recharge		Evaluation
				l/sec	m <sup>3</sup> /day <sup>*</sup>								m <sup>3</sup> /day (Recharge - Discharge)	m <sup>3</sup> /day		%		
1	Mawneh	Al Sha'afel Al Olyah & Al Suffia	A-01	4.4	127	312	0.6	260	12.8 - 21.3	3.7	3.7	3.7	9.1 - 17.6	-299.2 - -290.7	2437.4% - 1462.4%	D		
2			A-02	4.4	127	145	7.9	550	357.1 - 595.2	32.8	32.8	32.8	324.4 - 562.5	212.1 - 450.2	40.6% - 24.4%	A		
3			A-03	10.4	300	690	14.1	600	695.3 - 1,159	76.2	76.2	451.2	167.9 - 631.5	-445.9 - 17.7	164.1% - 98.5%	C		
4			A-04	4.4	127	85	15.8	350	454.5 - 757.5	40.4	40.4	505.6	-91.5 - 211.5	-136.1 - 166.9	129.9% - 78.0%	B-		
5	San'a	Bani Waleed-Al Asboor	S-01/1&2	5	144	94	6.5	380	203.0 - 338.4	10.9	123.7	134.6	68.4 - 203.7	-14.6 - 120.7	107.2% - 64.3%	B-		
6			S-02	2	58	79	20.0	220	361.6 - 602.7	60.6	60.6	380.5	-79.5 - 161.6	-97.8 - 143.2	127.1% - 76.2%	B-		
7			S-03	3.5	101	67	12.4	280	285.4 - 475.6	22.0	22.0	235.9	27.5 - 217.7	-17.5 - 172.7	106.1% - 63.7%	B-		
8			S-04	5.6	161	31	2.8	350	80.5 - 134.2	5.0	5.0	5.0	75.6 - 129.3	49.5 - 103.2	38.5% - 23.1%	A		
9			S-05	3.2	92	113	5.1	240	100.6 - 167.7	8.0	8.0	97.0	-4.5 - 62.6	-109.4 - -42.4	208.8% - 125.3%	C-		
10			S-06	4.2	121	52	19.7	150	242.9 - 404.8	54.2	54.2	374.8	-186.1 - -24.2	-183.9 - -22.0	175.7% - 105.4%	C-		
11			S-07	3.2	92	125	120.9	180	1788.7 - 2,981	332.7	332.7	2300.1	-844.1 - 348.3	-636.4 - 556.0	135.6% - 81.3%	C		
12			S-08	6	173	130	19.6	150	241.6 - 402.7	53.9	53.9	372.9	-185.2 - -24.1	-261.2 - -100.1	208.1% - 124.9%	C-		
13			S-09	3	86	140	18.7	190	292.0 - 486.7	51.5	51.5	355.8	-115.2 - 79.5	-203.7 - -9.0	169.8% - 101.9%	C		
14			S-10/1&2	6.3	181	225	9.9	180	146.5 - 244.1	15.3	15.3	188.3	-57.2 - 40.4	-266.9 - -169.2	282.2% - 169.3%	D		
15			S-11	3.8	109	116	12.3	170	171.9 - 286.4	23.2	23.2	234.0	-85.3 - 29.3	-178.1 - -63.6	203.7% - 122.2%	C-		
16			S-12	2.2	63	10	3.4	170	47.5 - 79.2	6.4	6.4	6.4	41.1 - 72.8	37.5 - 69.2	21.0% - 12.6%	A		
17			S-13	5.4	156	100	3.4	150	41.9 - 69.9	5.8	5.8	64.7	-28.5 - -0.6	-122.8 - -94.8	392.9% - 235.7%	D		
18			S-14	0.8	23	49	47.2	120	465.5 - 775.9	21.2	21.2	898.0	-453.7 - -143.3	-481.4 - -171.1	203.4% - 122.0%	C-		
19	Dahmar	Elow Al Mikhlaf	D-01	2.4	69	50	1.4	420	46.9 - 78.2	4.5	4.5	4.5	42.5 - 73.8	-3.1 - 28.2	106.5% - 63.9%	B-		
20			D-02	3.5	101	134	3.4	380	106.2 - 177.0	11.2	11.2	47.7	47.3 - 118.1	-75.5 - -4.7	171.1% - 102.7%	C		
21			D-03	5	144	86	1.1	360	32.5 - 54.2	3.6	3.6	3.6	28.9 - 50.6	-53.5 - -31.8	264.2% - 158.5%	C-		
22			D-04	0.3	9	110	0.6	280	14.7 - 24.5	1.8	1.8	9.0	4.0 - 13.8	-104.2 - -94.4	807.8% - 484.7%	D		
23			D-05	2.6	75	82	5.6	380	174.9 - 291.5	19.0	19.0	78.6	77.4 - 194.0	14.4 - 131.0	91.8% - 55.1%	B		
24			D-06	0.5	14	72	0.3	450	11.1 - 18.5	1.0	1.0	4.2	5.9 - 13.3	-65.1 - -57.7	686.8% - 412.1%	D		
25			D-07	4.5	130	105	5.7	190	89.0 - 148.4	13.0	13.0	80.0	-4.0 - 55.4	-95.9 - -36.6	207.8% - 124.7%	C-		
26			D-08	4.5	130	22	1.2	320	31.6 - 52.6	2.7	2.7	2.7	28.8 - 49.9	9.6 - 30.6	69.7% - 41.8%	A-		
27			I-01	4.5	130	297	7.1	580	338.5 - 564.1	22.8	22.8	22.8	315.7 - 541.3	41.5 - 267.1	87.7% - 52.6%	B		
28			I-02	3.9	112	192	19.9	580	948.7 - 1,581	211.3	211.3	396.0	341.3 - 973.7	360.6 - 993.1	62.0% - 37.2%	A-		
29	Irb	Mansa Al Marqab	I-03	1.6	46	90	1.2	610	60.2 - 100.3	12.7	12.7	12.7	47.4 - 87.5	-29.8 - 10.3	149.6% - 89.8%	C		
30			I-04	4.1	118	334	18.2	680	1,017 - 1,695	290.8	290.8	362.2	364.2 - 1042.3	321.0 - 999.1	68.4% - 41.1%	A-		
31			T-01	3	86	124	210.0	540	9,321 - 15,534	780.8	780.8	4179.3	4360.5 - 10574.2	4236.5 - 10450.2	54.5% - 32.7%	A-		
32	Tair	Bani Al Suror	T-02/1	5.1	147	187	3.9	300	96.2 - 160.3	25.0	25.0	25.0	71.2 - 135.3	-90.8 - -26.7	194.5% - 116.7%	C-		
			T-02/3	2.6	75	95	2.4	300	59.2 - 98.6	15.4	15.4	15.4	43.8 - 83.2	-35.8 3.6	160.5% - 96.3%	C-		
			T-02/4	5.4	156	197	7.0	300	172.6 - 287.7	44.9	44.9	44.9	127.7 - 242.8	-24.4 90.7	114.1% - 68.5%	B-		
			T-03/1	4	115	369	36.4	290	867.6 - 1,446	233.3	233.3	338.3	296.0 - 874.4	160.3 - 738.8	81.5% - 48.9%	B		
33	Tair	Sheb Humran	T-03/4	4.2	121	388	17.6	290	419.5 - 699.2	112.8	163.6	276.4	143.1 - 422.8	-132.1 - 147.6	131.5% - 78.9%	B-		
34			T-04	3	86	218	6.1	280	140.4 - 234.0	66.6	66.6	66.6	73.8 - 167.4	-77.6 - 16.0	155.3% - 93.2%	B-		
35			T-05/1&2	2	58	215	12.8	240	252.5 - 420.8	64.3	64.3	119.0	69.3 - 237.6	-81.5 - 86.9	132.3% - 79.4%	B-		
36	T-06	8.8	253	161	3.0	240	59.2 - 98.6	15.1	15.1	15.1	44.1 - 83.6	-101.8 - -62.4	272.1% - 163.2%	C-				
		Al Khunha			81	5.7	150	70.3 - 117.1	7.1	7.1	7.1	63.2 - 110.1	-10.7 - 36.1	115.3% - 69.2%	C			

\*\*): Estimated from recharge coefficient, 3-5 % of rainfall

\*): Pumping 8 hours/day

### 3.3.4 Evaluation on Potential of Water Sources

The potential of water sources were evaluated by two methods. The first one was evaluation based on values such as transmissivity, specific capacity and time of recovery from results of pumping tests. The other evaluation was conducted on the basis of calculation of exploitable potential of the groundwater basin in a catchment. From a viewpoint of groundwater potential, priority areas should be first selected from the sites ranked A in the result of water balance evaluation, and then they should be placed in order based on the ranking of time of recovery and transmissivity. The evaluation on the potential of water sources ranked in order of reliability is shown below.

Table 3-12 Evaluation of Water Source Potential

Site Name	Well Code	Water Balance	Recovery	Transmissivity	Water Level	Potential Evaluation	
						Rank	Potential
Jabal Al Taraf	A-02	A	A	A	A	1	High
Qamlan-Bait Al Najrani	S-04	A	A-	A	A	2	
Mahdah	S-12	A	A	B	A	3	
Al Muayteeb	T-01	A-	A	(B)	B	4	Moderately High
Masneat Abdul Aziz	D-08	A-	A	C	B	5	
Al Sana	I-02	A-	B	C	B	6	
Al Jahlah & Al Meshraq	I-04	A-	B	C	B	6	Moderate
Mayfa'at Yaer	D-05	B	A	A	A	8	
Sheb Humran	T-03/1&4	B	A	A	A	8	
Asfal Bani Saba	I-01	B	A	A	B	10	
Elow Al Mikhlaf	D-01	B-	A	A	B	11	
Yafoq Bani Hamad	T-04	B-	A	A	B	11	
Jarban	S-02	B-	A	A	D	13	
Al Khamis-Bani Ali	A-04	B-	A	B	A	14	
Al Kharaba	S-03	B-	B	B	A	15	
Ozlat Al Jaradi	A-03	C	A	A	A	16	
Bani Al Suror	T-02/1,3,4	C	A	A	B	17	Fair
Bait Al Hadrami	S-07	C	A	A	B	17	
Hamal-Bait Al Jabar	D-02	C	A	A	C	19	
Al Azaez	T-05/1&2	C	A	C	A	20	
Ruhm	S-09	C	A	C	C	21	
Mamsa Al Marqab	I-03	C	C	A	A	22	Low
Al Khunha	T-06	C-	A	A	A	23	
Al Asakera	D-07	C-	A	A	B	24	
Afesh	S-05	C-	A	A	C	25	
Al Lejam	S-06	C-	A-	A	B	26	
Hegrat Al A'asham	D-03	C-	B	A	B	27	
Al Hesn-Al Abyad	S-11	C-	B	C	C	28	
Dajah & Sarfah	S-08	C-	-	-	(D)	29	
Al Ghail	S-14	C-	-	-	-	30	Very Low (Not Sustainable)
Tawa'ar	S-10/1&2	D	A	A	B	31	
Al Kuob	D-04	D	A	C	A	32	
Wardasan	D-06	D	B	C	B	33	
Al Sha'afel Al Olyah & Al Sufla	A-01	D	C	B	A	34	
Al Ga'ra	S-13	D	-	-	(D)	35	
Bani Waleed-Al Asboor	S-01/1&2	B-	D	B	B	36	

### 3.3.5 Considerations on Results of Evaluation

#### (1) Necessity for Control of Over-discharge

The main cause of the present over discharge of some catchments is the groundwater consumption for irrigation, which is principally limited to qat and other cash crops. The estimated irrigation water requirement is  $8,000\text{m}^3/\text{ha}$ , or  $800,000\text{ m}^3/\text{km}^2$ , in a qat field. This value is believed to be reasonable considering evapotranspiration of the crop. On the other hand,  $800,000\text{m}^3$  of water is a volume enough to supply about 55,000 persons with 40 l/capita/day for one year. Considering that the population density is several hundred in Sana'a, this means that the volume used for irrigation can cover the people living in an area more than 100 times that of the qat field. An efficient and conservative irrigation water use is the most important issue for groundwater management.

#### (2) Possibility for Further Exploitation

For over half of the candidate sites, the recommended pumping rate of the production well is not sufficient to meet the projected water demand. Although some production wells have relatively higher transmissivities, it may be possible to construct another production well near the existing borehole in these cases, but exploring other catchments to develop another aquifer may be a better solution, depending on the volume of the projected water demand. The lower values of transmissivity show that the exploited fissure aquifers have rather poor potential. Additional production wells should be drilled targeting a larger fractured aquifer based on hydrogeological examinations of geological structure, especially analysis of lineaments, and catchment. For the sites of D-08, I-02, I-04, and S-01/1&2, drillings of additional production wells are recommended to exploit productive fractured aquifers.

At sites where the water balance is critical, an additional well should be constructed in another larger catchment. As an example, the area of the catchment where the target well is located in the site of A-01, Al Sha'afel Al Olyah & Al Sufla, is very small (less than  $1\text{km}^2$ ), but a wadi with a larger catchment is located beside this area, and a production well constructed in this wadi bed may give a larger yield. The areas having lower evaluation ranking, such as 16 and below, in Table 3-12, are also recommended to be explored from the above point of view. Of course, water balance analyses and proper hydrogeological examinations in the targeted catchment areas need to be carried out.

### 3.4 Overall Evaluation of Candidate Water Sources

Quality of the target water sources were evaluated in Section 3.2, and potential evaluation was carried out in Section 3.3. The table below summarizes the overall evaluation of the candidate water sources in terms of quality, quantity and potential.

Table 3-13 Overall Evaluation of Water Sources

Governorate	Site Code	Site Name	Source Code	Quality		Quantity/Potential		Source Evaluation
				Eval.	Poor Item	Eval.	Remark	
Al Mahweet	A-01	Al Sha'afel Al Olyah & Al Sufla	A-01	○		×	Slow recovery	×
	A-02	Jabal Al Taraf	A-02	○		○		○
	A-03	Ozlat Al Jaradi	A-03	○		○		○
	A-04	Al Khamis-Bani Ali	A-04	×	TDS, Mn, F, Cond.	○		×
Sana'a	S-01	Bani Waleed - Al Asboor	S-01/1	○		×	Slow recovery	×
			S-01/2	×	Mn			
	S-02	Jarban	S-02	○		○		○
	S-03	Al Kharaba	S-03	○		○		○
	S-04	Qamlan-Bait Al Najrani	S-04	○		○		○
	S-05	Afesh	S-05	○		○		○
	S-06	Al Lejam	S-06	×	pH	○		×
	S-07	Bait Al Hadrami	S-07	○		○		○
	S-08	Dajah & Sarfah	S-08	×	F	×	No pumping test	×
	S-09	Ruhm	S-09	○		○		○
	S-10	Tawa'ar	S-10/1	×	pH	×	Not sustainable	×
			S-10/2	○				
	S-11	Al Hesn-Al Abyad	S-11/1	○		○		○
			S-11/2	○				
S-12	Mahdah	S-12	×	pH	○		×	
S-13	Al Ga'ra	S-13	○		×	No pumping test	×	
S-14	Al Ghail	S-14	○		×	Well collapsed	×	
Dahmar	D-01	Elow Al Mikhlaf	D-01	○		○		○
	D-02	Hamal Bait Al Jabar	D-02	○		○		○
	D-03	Hegrat Al A'asham	D-03	○		○		○
	D-04	Al Kuob	D-04	○		×	Low pumping rate	×
	D-05	Mayfa'at Yaer	D-05	○		○		○
	D-06	Wardasan	D-06	○		×	Low pumping rate	×
	D-07	Al Asakera	D-07	○		○		○
	D-08	Masneat Abdul Aziz	D-08	○		○		○
Ibb	I-01	Asfal Bani Saba	I-01	○		○		○
	I-02	Al Sana	I-02	○		○		○
	I-03	Mamsa Al Marqab	I-03	×	F	×	Slow recovery	×
	I-04	Al Jahlah & Al Meshraq	I-04	○		○		○
Taiz	T-01	Al Muayteeb	T-01	×	Na, K, Mn, Cl, Temp.	×	No pumping test	×
	T-02	Bani Al Suror	T-02/1	○		○		○
			T-02/3	○				
			T-02/4	○				
	T-03	Sheb Humran	T-03/1	○		○		○
			T-03/4	○				
	T-04	Yafoq Bani Hamad	T-04	○		○		○
	T-05	Al Azaez	T-05/1	○		○		○
			T-05/2	○				
T-05/4			○					
T-06	Al Khunha	T-06	○		○		○	

Legend: ○ Good quality, Sufficient quantity/potential × Poor quality, Insufficient quantity/potential

#### **4. SCREENING AND RANKING OF STUDY SITES**

## 4. SCREENING AND RANKING OF STUDY SITES

Data and information on present conditions of socio-economic activities, water sources, water supply facilities and community awareness of the candidate sites collected and compiled in the First Fiscal Year survey, as well as results of the groundwater survey conducted in the Second Fiscal Year were used to screen the 36 candidate sites for selection of sites to formulate a rural water supply improvement plan. The concept and criteria for selection were discussed and agreed with GARWSP. The procedures for screening and ranking are presented below.

### 4.1 General Flow for Site Screening and Ranking

The overall flow of the above procedures for screening and ranking of the candidate sites is depicted below.

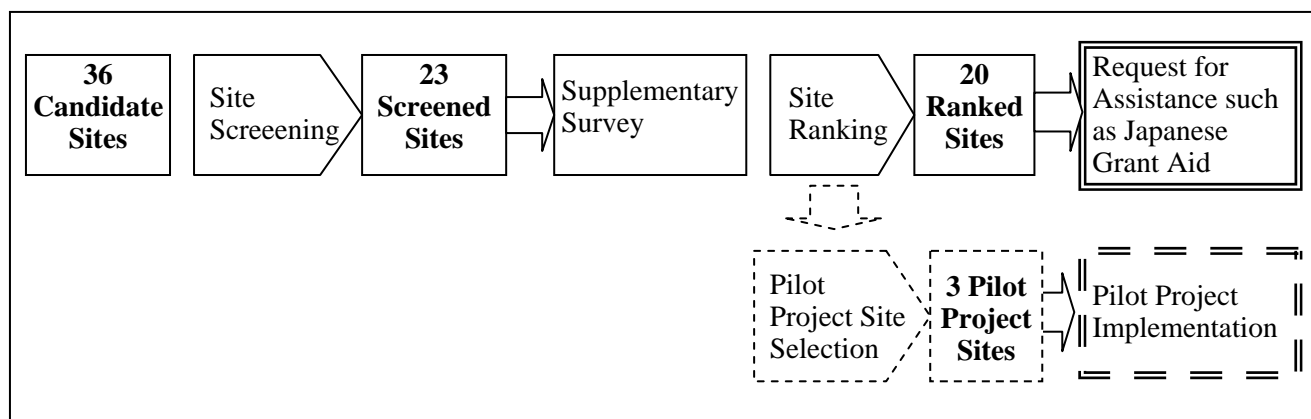


Figure 4-1 Flow of Site Screening and Ranking

From the list of screened sites, 3 sites were selected for implementation as pilot project. Conditions for selection of sites and implementation concepts for the pilot project were discussed with GARWSP and agreed.



## 4.2 Screening of Sites for Formulation of Rural Water Supply Improvement Plan

The following criteria were used for screening of candidate sites.

Table 4-1 Selection Criteria for Screening

Parameter	Selection Criteria	Justification
1. Availability of Water Source	<ol style="list-style-type: none"> <li>1) Reliable water source is available</li> <li>2) Target water source has a minimum yield of 25 gal/min (1.5 lit/sec)</li> <li>3) Quality of water source complies with Yemeni standards for drinking water</li> </ol>	<ol style="list-style-type: none"> <li>1. Target water source must be reliable with sufficient potential</li> <li>2. This is the minimum yield for successful well</li> <li>3. Water must be safe for drinking</li> </ol>
2. Water Supply Situation	<ol style="list-style-type: none"> <li>1) Existing water supply facilities cannot meet demand of beneficiaries</li> </ol>	Community is not receiving satisfactory water supply
3. Contribution from Beneficiary	<ol style="list-style-type: none"> <li>1) Water committee is existent or residents are willing to form one</li> <li>2) Residents are willing to contribute to construction of water supply facilities</li> <li>3) Residents are willing to pay operation and maintenance fees</li> </ol>	<ol style="list-style-type: none"> <li>1. Water committee is essential for sustainable water supply</li> <li>2. Contribution is essential to foster ownership of facilities</li> <li>3. Payment of water fees is essential for sustainable water supply</li> </ol>
4. Similar Projects	<ol style="list-style-type: none"> <li>1) No duplication of sites with similar plans of other donors</li> </ol>	Implementation by one donor only to avoid duplicating budgets
5. Land Use and Water Rights	<ol style="list-style-type: none"> <li>1) Public ownership of target water source and land for storage tanks and pump houses is confirmed by target site, GARWSP and District council*<sup>1</sup></li> <li>2) Conflicts over water rights or land use are non-existent within the site or with neighboring villages*<sup>2</sup></li> </ol>	<ol style="list-style-type: none"> <li>1. Completed water supply facilities become public entity, so private ownership is forbidden</li> <li>2. Conflicts can lead to problems with ownership of facilities which may cause vandalism, etc.</li> </ol>
6. Accessibility	<ol style="list-style-type: none"> <li>1) Construction machinery and equipment can access site</li> </ol>	Without proper access, construction works can be hindered

\*<sup>1</sup> Only verbal confirmation of ownership at stage of screening

\*<sup>2</sup> Existence of conflict confirmed by site observations and inquiries

Flow of the screening process is depicted in the next page.

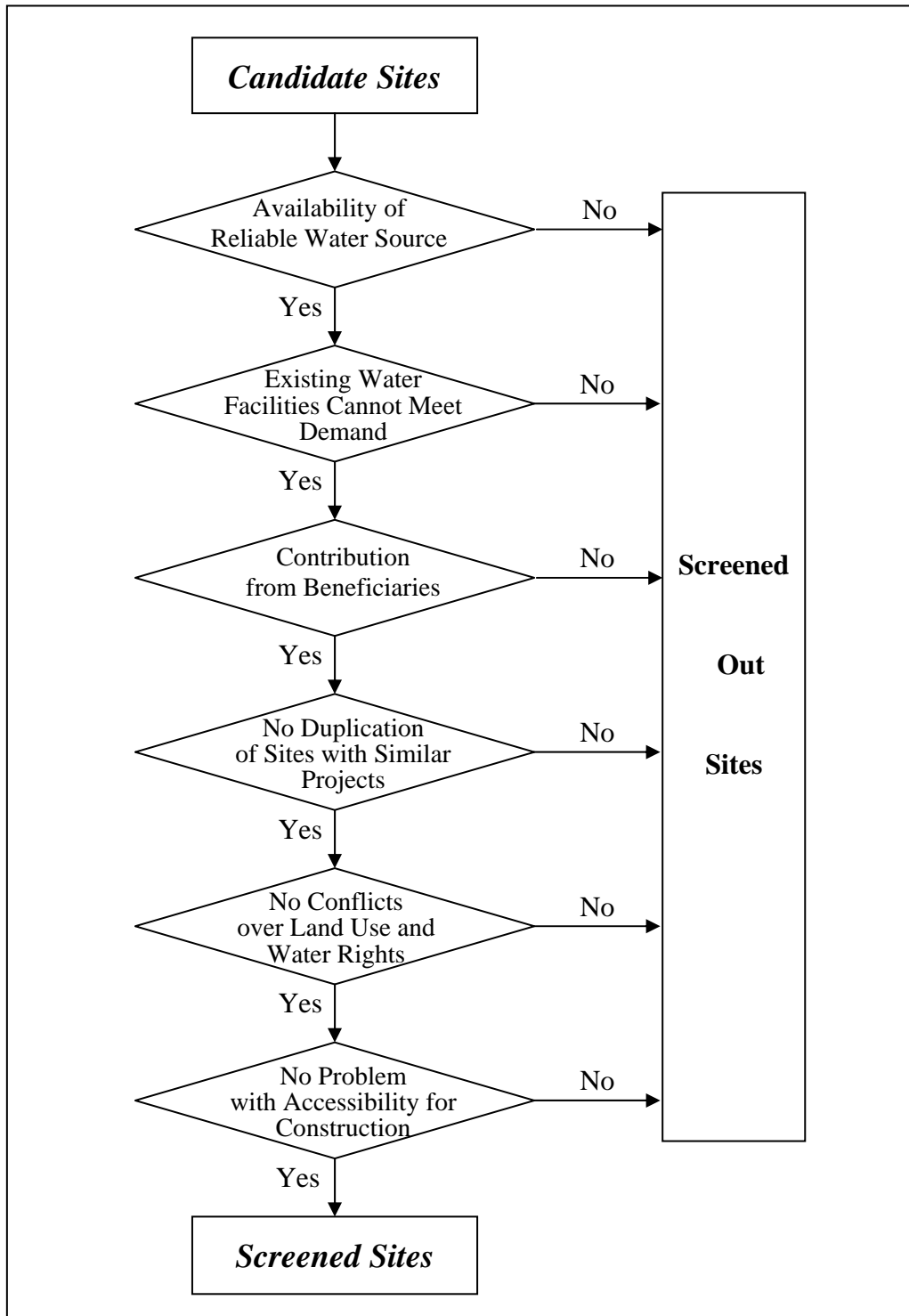


Figure 4-2 Flow of Screening Process

Through the above screening procedure, and as compiled in Table 4-2, twenty three (23) sites were selected for formulation of the rural water supply improvement plan. These sites were given ranking according to procedures explained in the next section.

**Table 4-2 Candidate Site Screening**

No.	Site Name	Code No.	Gov.	District	1. Water Source Availability			2. Water Supply Situation		3. Beneficiary Contribution			4. Similar Projects		5. Land Use & Water Rights		6. Accessibility	Evaluation
					Reliable Source Available	Sufficient Capacity	Water Quality	Existing Water Supply Facilities cannot meet Demand	Water Committee Formation	Contribute to Construction	Contribute to O&M	No Duplication	Water Source/Facilities Land are Public	No Conflicts over Land or Water	Equipment Access Possible			
1	Al Sha'atef Al Olyah & Al Sufia	A-01	Al Mahweet	Al Khabt	No	Yes	Good	Cannot	Yes	Yes	Yes	None	Yes	None	Yes	Yes	Out	
2	Jabal Al Taraf	A-02			Yes	Yes	Good	Cannot	Yes	Yes	Yes	None	Yes	None	Yes	Yes	Yes	In
3	Ozlat Al Jaradi	A-03			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
4	Al Khamis-Bani Ali	A-04			Yes	Yes	Poor	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	Out
5	Bani Waleed-Al Asboor	S-01	San'a	Al Haymah Al Kharijiyah	No	Yes	Good	Cannot	Yes	Yes	Yes	None	Yes	None	Yes	Yes	Out	
6	Jarban	S-02			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
7	Al Kharaba	S-03			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
8	Qamian-Bait Al Nejrani	S-04			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
9	Afesh	S-05			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
10	Al Lejam	S-06			Yes	Yes	Poor	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	Out
11	Bait Al Hadrami	S-07			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
12	Dajah & Sarfah	S-08			No	Yes	Poor	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	Out
13	Ruhm	S-09			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
14	Tawa'ar	S-10			No	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	Out
15	Al Hesn-Al Abyad	S-11			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
16	Mahdah	S-12			Yes	Yes	Poor	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	Out
17	Al Ga'ra	S-13	Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	Out		
18	Al Ghail	S-14	No	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	Out		
19	Elow Al Mikhlaf	D-01	Dahmar	Jabal Al Sharq	Yes	Yes	Good	Cannot	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In	
20	Hamal-Bait Al Jabar	D-02			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
21	Hegrat Al Aasham	D-03			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
22	Al Kuob	D-04			Yes	No	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	Out
23	Mayfat Yaer	D-05			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
24	Wardasan	D-06			No	No	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	Out
25	Al Asakera	D-07			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
26	Masneat Abdul Aziz	D-08			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
27	Asfal Bani Saba	I-01	Ibb	Al Qafir	Yes	Yes	Good	Cannot	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In	
28	Al Sana	I-02			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
29	Mamsa Al Marqab	I-03			No	Yes	Poor	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	Out
30	Jahliah & Al Meshraq	I-04	Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In		
31	Muayteeb	T-01	Taz	Mawiyah	No	Yes	Poor	Cannot	Yes	Yes	Yes	None	Yes	None	Yes	Yes	Out	
32	Bani Al Suror	T-02			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
33	Sheb Humran	T-03			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
34	Yafiq Bani Hamad	T-04			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
35	Al Azzez	T-05			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In
36	Al Khunha	T-06			Yes	Yes	Good	Cannot	Yes	Yes	Yes	Yes	None	Yes	None	Yes	Yes	In

### 4.3 Ranking of Screened Sites

Sites screened through the above procedure are ranked according to grades assigned to the parameters listed below, which were discussed and consented by GARWSP.

Table 4-3 Parameters for Ranking of Screened Sites

Parameter		Comparative Factor
1.	Difficulty to procure water	1) Whether protected water source within site is available to community 2) Conditions for presently accessible protected water source within or outside site: a. Average water consumption rate per day per household b. Average time required to fetch water per day per household
2.	Needs for Water Supply Improvement	1) Needs ranking for water supply in relation to improvement of living environment
3.	Water Source Potential	1) Using target water source, ratio of population able to be covered to total population
4.	Capacity for Payment of Operation and Maintenance Fees	1) Ratio between amount payable per household per 1 m <sup>3</sup> of water and cost to supply 1 m <sup>3</sup> of water

When the total grade was the same for 2 or more sites, priority ranking of target governorates and priorities of screened sites by governorates (see table below), as designated by GARWSP, were used to make further ranking.

Table 4-4 Priorities of Governorates and Governorate-Wise Sites as Decided by GARWSP

Governorate	Governorate Priority	Code	Site Name	Governorate-wise Site Priority
Al Mawheet	<b>5</b>	A-02	Jabal Al Taraf	1
		A-03	Ozlat Al Jaradi	2
Sana'a	<b>1</b>	S-02	Jarban	1
		S-03	Al Kharaba	4
		S-04	Qamlan-Bait Al Najrani	6
		S-05	Afesh	5
		S-07	Bait Al Hadrami	2
		S-09	Ruhm	3
		S-11	Al Hesn - Al Abyad	7
Dahmar	<b>2</b>	D-01	Elow Al Mikhlaf	3
		D-02	Hamal Bait Al Jabar	4
		D-03	Hegrat Al A'asham	5
		D-05	Mayfa'at Yaer	1
		D-07	Al Asakera	2
		D-08	Masneat Abdul Aziz	6
Ibb	<b>4</b>	I-01	Asfal Bani Saba	3
		I-02	Al Sana	2
		I-04	Al Jahlah & Al Meshraq	1
Taiz	<b>3</b>	T-02	Bani Al Suror	5
		T-03	Sheb Humran	2
		T-04	Yafiq Bani Hamad	4
		T-05	Al Azaez	3
		T-06	Al Khunha	1

The ranking proceeded along the following flow chart.

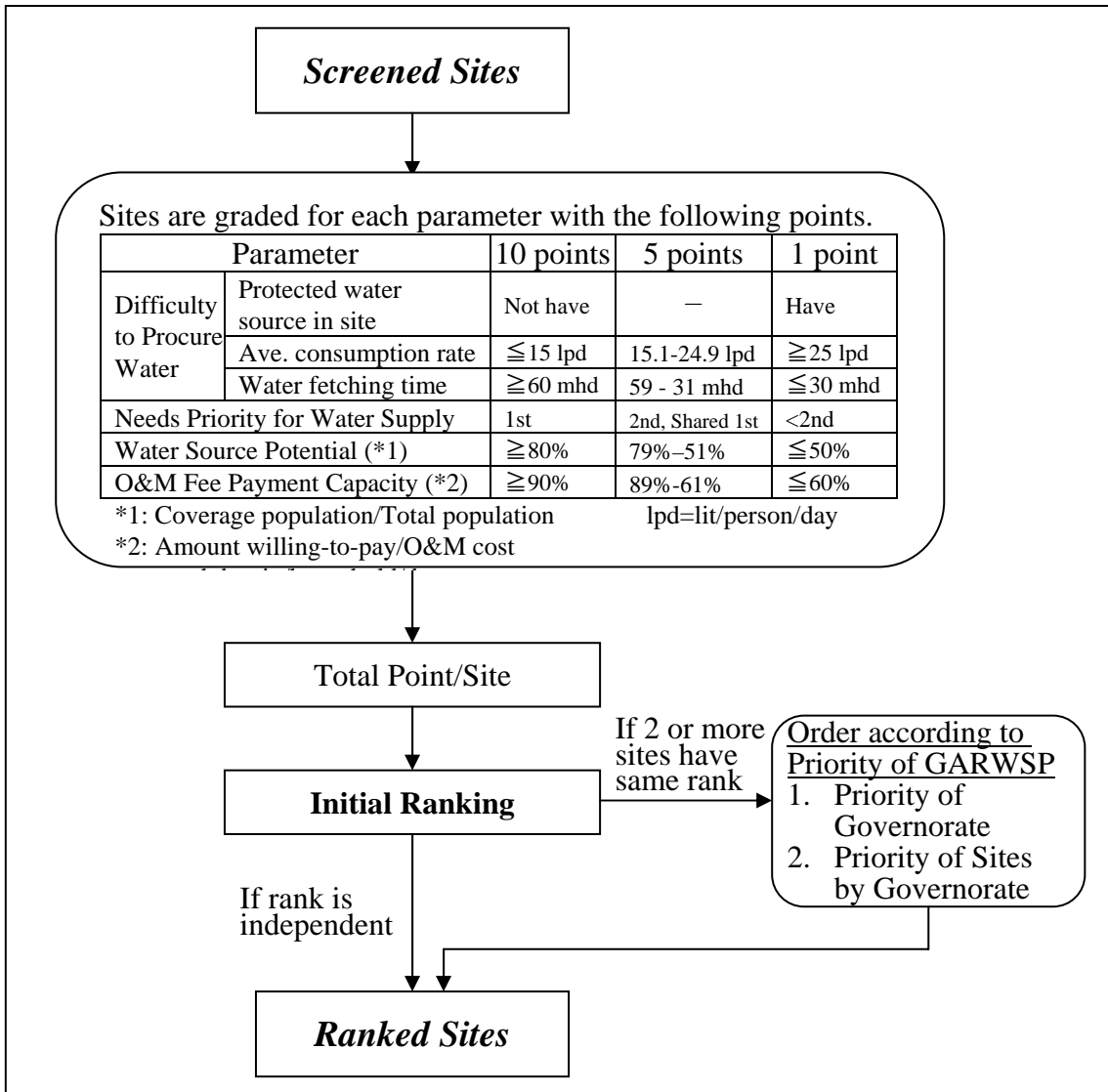


Figure 4-3 Flow Chart for Ranking

The procedures for ranking of the screened sites following the above flow are compiled in Table 4-5.

The ranked sites can be requested to donor organizations for project implementation in accordance with budget constraints and assistance concepts of the donor organization. The preconditions required for project implementation of the ranked sites are the following.

1. Land required for construction including water source are publicly owned and necessary legal procedures are taken.
2. Security along access routes and within site is assured.
3. If request is submitted for assistance from a donor organization, the site is not located within an area designated as “restricted area for donor country citizens”.

**Table 4-5 Ranking of Screened Sites**

Gov. No.	Site Name	Code No.	District	1. Difficulty for Water Procurement					2. Water Supply Needs		3. Water Source Potential		4. O&M Fee Payment Capacity			Ranking	Gov. Priority	Site Priority by Gov.	Final Ranking
				Protected Water Source in Site Available	Point	Average Consumption Rate lit/pers./day	Point	Water Fetching Time (One Way+Queue) min/HH/day	Point	Water Supply Improvement	Priority	Point	Coverage Population/ Total Population	%	Point				
Al Mahweet	1 Jabal Al Taraf	A-02	Al Mahweet	Yes	1	23.4	5	35	5	<2nd	1	88	10	74	5	27	18	1	19
	2 Ozlat Al Jaradi	A-03	Al Rujum	Yes	1	20.0	5	45	5	1st	10	27	1	64	10	32	14	2	16
Sana'a	3 Jarban	S-02	Hamdan	Yes	1	33.3	1	35	5	1st	10	73	5	27	1	23	20	1	20
	4 Al Kharaba	S-03	Bani Matar	Yes	1	30.0	1	45	5	1st	10	100	10	32	1	28	17	4	17
	5 Qamlan-Bait Al Nejrani	S-04	Bani Matar	No	10	30.0	1	35	5	1st	10	100	10	40	1	37	9	6	10
	6 Afesh	S-05	Belad Al Rous	No	10	23.3	5	35	5	1st	10	51	5	30	1	36	12	5	12
	7 Bait Al Hadrami	S-07	Sanhan & Bany Bahlool	Yes	1	26.7	1	65	10	1st	10	74	5	77	10	37	9	2	9
	8 Ruhm	S-09	Sanhan & Bany Bahlool	Yes	1	25.0	1	<30	1	1st	10	39	1	65	5	19	21	3	21
	9 Al Hesn-Al Abyad	S-11	Jehana	Yes	1	20.8	5	45	5	1st	10	94	10	79	5	36	12	7	13
	11 Elow Al Mikhlaf	D-01	Jabal Al Sharq	No	10	16.7	5	>150	10	1st	10	100	10	112	10	55	1	3	1
	12 Hamat-Bait Al Jabar	D-02	Jabal Al Sharq	Yes	1	19.1	5	90	10	1st	10	75	5	168	10	41	6	4	7
	13 Hegrat Al A'sham	D-03	Jabal Al Sharq	Yes	1	19.2	5	>150	10	1st	10	100	10	171	10	46	3	5	4
14 Mayfa at Yaer	D-05	Ans	Yes	1	18.1	5	>240	10	1st	10	92	10	109	10	46	3	1	3	
15 Al Asakera	D-07	Mayfa'a	Yes	1	20.0	5	35	5	1st	10	100	10	176	10	41	6	2	6	
16 Masneat Abdul Aziz	D-08	Mayfa'a	No	10	19.4	5	65	10	1st	10	100	10	107	10	55	1	6	2	
17 Asfal Bani Saba	I-01	Al Qatr	No	10	16.9	5	90	10	1st	10	27	1	160	10	46	3	3	5	
18 Al Sana	I-02	Al Makhader	Yes	1	15.0	10	90	10	1st	10	37	1	66	5	37	9	2	11	
19 Al Jahlah & Al Meshraq	I-04	Ibb	Yes	1	20.0	5	45	5	1st	10	22	1	178	10	32	14	1	15	
20 Bani Al Suror	T-02	Al Ma'afar	Yes	1	20.8	5	45	5	<2nd	1	79	5	55	1	18	22	5	22	
21 Sheb Humran	T-03	Al Ma'afar	Yes	1	20.4	5	35	5	Shared 1st	5	20	1	154	10	27	18	2	18	
22 Yafaq Bani Hamad	T-04	Al Mawaset	Yes	1	17.8	5	45	5	1st	10	25	1	75	10	32	14	4	14	
23 Al Azaez	T-05	Al Shamyaten	Yes	1	25.0	1	<30	1	<2nd	1	34	1	78	5	10	23	3	23	
24 Al Khunha	T-06	Al Wazieyah	No	10	18.8	5	35	5	1st	10	100	10	54	1	41	6	1	8	
Point	10 Points		No		≤15		≥60		1st		≥80		≥90						
	5 Points		-		15.1-24.9		59 - 31		2nd, Shared 1st		79 - 51		89 - 61						
	1 Point		Yes		≥25		≤30		<2nd		≤50		≤60						

#### **4.4 Treatment of Screened Out Sites**

As a result of the screening process previously explained, from the 36 candidate sites, 23 sites were selected for water supply improvement planning, while 13 sites had to be screened out as being not feasible for implementation. However, since the main reasons of sites being screened out are due to problems with water sources in terms of quality, quantity and potential, if water sources appropriate for supply requirements can be found such as drilling wells in neighboring basins, then these sites may become feasible. However, if appropriate alternative water sources are not available, then other solutions such as the recommendations listed below need to be developed.

- Handpump system or a point-source scheme for low quantity sources
- Installation of small-scale water treatment units for poor quality sources (however, maintenance requirements need to be carefully considered)
- Rainwater harvester as complementary supply

**5. SURVEY FOR WATER SUPPLY  
FACILITIES PLANNING**



## **5. SURVEY FOR WATER SUPPLY FACILITIES PLANNING**

Complementary field surveys were conducted at the screened sites to support formulation of the water supply improvement plan. The complementary surveys included the following.

- Topographic surveying
- Confirmation of land and accessibility for construction of water supply facilities
- Survey on procurement of construction equipment and materials

GARWSP branch offices have prepared water supply plan, facilities design and rough drawings for some sites. These were used to identify the capacity of GARWSP branch offices for water supply designing. Also, these existing documents of GARWSP were used as basis for the complementary surveys.

### **5.1 Topographic Surveying**

At the screened sites, a summary surveying including route (profile) surveying and plane surveying was carried out for preliminary facilities design. Route surveying was conducted by the Study Team, and plane surveying was carried out using satellite images to prepare a site plan (facilities layout).

The topographic surveying was carried out for the following 2 methods.

- Route surveying for pipeline route design
- Plane surveying for planning of water supply facilities layout

The purpose of surveying was to determine the following factors for preliminary designing. The results are reflected in facilities designing and preliminary drawings as described in Chapter 6 of the Main Report.

- Locations of water sources, candidate tank and booster station sites, and service areas
- Routes of pipelines from water source to distribution tank and service area
- Extent of water supply coverage

Surveying equipment was procured for this study to be used as material for on-the-job training (OJT) of GARWSP staff from headquarters and branch offices as part of the capacity development program. The training was conducted on the use of surveying equipment, method of summary surveying, practical training at sites and compilation of surveying data. These equipment were handed over to GARWSP after completion of the topographic surveying activities at the screened sites.

## **5.2 Confirmation of Construction Land and Accessibility**

Confirmation on the availability of public land necessary for construction of water supply facilities within the screened sites was made. Also, accessibility of construction equipment and vehicles to construction areas at the screened sites was confirmed. In some sites, the availability of land especially for booster stations has not yet been confirmed and the accessibility to tank and booster station locations needs to be secured prior to construction. The results were used as justification to prepare the preliminary facilities design of water supply facilities for the screened sites.

## **5.3 Procurement of Materials and Equipment for Construction**

The possibilities for local procurement and third country procurement of materials and equipment as well as use of local contractors were surveyed. Materials for civil works such as cement, concrete blocks and aggregates are locally produced, and imported steel and metallic products can be procured. Concerning local importers of water supply equipment, GARWSP has a list of ranking of reliable dealers of pumps, engines, pipes and other equipment.

In Yemen, diesel engine driven vertical (borehole) pumps are most popular, but submersible motor pumps are also being used. Various types of pumps are imported and can be procured locally, and since vertical and horizontal pumps account for a large share of the market, obtaining their spare parts and making repairs are easier than other types. Diesel engines and generators are also imported and available locally. Imported galvanized steel pipes and

fittings are widely popular and available, however they should be procured with careful attention to avoid inferior products. Specialized equipment and materials such as pressure-resistant pipe materials and special valves may need to be procured from Japan or a third country.

Market conditions of consumables and spare parts, and guarantees and repair system of suppliers and manufacturers were considered so that operation and maintenance of water supply facilities can be handled easily by local management.

Concerning local contractors for drilling and construction works, they must be registered with GARWSP in order to contract work with GARWSP projects. About 50 drilling companies and over 70 construction companies are registered under GARWSP, and GARWSP has ranked them by their capacity, reliability, experience and other relevant factors into graded groups.

## **6. IEE ASSISTANCE**

## **6. IEE ASSISTANCE**

Based on “JICA Guidelines for Environmental-Social Consideration”, an initial environmental examination (IEE) was made for this study. Moreover, confirmation was made with the Environmental Protection Authority (EPA) of Yemen on the necessity of an environmental impact assessment (EIA).

### **6.1 Method**

Environmental impact assessment (EIA) in Yemen is regulated by the Environmental Protection Law (Law No.26, 1995) and Article 35 of this law states that all projects must conduct an EIA. However, past rural water supply projects of GARWSP have not been subjected to legal procedures for EIA due to their scale being comparatively small to impart no serious impact on the environment. The Environmental Impact Assessment Policy (EPC, 1996), which stipulates the policies and procedures of the EIA system in Yemen, states that small scale rural water and sanitation projects are categorized as Category 3, which is defined as projects “which need preliminary assessment to decide on the necessity of a full EIA”.

Moreover, for projects funded by the SFD, the Fund independently classifies its projects to either Class A or Class B, the former having more serious influence, different from the EPA system. Since Class B projects of SFD are not subjected to the EIA system of Yemen, and all of the rural water supply projects of SFD are classified into Class B, thus all SFD rural water supply projects do not need EIA approval.

On the other hand, a “JICA Guidelines for Environmental-Social Consideration” was prepared by JICA in April 2004. The guidelines explain procedures for each category of projects to aim for meaningful participation by stakeholders and assurance of transparency in decision making processes. In the guidelines, since the main actor for environmental-social consideration is the recipient government, JICA will confirm and support the procedures.

In this respect, the implementation concept of environmental-social consideration for this study will be as follows.

- a. The recipient government will initiate execution of the environmental-social consideration in accordance with the environmental impact assessment regulation of Yemen, and the Study Team will give support from the sidelines for its smooth execution. Especially, results of the socio-economic and water quality surveys and other information collected in this study can be fully utilized as data necessary for scoping and formulation of assessment planning.

- b. Discussions were made with the recipient government so that items stipulated in the JICA Guidelines such as open viewing of information, stakeholder meetings and determination of alternative measures will be obeyed.

## 6.2 Description of Assistance

### 6.2.1 Interviews with Deputy Minister for Environment of MWE

Interviews with the Deputy Minister in charge of Environmental Affairs of the Ministry of Water & Environment were carried out to obtain advice on the screening of sites which require EIA. A site description paper was made to clear out the site situation.

As a result, the Deputy Minister advised the team to consider the following factors:

- i) Consideration should be made to social aspects of the area
- ii) Care should be taken to the water quality of each target well

### 6.2.2 Assistance to Preparation of Documents on Project Discussion Papers and Screening

Assistance was given to prepare the Project Discussion Paper (PDP) and Screening Categorization. In Yemen, the procedures for the EIA are as follows:

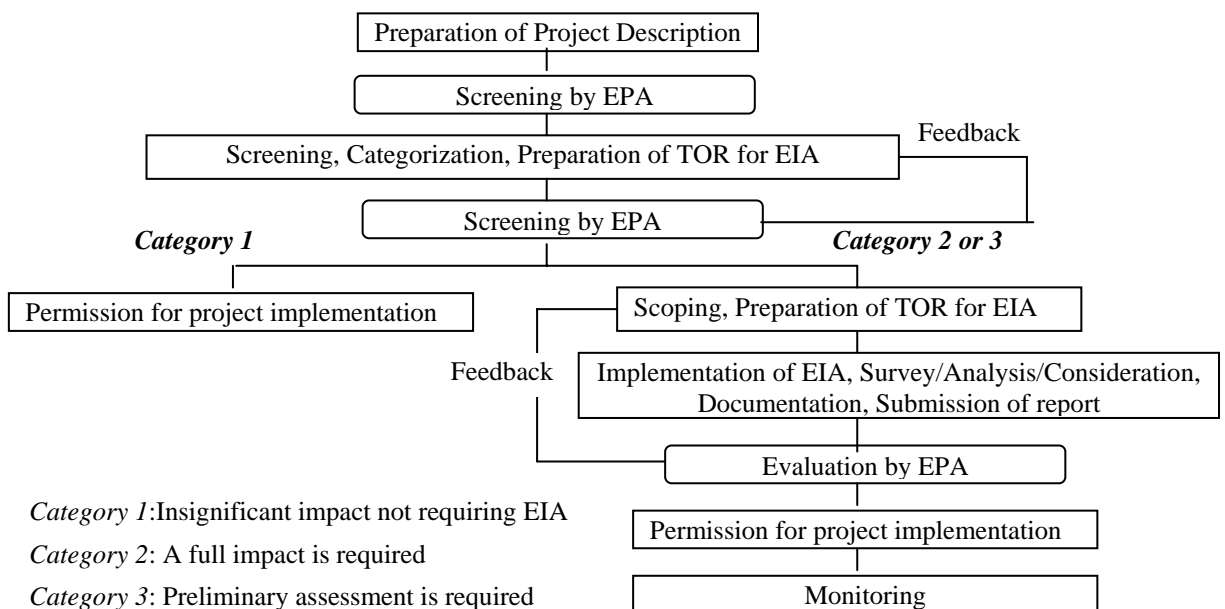


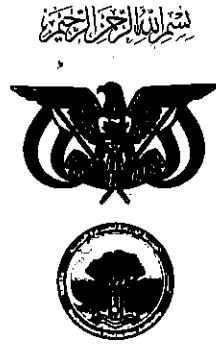
Fig. 6-1 EIA Process of Yemen

As stated above, rural water and sanitation projects such as this project are categorized under Category 3, which requires preliminary assessment to decide on the necessity of a full EIA. As such, the PDP (Project description paper) regarding the project sites was submitted to EPA to be in line with the EIA policy. In response to the PDP, a letter was issued from EPA to GARWSP on 18th March, 2007 (refer to letter shown in the next page). This letter mentions that *“the General Authority approves the contents of the report and points out some issues that could have some impacts in the future.”* This means that EPA has approved the sites with no need for further procedures under the condition that project implementation takes into consideration of the issues pointed out in the report, which are as follows. Measures to be taken (which are recommended by the Study Team) in case these issues are identified are also listed in the table below.

Table 6-1 Issues for Consideration during Implementation

Issue for Consideration	Description of Issue	Measures to be Taken (Recommended by the Study Team)
1. Effects on surrounding wells	Effects on nearby private operating wells need to be taken into consideration in terms of future productivity of the site.	If a private well exists within a perimeter of 500 m of the project target well, then discussions are needed with the well owner.
2. Effects from settlements' waste	Effects from settlements' waste and its impact on well water need to be taken in consideration during the implementation stage.	Advice should be given to residents not to dump waste within a perimeter of 10m of the project well.
3. Scarcity of water issue	Due to a) population increase, b) no limitation on groundwater use for Qat irrigation and c) low average rainfall, the groundwater availability is put under risk and the sustainability of some projects needs to be well considered.	Design for water supply should be confirmed according to conditions at the time of implementation.
4. Water storage barriers and small dams	Water storage barriers and small dams should be noted that they may be polluted and can have impact on the health of villagers.	Residents should be advised that drinking water must be taken only from the project well and water for other uses can be taken from other sources, but with precaution.
5. Air, soil and noise pollution	Air pollution and noise pollution due to generators should be noted as potential impacts.	Since pump houses are located away from residences and engines are operated during the daytime, this should not possess any problems.
6. Potential of conflicts	Although the residents are long-waiting for the project to start and thus improve the living conditions and life style, precautions need to be taken into consideration during the implementing stage for conflicts between the beneficiaries.	If potential for conflicts are encountered, discussions between the conflicting parties are necessary to form a mutual understanding of their needs.

**REPUBLIC OF YEMEN**  
Ministry of Water and Environment  
Environment Protection Authority



الجمهورية اليمنية  
وزارة المياه والبيئة  
الهيئة العامة لحماية البيئة  
الرقم / المرجع: ٢٦٤ هـ م ب  
التاريخ: ١٤١٠ / ٣ / ١٨  
عدد المرفقات:

No/Ref: .....

Date: .....

No.of Pages: .....

**From The Environment Protection Authority**

**No Ref 161**  
**Date 18/3/2007**

**To: The General Authority for Rural Water Supply**

**Subject : Approval of the Environmental and Social Impact Report**

Dear sir,

The Environmental Protection Authority (EPA) presents its best regards to you.

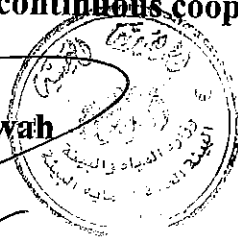
and would like to inform you that the concern Department in the authority has reviewed the above report dealing with Environmental and Social Impact (EIA) of the 23 water projects that are distributed in Five Governorates , Sana'a Al-Mahweet , Dhamar , Ibb, and Taiz . Therefore, (EPA) approved the contents of the report and its pointing out some of the signs and issues that could have some impacts in the future and its mitigation measures.

Please, inform the authority branches in the governorates to give attention to such issues during the operation of these projects.

Thank you for your continuous cooperation.

Best regards ,

**Mahmoud M. Shidiwah**  
Chairman, EPA



صنعاء - ص.ب: (١٩٧١٩) - هاتف: ٢٠٧٨١٦ / ٧ - فاكس: ٢٠٧٣٢٧ - بريد إلكتروني: environment@yemen.net.ye  
Sana'a - P.O.Box: (19719) - Tel: (207816 / 7) - Fax: (207327) - E-mail: epa-yemen@yemen.net.ye

**www.yemenenvironment.org**



### 6.2.3 Assistance to Execution of IEE

Although project implementation is permitted by the Yemeni authorities according to the EPA examination, a simple environmental-social assessment of IEE level was carried out based on JICA guidelines. As a result of scoping, the below listed parameters were judged to have impact.

Table 6-2 Results of Scoping

Environmental Parameter	Evaluation	Justification
Economic Activity	c	Water vendors can become unemployed.
Water Rights	c	Pumping rates of existing irrigation wells may decrease.
Groundwater	c	Due to groundwater development, depending on the amount of development, groundwater level can be lowered.
Water Contamination	c	As a result of increase in water supply, household wastewater will increase to provoke possibilities of water contamination.

a: Serious impact expected, b: Some impact expected, c: Possibility for impact, d: No impact (IEE or EIA not necessary)

In case the above impacts are suspected, survey methods and countermeasures for the parameters are shown below.

Table 6-3 Survey Methods and Countermeasures for Environmental Impacts

Environmental Parameter	Evaluation	Survey Method	Countermeasure
Economic Activity	c	Through a socio-economic survey, by determining the number of water vendors, sales records and other information, the economic position of vendors in the community can be identified. Then, predict the impacts on the vendors due to the water supply improvement.	One way to counter the negative impact is to incorporate the water vendors who became unemployed into the operation and maintenance system, such as using them as water source guardians.
Water Rights	c	Determine location of irrigation wells and their pumping rates through survey of existing water sources.	Select well drilling points that have least impact on existing irrigation wells.
Groundwater	c	Make a rough estimate of groundwater potential.	Determine the safe pumping rate based on groundwater potential.
Water Contamination	c	Determine the discharge rate and treatment situation of household wastewater through a survey on existing water supply facilities. Then, identify the extent of load by determining the unit discharge load factor.	When the load increases and a significant impact is predicted, small-scale treatment facilities need to be considered.

### 6.3 Results of IEE

First, descriptions of the sites are shown in the following table.

Table 6-4 Site Description

Code No.	Site Name	Major Crops	Present Sources for Water Fetching	Potential Conflict
A-02	Jabal Al Taraf	Sorghum, millet, qat	Existing water facility	
A-03	Ozlat Al Jaradi	Sorghum, millet	Existing water facility	Conflicts between old and new users
S-02	Jarban	Qat	Private wells, water vendors, cistern	
S-03	Al Kharaba	Wheat, sorghum, qat, vegetables, fruits	Private wells, cistern	
S-04	Qamlan – Bait Al Najrani	Qat, sorghum	Private wells	Conflict between Qamlan and Bait Al Najrani
S-05	Afesh	Qat	Springs, water vendors	
S-07	Bait Al Hadrami	Qat	Private wells, water vendors	Conflict between old and new residents
S-09	Ruhm	Qat	Water vendors	Conflict between old and new residents
S-11	Al Hesn–Al Abyad	Grapes	Existing water facility	
D-01	Elow Al Mikaf	Sorghum and qat	Spring, cistern	
D-02	Hamal Bait Al Jabar	Qat, sorghum	Private wells, springs	
D-03	Hegrat Al A’asham	Qat, coffee, sorghum	Springs, cistern	
D-05	Mayfa’at Yaer	Sorghum, qat	Existing facility, spring	
D-07	Al Asakera	Qat	Private wells	Conflict between residents and poor farm laborers
D-08	Masneat Abdul Aziz	Sorghum, wheat, barley	Cistern, nearby village	
I-01	Asfal Bani Saba	Qat	Private wells, spring	
I-02	Al Sana	Qat, coffee	Private wells, spring	
I-04	Al Jahlah – Al Meshraq	Qat	Water vendors, spring	
T-02	Bani Al Suror	Vegetables, qat	Existing water facility, private wells	
T-03	Sheb Humran	Sorghum, qat	Existing water facility, private wells	
T-04	Yafoq Bani Hamad	Sorghum, qat	Existing water facility	
T-05	Al Azaez	Sorghum vegetables, fruits	Existing water facility	
T-06	Al Khunha	Sorghum	Dug Wells	

The possibilities of the scoped factors having influence to each site are shown in the table below. Since there are no potentially significant factors influencing the environment, all of them are evaluated as either 3 or 4, which implies impact is very few or none. Those evaluated as 4 should have absolutely no influence related to the concerned factor. Evaluation 3 was given to a few sites due to some possibility for influence as explained below.

- Economic Activity: Some residents are presently buying water from vendors.
- Water Rights: Potential conflicts such as between old and new residents were identified.
- Groundwater: Evaluation on potential of target water source revealed fair to low potential, but sufficient to supply the design water supply rate.

Table 6-5 Evaluation of Scoped Factors for Each Site

Code No.	Site Name	Economic Activity	Water Rights	Groundwater	Water Contamination
A-02	Jabal Al Taraf	4	4	4	4
A-03	Ozlat Al Jaradi	4	3	3	4
S-02	Jarban	3	4	4	4
S-03	Al Kharaba	4	4	4	4
S-04	Qamlan–Bait Al Najrani	4	3	4	4
S-05	Afesh	3	4	3	4
S-07	Bait Al Hadrami	3	3	3	4
S-09	Ruhm	3	3	3	4
S-11	Al Hesn–Al Abyad	4	4	3	4
D-01	Elow Al Mikaf	4	4	4	4
D-02	Hamal Bait Al Jabar	4	4	3	4
D-03	Hegrat Al A’asham	4	4	3	4
D-05	Mayfa’at Yaer	4	4	4	4
D-07	Al Asakera	4	3	3	4
D-08	Masneat Abdul Aziz	4	4	4	4
I-01	Asfal Bani Saba	4	4	4	4
I-02	Al Sana	4	4	4	4
I-04	Al Jahlah–Al Meshraq	3	4	4	4
T-02	Bani Al Suror	4	4	3	4
T-03	Sheb Humran	4	4	4	4
T-04	Yafoq Bani Hamad	4	4	4	4
T-05	Al Azaez	4	4	3	4
T-06	Al Khunha	4	4	3	4

- 1: Potential for significant influence  
2: Potential for some influence  
3: Possibility for influence  
4: No influence at all

Explanation of the above factors for scoping is given below.

a. Economic Activity

According to interviews with a number of water vendors in Sana'a and other target areas, these water vendors are selling water on demand. This means that the vendors go to and sell to the people who want them. Therefore, even if the water supply system is constructed, the vendors will continue to sell on demands, such as to other villages which have needs of water or some temporal uses such as at construction sites. Water vendors are used to such changes and have adapted to these changes, and consequently, a new water supply system will not be a threat to the vendors. As such, the vendors will not go out of work even after the water supply system is completed.

b. Water Rights

Although water rights such as those concerning groundwater are not legally adopted in Yemen, in reality some conflicts sometimes occur concerning who has the right to use the water supply facilities. For example, in one of the sites in Sana'a Governorate, the original residents claim that they have the priority to use the water supply facility, compared to the newly settled residents, but conflicts such as these are settled through internal discussions. As such, care should be taken when designing the supply systems of these sites with consideration of fair and equal water distribution to all residents to avoid unnecessary conflicts. Also for such sites, in-depth dialogues between the concerned parties are necessary before designing the facilities and during site transfer for construction works.

c. Groundwater

Because most of the sites are using private wells for various water uses, and because most of the sites are cultivating qat (which needs large quantities of water) for living, there will still be demand for groundwater from the private wells even after completion of the water supply system. Therefore, care should be taken when designing the water supply rate, so that the minimum amount needed is supplied to the area and careful attention is made to properly balance the supply rate with the natural recharge rate. Also, for sustainable use of limited groundwater in Yemen, conservative use of water not only for domestic use, but especially for irrigation purposes needs to be warned to and obliged by the users.

#### d. Water Contamination

Although if the water supply system is completed, there are fears that load on water contamination might increase, but in most of the sites the increase rate will be small because the newly targeted population is relatively small. Therefore, the impact will be small enough to be negligible.

#### e. Ecosystem

All of the sites encompass villages where land-use is either settlements or farmlands. Therefore, none of the sites are habitats for endangered or indigenous fauna or flora species.

#### f. Consideration of Zero Option

If the project is not implemented (zero option), then the sites will receive no impact. However, the residents of the sites must continue to tolerate severe shortage of water, and they will need to rely on water from unsanitary sources such as dugwells and streams which can affect their health.

### **6.4 Evaluation on IEE**

From the above examination through IEE, it can be concluded that negative impacts from the construction or implementation of the project will be limited. Therefore, conducting further EIA is not required and procedures to the next step can follow. Furthermore, the project was approved by the EPA, meaning that there are no more legal steps to be followed as far as the EIA system in Yemen is concerned.

### **6.5 Stakeholder Meeting**

The results of IEE were explained in the seminar held in February 2007. Comments and/or opinions concerning the results were not received from the stakeholders, which can be implied as no opposition to the results.

## **7. WORKSHOP/SEMINARS**

## 7. WORKSHOP/SEMINARS

### 7.1 Participatory Workshop for Capacity Identification

With objectives of capacity identification of GARWSP headquarters and branch offices as well as local authorities for rural water supply project implementation and needs assessment for capacity development, a participatory workshop was held in February 2006. The workshop participants and program are shown below.

**Table 7-1 Participatory Workshop Attendants and Schedule**

**Attendants :**

His Excellency, Mr. Ishii, Ambassador of Japan

Dr. Al Hamadi, Deputy Minister for Water, MWE

Mr. Al Suraimi, Chairman of GARWSP

Representatives from GARWSP Headquarters 15 persons

5 persons each from 3 GARWSP Branch Offices 15 persons

1 person each from 17 Local Authorities in Target Branches 17 persons

JICA Study Team 6 persons

**Agenda for First Day / 4<sup>th</sup> February 2006 (Saturday)**

Time	Session	Description
8:30-9:00	Registration of Participants	
9:00-9:45	Introduction	Opening Speeches: <ul style="list-style-type: none"> <li>■ JICA Study Team Leader</li> <li>■ GARWSP Chairman</li> <li>■ Ambassador of Japan</li> <li>■ MWE Deputy Minister for Water</li> </ul>
9:45-10:00	Break	
10:00-12:00	Session 1	<ul style="list-style-type: none"> <li>■ Workshop Orientation</li> <li>■ Overview on the Study and Workshop</li> <li>■ Presentation / Historical background, current water sector reform, and institutional framework for rural water service delivery</li> <li>■ Question and Answer, Clarification</li> </ul>
12:00-12:30	Tea Break & Praying	
12:30-14:30	Session 2	Functional Roles and Responsibilities of Each Stakeholders in Rural Water Supply Service Delivery under Emerging Institutional Framework <ul style="list-style-type: none"> <li>■ Brief Explanation of the Session</li> <li>■ Group Discussion</li> <li>■ Group Presentation</li> </ul>
14:30 -	Lunch	

### Agenda for Second Day / 5<sup>th</sup> February 2006 (Sunday)

Time	Session	Description
8:30-8:45	Summary of Previous Day Sessions	
8:45-10:45	Session 3	Initial Assessment of Capacity Area <ul style="list-style-type: none"><li>■ Brief Explanation of the Session</li><li>■ Group Discussion</li><li>■ Group Presentation</li></ul>
10:45-11:00	Tea Break	
11:00-13:30	Session 4	Problem and Objective Analysis <ul style="list-style-type: none"><li>■ Brief Explanation of the Session</li><li>■ Group Discussion</li><li>■ Group Presentation</li></ul>
13:30-14:00	Break and Praying	
14:00-14:30	Workshop Evaluation and Closing	
14:30 -	Lunch	

In this workshop, the roles and responsibilities of each organization (GARWSP headquarters/branch offices and local authorities) and community in the implementation framework for new rural water supply projects were further understood, and gaps between present capacities and assigned functions of each body were confirmed. The needs for capacity development confirmed by many of the participants was the necessity for community selection process, community-based organization and training provision, which are conducted through participatory development methods based on community needs such as DRA.

The activities and results of the workshop were compiled into a report (in English). Subsequently, an Arabic version was prepared and submitted to the participants and GARWSP headquarters. The results of analysis made by the participants are reflected in the capacity development plan.

## 7.2 First Seminar: Presentation of Interim Results

A seminar was held in the capital city of Sana'a on 13 February 2007 to explain the results of Phase I activities compiled as the Interim Report, which was submitted to the Yemeni side at the end of Phase I. Also, the seminar had objectives to exchange and share experiences between the participants. The participants included members from GARWSP headquarters, GARWSP branch offices, donors, NGOs and District/local councils. The list of participants is shown below.



Table 7-2 Participants in First Seminar on Presentation of Interim Results

Organization	Participant	Position
GARWSP Headquarters	Ali Mohammed Al-Suraimi	Chairman
	Abdulhameed Al-Bashiri	Vice Chairman
	Ali Ali Al-Emad	Deputy Chairman
	Ali Ahmed Al-Rabwae	Gen. Dir. of Planning & Int'l Coop.
	Fawzi Al-Khirbash	Dep. G. D. of Plan. & Int'l Coop.
	Adullah Abdulmalek	Head of Technical Office
	Kaid Al-Darwish	Deputy of Technical Office
	Abdulkarim Abdulnor	Technical Office
	Abdulnasser Al-Makhlafy	Dep. G. D. of Studies, Sup. & FO
	Abdulatif Ahmed Salah	G. D. of Public Relations and Information
	Mohammed Ali Raweh	Chief of Registration & Expenses Div.
	Ali Tahir	Lab. Dir. of Geog. & Env. Section
	Helmi	Technical Office
	Mohamed Al-Humam	Responsible of Coordination Meetings
GARSWP Branch Office	Abdul Ghani Algazali	Director of Sana'a Branch
	Mohamed Alnuzayli	Director of Al Mawheet Branch
	Abdul Malek Fare	Director of Dahmar Branch
	Najeeb Damag	Director of Ibb Branch
	Samir Qasem Al-Shahsi	Director of Taiz Branch
Sana'a Governorate Local Council	Ali Mohammed Mojob	General Director of Hamdan District
	Abdu Ismail	General Director of Jehana District
	Ali Al-Qudaimi	General Director of Belad Al Ros District
	Mohammed Al-Gholi	General Director of Sanhan District
Dahmar Governorate Local Council	Abdulmalik Al-Ta'ifi	General Director of Bani Matar District
	Husein Wasel	General Director of Jabal Al Sharq Dist.
	Husein Hashim Al-Kibsi	General Director of Ans District
Ibb Governorate Local Council	Ali Al-Jarbani	General Director of Mayfa'a District
	Ali Al-Marani	General Director of Al Qafr District
Al Mahweet Gov. Local Council	Obed Mohammed Al-Muraisi	General Director of Ibb District
Al Mahweet Gov. Local Council	Abdullatif Al-Yameni	General Director of Al Rujum District
Taiz Governorate Local Council	Sha'if Al-Dakam	General Director of Al Shamayten Dist.
	Al-Izzi Mohammed Noman	General Director of Al Ma'afar District
	Abdulqader Al-Batool	General Director of Al Wazieyah Dist.
	Abdulmomen Al-Quasi	General Director of Al Mawaset Dist.
Ministry of Planning & Int'l Coop.	Hesham Sharaf Abdullah	Deputy
Ministry of Local Administration	Abdulghani Ahmed Saif	Deputy of Local Affairs Development
SFD	Abduwahab Al-Mujahed	Head of Water & Environment Unit
PWP	Saeed Abdo Ahmed	Project Director
UNICEF	Sami Abdubaker Saeed	Director, Water and Sanitation
World Bank	Satoru Ueda	Senior Water Resources Specialist
World Bank RWSSP	Mohamed Abdul Razzak	Project Director
Al-Salih Philanthropic Foundation	Ali Al-Barmaki	Society Development Program Director
Royal Netherlands Embassy	Tone Tenkhman	Secretary
	Mohammed Al-Aroosy	Water Program Manager
Embassy of Japan	Yoji Hattori	First Secretary
	Mansour Al-Shamiri	
JICA Yemen Office	Kenichi Sasaki	Resident Representative
JICA Advisory Committee	Kenji Nagata	Water Resources Management
	Dr. Hiroshi Sato	Socio-Economist
	Shinichi Masuda	Task Officer
JICA Study Team	Shoji Fujii	Team Leader/Water Supply Plan
	Yusuke Oshika	Hydrogeology/Groundwater Dev. Plan
	Mikiko Azuma	Socio-Economic
	Akinori Miyoshi	Facilities Design
	Naoki Mori	Operation and Maintenance
	Takafumi Ohashi	Consultant Coordination

The seminar proceeded as shown in the following program.

Table 7-3 Program for First Seminar on Presentation of Interim Results

<b>Date</b>	13 February 2007, Tuesday
<b>Venue</b>	Eagle Hotel, Cairo St., Sana'a
<b>Time Period</b>	8:30 to 14:30
<b>Program</b>	
Time	Agenda
8:30	Opening Ceremony Opening Speech Introduction of Guests
9:00	Study Presentation Introduction to Study Study Flow Briefing on Survey Activities Socio-Economic Survey Water Resources Survey Survey on Water Supply Planning and Facilities
10:45	<i>Coffee Break</i>
11:00	Continuation of Presentation Site Screening Rural Water Supply Improvement Plan Draft Action Plan for Capacity Development Interim Conclusion
12:30	Discussion Session
13:15	Closing Ceremony
13:30	<i>Lunch Invitation</i>

### 7.3 Second Seminar: Presentation of Draft Final Results

Upon submission of the Draft Final Report, a second seminar was held on 1<sup>st</sup> October 2007 to explain the main issues of the Draft Final Report and to exchange views and experiences between the participants. Participants in the seminar were representatives from GARWSP headquarters, GARWSP branch offices, relevant governmental organizations, donors, NGOs, local councils and others similar to the first seminar. Comments on the Draft Final Report as well as the Study itself were accepted from the participants to be reflected into the Final Report.

The list of participants is shown in the following table.

Table 7-4 Participants in Second Seminar on Presentation of Draft Final Results

Organization	Participant	Position
Ministry of Water and Environment	His Excellency, Eng. Abdul Rahman Fadl Al-Eryani	Minister of Water and Environment
	Dr. Mohammed Al-Hamdi	Deputy Minister for Water Affairs
GARWSP Headquarters	Ali Mohammed Al-Suraimi	Chairman
	Abdulhameed Al-Bashiri	Vice Chairman
	Ali Ali Al-Emad	Deputy Chairman
	Fawzi Al-Khirbash	Dep. G. D. of Plan. & Int'l Coop.
	Adullah Abdulmalek	Head of Technical Office
	Abdulkarim Abdulnor	Technical Office
	Abdulnasser Al-Makhlafy	Dep. G. D. of Studies, Sup. & FO
	Abdulatif Ahmed Salah	G. D. of Public Relations and Media
	Helmi M. Ana'an	Technical Office
GARSWP Branch Office	Abdul Khaleg Sharhan	Director of Sana'a Branch
	Husen Al-Murakab	Vice Director of Sana'a Branch
	Mohamed Alnuzeyli	Director of Al Mawheet Branch
	Abdul Malek Fare	Director of Dahmar Branch
	Najeeb Damag	Director of Ibb Branch
	Samir Qasem Al-Shahsi	Director of Taiz Branch
Sana'a Governorate Local Council	Abdul Ghani Jamel	Secretary General of Local Council
	Hefdalla Al-Lesani	Head of Services Committee
	Abdulla Al-Seragi	General Director, Social Affairs Office
	Ali Mohammed Mojob	General Director of Hamdan District
	Abdu Ismail	General Director of Jehana District
	Nabil Al-Qawbani	General Director of Belad Al Ros District
	Bakil Rubayed	General Director of Sanhan Bani Bahlool Dist.
	Abdulmalik Al-Ta'ifi	General Director of Bani Matar District
	Atef Al-Musali	Secretary General of Hamdan District
	Mohamed Al-Eshari	Secretary General of Hamdan District
	Sarka Ateya Saika	Secretary General of Belad Al Ros District
	Husein Wahas	Secretary General of Sanhan Bani Bahlool Dist.
	Bakeel Al-Matari	Secretary General of Bani Matar District
	Dahmar Governorate Local Council	Mujahed Al-Ansi
Mohamed Al-Adrael		Director, Social Affairs Office
Husein Wasel		General Director of Jabal Al Sharq District
Abdul Wahab Sarie		General Director of Ans District
Ali Al-Jarbani		General Director of Mayfa'a District
Ahmed Ali Al-Jabar		Secretary General of Jabal Al Sharq District
Naji Dayfalla		Secretary General of Ans District
Senan Abduljabler		Jabal Al Sharq District
Ali Al-Qaysi		Secretary General of Mayfa'a District
Ibb Governorate Local Council	Amen Al-Warafi	Secretary General of Local Council
	Nasr Al-Badani	General Director, Social Affairs Office
	Obed Mohammed Al-Muraisi	General Director of Ibb District
	Mostafa Al-Qasem	Secretary General of Ibb District
	Ali Al-Marani	General Director of Al Qafr District
	Hamood Noman Al-Bareh	Secretary General of Al Qafr District
	Mohamed Al-Majni	General Director of Al Makhader District
Al Mahweet Gov. Local Council	Abdul Hakeem Al-Sabri	Secretary General of Al Makhader District
	Ali Ahmed Al-Zaykm	Secretary General of Local Council
	Adel Al-Zareka	General Director, Social Affairs Office
	Abdulla Mohammed Al-Ganis	General Director of Al Mahweet District
	Yahya Gudef	Secretary General of Al Mahweet District
	Abdulhameed Al-Yameni	General Director of Al Rujum District
Ahmed Mutabar Jalal	Secretary General of Al Rujum District	

Taiz Governorate Local Council	Sha'if Al-Dakam	General Director of Al Shamayten Dist.
	Saleh Al-Kalali	General Director of Al Ma'afar District
	Saeed Abdul Gafar	General Director of Al Wazieyah District
	Abdulmomen Al-Quasi	General Director of Al Mawaset District
	Abdul Kawi Aiyed	Secretary General of Al Wazieyah District
	Mohamed Rashad Tarboosh	Secretary General of Al Mawaset District
Ministry of Local Administration	Abdulghani Mohamed Saif	Deputy of Local Affairs Development
PWP	Abdul Waly Al-Shami	Director of Water and Environment Unit
Embassy of Japan	Matahiro Yamaguchi	Counsellor
	Ms. Terumi Yamazaki	Cultural Attaché
JICA Yemen Office	Kenichi Sasaki	Resident Representative
JICA Advisory Committee	Kenji Nagata	Water Resources Management
	Dr. Hiroshi Sato	Socio-Economist
JICA Study Team (Rural Water Supply Component)	Shoji Fujii	Team Leader/Water Supply Plan
	Akinori Miyoshi	Facilities Design
	Naoki Mori	Operation and Maintenance
	Takafumi Ohashi	Consultant Coordination
JICA Study Team (Water Resources Management Component)	Hiroyoshi Yamada	Team Leader
	Masao Uematsu	Member

The second seminar proceeded along the program shown below.

Table 7-5 Program for Second Seminar on Presentation of Draft Final Results

<b>Date</b>	1 October 2007, Monday
<b>Venue</b>	Sheraton Hotel, Al Kawkaban Ballroom Berlin Street, Sana'a
<b>Time Period</b>	13:00 to 18:00
<b>Program</b>	
Time	Agenda
13:00	Opening Ceremony Opening Speech
<i>Part 1</i>	
13:30	Presentation of Draft Final Results Introduction to Study Rural Water Supply Improvement Plan Pilot Project Implementation Action Plan for Capacity Development
15:00	<i>Prayer</i>
<i>Part 2</i>	
16:00	Special Presentation by Dr. Sato, JICA Advisory Committee
16:45	Discussion Session
17:30	Closing Ceremony
18:00	<i>Al-Iftar Dinner Invitation</i>

**8. EQUIPMENT USED FOR CAPACITY  
DEVELOPMENT**

## 8. EQUIPMENT USED FOR CAPACITY DEVELOPMENT

### 8.1 List of Equipment Provided to GARWSP

In the course of the Study, to enhance capacity development interventions by the Study Team for GARWSP headquarters and branch offices, certain equipment were used as hands-on tools during on-the-job training (OJT) and training-of-trainers (TOT) activities. The equipment can be divided into the following 3 broad categories.

- Office equipment and vehicle
- Water quality analysis equipment
- Topographic surveying equipment

The list of equipment is shown below. The following equipment were provided to GARWSP after completion of capacity development activities.

**Table 8-1 Equipment used for Capacity Development and Provided to GARWSP**

Category	Equipment	Main Specifications	Quantity Handed Over					
			Headquarters	Al Mahweet Branch Office	Sana'a Branch Office	Dahmar Branch Office	Ibb Branch Office	Taiz Branch Office
Office Equipment and Vehicle	Computer	Desk-top	1	1	1	1		
	Printer	B&W, laser	1					
		Ink jet type, color		1	1	1		
	Copy Machine	A3, B&W, laser	1	1	1	1		
	Fax Machine	–	1					
Pick-up Truck	Double cabin	2						
Water Quality Analysis Equipment	Water Sampler	600cc with 150m cable		1	1	1		
	pH Meter	Portable type		1	1	1		
	Conductivity Meter	Portable type		1	1	1		
	E. Coli Testing Paper	Test paper type		200	200	200		
Topographic Surveying Equipment	Surveying Equipment	Laser type		1	1	1	1	1
	Staff	Aluminum, 5m		2	2	2	2	2
	Surveying Compass	With tripod		1	1	1	1	1
	Measuring Tape	50m		1	1	1	1	1
	GPS	Portable type		1	1	1	1	1

## **8.2 Certificates of Equipment Hand-Over**

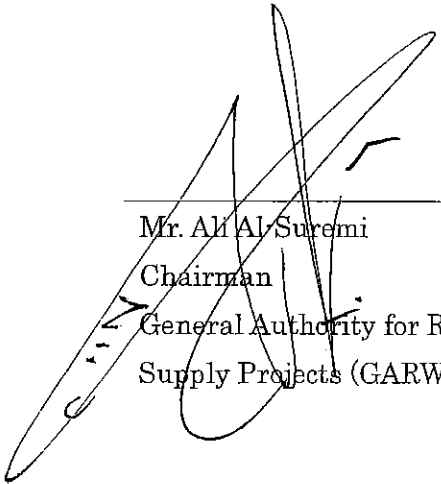
The equipment listed above were handed over to GARWSP headquarters and study target GARWSP branch offices in the 5 governorates of Al-Mahweet, Sana'a, Dahmar, Ibb and Taiz. The documents to certify the hand-over procedures which were signed by GARWSP and confirmed by the Study Team are attached in the following pages.

RURAL WATER SUPPLY COMPONENT OF  
THE STUDY FOR WATER RESOURCES MANAGEMENT AND  
RURAL WATER SUPPLY IMPROVEMENT IN  
THE REPUBLIC OF YEMEN

CERTIFICATE OF RECEIPT  
FOR  
EQUIPMENT TO BE PROVIDED TO  
GARWSP UPON USE FOR CAPACITY DEVELOPMENT

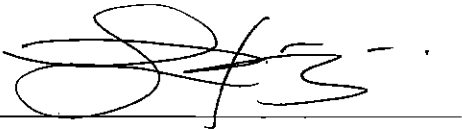
The equipment listed in Attachment were used for capacity development by the Study Team in the captioned study and provided to General Authority for Rural Water Supply Projects (GARWSP). GARWSP confirmed the receipt of the above equipment from the Study Team.

Sana'a, 6 October 2007



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Mr. Ali Al-Suremi  
Chairman  
General Authority for Rural Water  
Supply Projects (GARWSP)



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Shoji Fujii  
Team Leader  
JICA Study Team

Attachment : List of Equipment to be provided to GARWSP upon use for Capacity Development



**Rural Water Supply Component of the Study for Water Resources Management and  
Rural Water Supply Improvement in the Republic of Yemen**

**List of Equipment to be provided to GARWSP upon use for Capacity Development**

GARWSP Headquarters			
Item	Brand, Model	Main Specifications	Quantity
1 Computer	Hewlet-Packard	Desk-top	1
2 Printer for Above	Hewlet-Packard, hp Laser Jet 5100	B&W, laser	1
3 Copy Machine	Xerox C118	A3, B&W, laser, with zoom	1
4 Fax Machine	Hewlet-Packard, Officejet 4355		1
5 Pick-up Truck	Toyota, HILUX	Double cabin	2

GARWSP Al Mawheet Branch Office			
Item	Brand, Model	Main Specifications	Quantity
1 Computer	Hewlet-Packard	Desk-top	1
2 Printer for Above	Hewlet-Packard, hp Laser Jet 5100	Ink jet type, color	1
3 Copy Machine	Xerox C118	A3, B&W, laser, with zoom	1
4 Water Sampler	Yoshino Keisoku Sampler	150m, 600cc	1
5 pH Meter	TOA HM-20P	Portable type	1
6 Conductivity Meter	CM-21P	Portable type	1
7 E-Coli Testing Paper	Sun Chemical, Sun Coli Test Paper	Test paper type, 100 sheets	2
8 Surveying Equipment	Rangefinder, Bushnell Elite 1500	Laser type	1
9 Staff	SK-Taihei	Aluminum, 5m, retractable in 5 stages	2
10 Leveling Compass	Ushikata, LS-25, No. 33 Tripod	With tripod	1
11 Measuring Tape	Yamayo 3X Million	50m	1
12 GPS	Magellan, Explorist 300	Portable type	1

GARWSP Sana'a Branch Office			
Item	Brand, Model	Main Specifications	Quantity
1 Computer	Hewlet-Packard	Desk-top	1
2 Printer for Above	Hewlet-Packard, hp Laser Jet 5100	Ink jet type, color	1
3 Copy Machine	Xerox C118	A3, B&W, laser, with zoom	1
4 Water Sampler	Yoshino Keisoku Sampler	150m, 600cc	1
5 pH Meter	TOA HM-20P	Portable type	1
6 Conductivity Meter	CM-21P	Portable type	1
7 E-Coli Testing Paper	Sun Chemical, Sun Coli Test Paper	Test paper type, 100 sheets	2
8 Surveying Equipment	Rangefinder, Bushnell Elite 1500	Laser type	1
9 Staff	SK-Taihei	Aluminum, 5m, retractable in 5 stages	2
10 Leveling Compass	Ushikata, LS-25, No. 33 Tripod	With tripod	1
11 Measuring Tape	Yamayo 3X Million	50m	1
12 GPS	Magellan, Explorist 300	Portable type	1

GARWSP Dahmar Branch Office			
Item	Brand, Model	Main Specifications	Quantity
1 Computer	Hewlet-Packard	Desk-top	1
2 Printer for Above	Hewlet-Packard, hp Laser Jet 5100	Ink jet type, color	1
3 Copy Machine	Xerox C118	A3, B&W, laser, with zoom	1
4 Water Sampler	Yoshino Keisoku Sampler	150m, 600cc	1
5 pH Meter	TOA HM-20P	Portable type	1
6 Conductivity Meter	CM-21P	Portable type	1
7 E-Coli Testing Paper	Sun Chemical, Sun Coli Test Paper	Test paper type, 100 sheets	2
8 Surveying Equipment	Rangefinder, Bushnell Elite 1500	Laser type	1
9 Staff	SK-Taihei	Aluminum, 5m, retractable in 5 stages	2
10 Leveling Compass	Ushikata, LS-25, No. 33 Tripod	With tripod	1
11 Measuring Tape	Yamayo 3X Million	50m	1
12 GPS	Magellan, Explorist 300	Portable type	1

GARWSP Ibb Branch Office			
Item	Brand, Model	Main Specifications	Quantity
1 Surveying Equipment	Rangefinder, Bushnell Elite 1500	Laser type	1
2 Staff	SK-Taihei	Aluminum, 5m, retractable in 5 stages	2
3 Leveling Compass	Ushikata, LS-25, No. 33 Tripod	With tripod	1
4 Measuring Tape	Yamayo 3X Million	50m	1
5 GPS	Magellan, Explorist 300	Portable type	1

GARWSP Taiz Branch Office			
Item	Brand, Model	Main Specifications	Quantity
1 Surveying Equipment	Rangefinder, Bushnell Elite 1500	Laser type	1
2 Staff	SK-Taihei	Aluminum, 5m, retractable in 5 stages	2
3 Leveling Compass	Ushikata, LS-25, No. 33 Tripod	With tripod	1
4 Measuring Tape	Yamayo 3X Million	50m	1
5 GPS	Magellan, Explorist 300	Portable type	1

## **9. CONCERNED PERSONS**

## 9. CONCERNED PERSONS

<b>MWE: Ministry of Water and Environment</b>	
H.E. Eng. Abdulrahman Fadl Al Eryani	Minister of Water & Environment
Dr. Mohamed L. Al Eryani	(Former) Minister of Water & Environment
Dr. Mohamed I. Al Hamdi	Deputy Minister for Water Affairs
Dr. Hussien A. Al Gunied	Deputy Minister for Environmental Affairs
Eng. Abdul-Kader Hanash	Assistant Deputy Minister
Eng. Abdulkalig Y. Al Ghaberi	Environmental Management Expert
Mr. Mohammed A. Shamsan	General Director of Environmental Affairs
Eng. Ismail M. Rawyah	General Director, Dahmar Office
<b>GARWSP: General Authority for Rural Water Supply Projects</b>	
Mr. Ali Mohammed Al Suraimi	Chairman
Mr. Abdulhameed Al Bashiri	Vice Chairman
Mr. Ali Ali Al Emad	Deputy Chairman
Mr. Ali Ahmed Al-Rabwae	General Director of Planning and Internat'l Coop., Civil Engineer
Mr. Fawzi A. Al-Khribash	Deputy General Director of Planning and International Cooperation Director of International Cooperation Department, Hydrogeologist
Mr. Mahdi Mohammed Mahdi	Adviser
Mr. Abdullah Abdulmalek Badr	Technical Office, Director, Hydrogeologist
Mr. Ahmed Mohammed Qamaz	Technical Office, Vice Director
Mr. Kaid A. Al Darwish	Deputy of Technical Office, Hydrogeologist
Mr. Abdul Kaher Ali Ahmed	Technical Office, Mechanical Engineer
Mr. Abdul Karim Abdulnoor	Technical Office, Social and Financial Analyst
Mr. Abdulkaher Ali Ahmed	Technical Office, Mechanical Engineer
Mr. Mohammed Al Humam	Technical Office Member, Responsible of Coordination Meetings
Mr. Helmi M. Ana'an	Technical Office Member
Mr. Yahya Al Shami	General Director of Studies, Supervision and Follow-up Dep.
Mr. Abdulnaser Al Makhlafy	Deputy General Director of Studies, Supervision and Follow-up Dep. Director of Studies Department, Civil Engineer
Ms. Nemat Mohamed Al Magdoob	Studies, Supervision and Follow-up Dep., Civil Engineer
Mr. Fath Ali Alanisi	Studies, Supervision and Follow-up Dep., Geologist
Mr. Hussien Alshaabi	Director of Laboratory and Environment Section
Mr. Ali Mohamed Tahir	Deputy Director of Laboratory and Environment Section
Mr. Abdullatif Ahmed Salah	General Director of Public Relations and Media Dep.
Ms. Sahar Al-Nader	Public Relations and Media Dep., Head of Media Section
Mr. Mohammed Ali Raweh	Chief of Registration & Expenses Division, Accountant
Mr. Abdul Galil Algradi	Director of Account Department
Mr. Abdullah Hamoud	General Director of Branches
Mr. Sharaf Al-Moshaki	Director of Training
Mr. Talal Al-Kadasi	General Director of Self-Implementation Unit
Mr. Saleh Zuhair	Direction of Drilling Section
<b>GARWSP Sana'a Branch</b>	
Mr. Abdul Khaleg Sharhan	General Director, Hydrogeologist
Mr. Husein Al Morqab	Deputy General Director
Mr. Ibrahem Algabri	Geologist
Mr. Nazer Al Maktari	Socio-Economist
Mr. Walid Al Meklafi	Civil Engineer
Mr. Fouad Moqbil	Director of Planning
Mr. Ali Fari	Director of Monitoring
Ms. Einas Fawzi Al Semah	Accountant/Secretary

<b>GARWSP Al Mahweet Branch</b>	
Mr. Mohamed Al Nuzayli	General Director
Mr. Najib Yahya Al Nuzayli	Director of Studies
Mr. Amin Saad Al Mahweeti	Director of Planning
Mr. Khadija Rabee Al Ridha	Planning
Mr. Yahya Abdulrahman Al Sharafi	Financial Affairs
<b>GARWSP Dahmar Branch</b>	
Mr. Abdul Malek Fare	General Director, Civil Engineer
Mr. Aref Saeed Muhsen Al Hamadi	Director of Studies, Geologist (Deceased)
Mr. Abdulaziz Al-Kibsi	Accountant, Financial Director
Mr. Abdulghani Hajar	Director of Planning
Mr. Yahya Al Shihari	Civil Engineer
Mr. Ahmed Al Rijami	Civil Engineer
<b>GARWSP Ibb Branch</b>	
Mr. Najeeb Damag	General Director, Civil Engineer
Mr. Abdul Hamid Algazali	Civil Technician
Mr. Abdul Mogni Albashiri	Geologist
<b>GARWSP Taiz Branch</b>	
Mr. Samir Qasim Al-Shahsi	General Director, Civil Engineer
Mr. Khaled Mohamed Said	Director of Studies and Supervision, Geologist
Mr. Ahmed Al Buhayri	Director of Planning, Civil Engineer
Mr. Said Hasan	Mechanical Engineer
<b>GARWSP Hodeidah Branch</b>	
Mr. Abdul Ghani Algazali	General Director, Civil Engineer
<b>GARWSP Ad Dahle Branch</b>	
Mr. Nawfal Abdul Raheem Al-Ahdal	General Director
<b>NWRA: National Water Resources Authority</b>	
Eng. Salem Hassan Bashuaib	Chairman
Mr. Abdulla M. Al Thany	Deputy Chairman
Mr. Mahmood Sultan	Head of Study Section
<b>EPA: Environmental Protection Authority</b>	
Mr. Mahmood M. Shidiwah	Chairman
<b>Sana'a Water and Sanitation Local Corporation</b>	
Mr. Fadel Saeed	Director of Engineering Dept.
<b>Al Mahweet Governorate</b>	
Mr. Ali Ahmed Al Zaykm	Secretary General of Local Council, Al Mahweet Governorate
Mr. Adel Al Zareka	General Director, Al Mahweet Social Affairs Office
Mr. Abdulwahab Al Haid	Bani Sa'ad District Local Council
Mr. Abed Al Sharqi	Bani Sa'ad District Local Council
Mr. Faydi	Sheikh, Deputy Secretary General, Bani Sa'ad Local Council
Mr. Mohammed Al Ganis	General Director, Al Mahweet District Local Council
Mr. Yahya Gudef	Secretary General of Local Council, Al Mahweet District
Mr. Abdullatif Al Yameni	General Director, Al Rujum District Local Council
Mr. Ahmed Mutabar, Jalal	Secretary General of Local Council, Al Rujum District
Mr. Mohammed Sageer Gubran	Secretary General, Al Khabt District Local Council
Mr. Mohammed Jaafer Jobran	Al Khabt District Local Council
Mr. Mohammed Yahyia Shareef	Member of Al Khabt District Local Council
Mr. Mohammed Ali Al Tayari	Vice Director, Al Mahweet District
Mr. Ibrahim Mohamed Khalufa	Sheikh, Lower Al Sha'afel (Al Khabt District)
Mr. Saleh Al Jamadi	Water Project Director, Jabal Al Taraf (Al Mawheet District)
Mr. Saleh Galeb	Bani Ali (Bani Sa'ad District)
Mr. Hasan Ali Al Sageer	Bani Ali (Bani Sa'ad District)
Mr. Ali Al Sageer	Bani Ali (Bani Sa'ad District)

<b>Sana'a Governorate</b>	
Mr. Abdul Gani Gamel	Secretary General of Local Council, Sana'a Governorate
Mr. Hefdalla Al-Lesani	Head of Services Committee, Sana'a Governorate
Mr. Abdulla Al Seragi	General Director, Sana'a Social Affairs Office
Mr. Abdulwahab Muhsin Saree	(Former) Sana'a Governorate
Mr. Naji Farhan	General Director, Nehm District Local Council
Mr. Ali Mohammed Mojab	General Director, Hamdan District Local Council
Mr. Al Shaikh Atef Bin Atef Al Musali	Secretary General, Hamdan District Local Council
Mr. Abdul Alazeez Ali Shoulan	General Director, Alteyal District Local Council
Mr. Ahmed Abdullah Al Soufi	Secretary General, Al Hesn District Local Council
Mr. Ahmed Al Tahri	Al Hesn District Local Council
Mr. Abdu Ismail Al Humaidi	General Director, Jehana District Local Council
Mr. Mohamed S. Al Eshari	Secretary General, Jehana District Local Council
Mr. Ahmed Ahmed Naser Al Rusabi	Director of Youths Department, Jehana District Local Council
Mr. Nabil Al Qawbai	General Director, Belad Al Rous District Local Council
Mr. Ali Al Qudaimi	(Former) General Director, Belad Al Rous District Local Council
Mr. Sarka Ateya Saika	Secretary General, Belad Al Rous District Local Council
Mr. Harkam Bin Harkam	(Former) Secretary General, Belad Al Rous District Local Council
Mr. Mohammed Naji	Belad Al Rous District Local Council
Mr. Bakeel Rubayed	General Director, Sanhan Bani Bahlool District Local Council
Mr. Mohammed Al Gholi	(Former) General Director, Sanhan Bani Bahlool District Local Council
Mr. Husein Wahas	Secretary General, Sanham Bani Bahlool District Local Council
Mr. Ahmed Hamoud	Sheikh, Bait Al Hadrami (Sanhan&Bani Bahool District)
Mr. Abdulmalik Al Taifi	General Director, Bani Matar District Local Council
Mr. Bakeel Yahyia Al Matari	Secretary General, Bani Matar District Local Council
Mr. Saleh Al Nuwayra	Qamlan-Bait Al Najrani (Bani Matar District)
Mr. Mutahar Ahmed Al Zuwar	Secretary General, Al Haymah Al Kharijiyah District Local Council
Mr. Husein Hadi Al Hashishi	Al Haymah Al Kharijiyah District Local Council
<b>Dahmar Governorate</b>	
Mr. Mujahed S. Al Ansi	Secretary General of Local Council, Dahmar Governorate
Mr. Mohamed Al Adrael	Director, Dahmar Social Affairs Office
Mr. Mahmoud Al Jabin	(Former) General Director of Duran District Local Council
Mr. Faisal Al Nehmi	Head of Planning Committee, Duran/ Al Koub
Mr. Husien Wasel	General Director, Jabal Al Sharq District Local Council
Mr. Ahmed Ali Al Jabar	Secretary General, Jabal Al Sharq District Local Council
Mr. Mohammed Al Matari	Director of Account Unit, Jabal Al Sharq District Local Council
Mr. Senan AbdulJabler	Jabal Al Sharq District
Mr. Ahmed Ali Al Gabar	Sheikh, Hamal-Bait Al Jabar (Jabal Al Sharq Districti)
Mr. Ahmed Al A'asham	Sheikh, Hegrat Al A'asham (Jabal Al Sharq Districti)
Mr. Ali Ghobar	Sheikh, Elow Al Mikhlaf (Jabal Al Sharq District)
Mr. Abdul Wahab M. Sarie	General Director, Ans District Local Council
Mr. Husien Hashim Al Kibsi	(Former) General Director, Ans District Local Council
Mr. Naji Dhaif Allah	Secretary General, Ans District Local Council
Mr. Ali Al Jarbani	General Director, Mayfa'a District Local Council
Mr. Ali Al Qaysi	Secretary General, Mayfa'a District Local Council
Mr. Mahmoud Hussien Al Hesni	Head of Services Committee, Mayfa'a District Local Council

<b>Ibb Governorate</b>	
Mr. Amen Al Warafi	Secretary General of Local Council, Ibb Governorate
Mr. Nasr Al Badani	General Director, Ibb Social Affairs Office
Mr. Ali Al Marani	General Director, Al Qafr District Local Council
Mr. Hamoud Noman Ali Al Bareh	Vice-Director of District/ Secretary General, Al Qafr District Local Council
Mr. Ahmed M. Naser Shrafat	Head of Planning, Development and Finance Committee, Al Qafr District Local Council
Mr. Mohamed Al Majni	General Director, Al Makhadar District Local Council
Mr. Abdul Hakeem Al Saberi	Secretary General, Al Makhadar District Local Council
Mr. Obed Mohammed Al Muraisi	General Director, Ibb District Local Council
Mr. Mostafa Al Qasem	Secretary General, Ibb District Local Council
Mr. Hassan Naji Abdu	(Former) Secretary General, Ibb District Local Council
Mr. Abdu Ismail	Head of Planning Committee, Ibb District Local Council
Mr. Mohammed Taha Mahdi	Head of Social Affairs Committee, Ibb District Local Council
<b>Taiz Governorate</b>	
Mr. Mohammed Ahmed Al Haj	Secretary General, Taiz Governorate Local Board
Mr. Abdulmomem Al Quasi	General Director, Al Mawaset District Local Council
Mr. Mohamed Rashad Tarboosh	Secretary General, Al Mawaset District Local Council
Mr. Abdullah M. Qasim Mughalis	(Former) Secretary General, Al Mawaset District Local Council
Mr. Saleh Al Kalali	General Director, Al Ma'afar District Local Council
Mr. Al Izzi Mohammed Noman	(Former) General Director, Al Ma'afar District Local Council
Mr. Mohammed Rashad Abdul Wahab	Secretary General, Al Ma'afar/ Finance Office
Mr. Faisal Abdul Raqeeb Noman	Head of Service Committee, Al Ma'afar/ Education Office
Mr. Hameed Nasr Al Mahjari	General Director of Mawiyah District Local Council
Mr. Jameel Ali Al Bahar	Head of Planning, Development and Finance Committee, Mawiyah District
Mr. Sha'if Al Dukm	General Director, Al Shamayaten District Local Council
Mr. Ibrahim Shukri Ahmed Al Shaibani	Secretary General, Al Shamayaten District Local Council
Mr. Saeed Abdul Gafar	General Director, Al Wazieyah District Local Council
Mr. Abdulqader Al Batool	(Former) General Director, Al Wazieyah District Local Council
Mr. Abdul Kawi Aiyed	Secretary General, Al Wazieyah District Local Council
Mr. Abdu Ahmed Salem	(Former) Secretary General, Al Wazieyah District Local Council
<b>MPIC: Ministry of Planning and International Cooperation</b>	
Mr. Hesham Sharaf Abdullah	Deputy for International Cooperation Sector
<b>Central Statistical Organization</b>	
Dr. Abdul Hakim Al-Obeid	Deputy Chairman
<b>PWP: Public Works Project</b>	
Eng. Saeed Abdo Ahmed	Project Director
Mr. Abdul Waly Al Shami	Director of Water and Environment Unit
<b>MLA: Ministry of Local Administration</b>	
Mr. Amin Mohammed Al Maqtairi	Assistant Deputy Minister, Local Finance and Control
Mr. Abdulghani Mohamed Saif	Deputy of Local Affairs Development
<b>MSAW: Ministry of Social Affairs and Works</b>	
<b>SFD: Social Fund for Development</b>	
Eng. Abdulwahab Almujaheed	Head of Water and Environment Unit
<b>Sana'a Water and Sanitation Local Corporation</b>	
Mr. Fadel Saeed	Director of Engineering Dept.
<b>Sana'a University</b>	
Dr. Ghazi Saqaf	Professor
Dr. Abdulla A. Baisa	Professor, Department of Chemistry, Faculty of Science
Eng. Aref Shamsen	Faculty of Engineering, Material Testing Lab.

<b>World Bank</b>	Water, Environment, Social and Rural Development Department
Mr. Satoru Ueda	Senior Water Resources Specialist
<b>World Bank-RWSSP (Rural Water Supply &amp; Sanitation Project)</b>	
Eng, Mohamed Abdul-Razzak	Project Director
Mr. Nasser Al Eshawi	Procurement Officer
Mr. Ahmed Al Fathli	Technical Officer
<b>UNICEF</b>	
Mr. Sami Abdulbaker Saeed	Director, Asst. Project Officer, Water & Sanitation
<b>UNDP</b>	
Mr. Akadeen Shawa	Chief Technical Advisor, Decentralization & Local Development Support Program
<b>Al-Salih Philanthropic Foundation</b>	
Mr. Ali Al Barmaki	Society Development Program Director
<b>Royal Netherlands Embassy</b>	
Mr. Tone Tenkhman	Secretary
Mr. Mohamed Saleh Al Aroosi	Senior Program Officer, Water
<b>Embassy of Japan in Yemen</b>	
H.E. Mr. Masakazu Toshikage	Ambassador
Mr. Yuichi Ishii	(Former) Ambassador
Mr. Matahiro Yamaguchi	Counsellor, Deputy Head of Mission
Mr. Yoji Hattori	First Secretary
Mr. Yosuke Miyamoto	Second Secretary
Ms. Terumi Yamazaki	Cultural Attaché
Mr. Shinsuke Mori	Program Associate
Mr. Shinji Hirose	Program Associate
Mr. Mansour Al Shamiri	Economic Cooperation Assistant
<b>JICA Yemen Office</b>	
Mr. Kenichi Sasaki	Resident Representative
Mr. Shinichi Osaka	(Former) Resident Representative, Coordinator of JOCV/JICA
Mr. Katsuyoshi Fukai	Project Formulation Adviser
Ms. Megumi Shuto	Project Formulation Adviser
Ms. Mikiko Orii	Volunteer Coordinator
<b>JICA Cairo Office</b>	
Mr. Shigeru Okamoto	Resident Representative
Ms. Izumi Shoji	Assistant Resident Representative
Mr. Kentaro Nagai	Assistant Resident Representative
Mr. Mitsutaka Hoshi	Assistant Resident Representative

## **10. MINUTES OF MEETINGS**

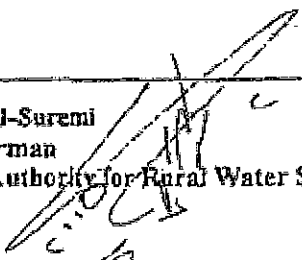
- 10.1 Scope of Work**
- 10.2 Minutes of Meetings on Scope of Work**
- 10.3 Minutes of Meetings on Inception Report**
- 10.4 Note of Agreement**
- 10.5 Note of Agreement 2**
- 10.6 Addition to Note of Agreement 2**
- 10.7 Minutes of Meetings on Interim Report**
- 10.8 Technical Note on Progress Report**
- 10.9 Minutes of Meetings on Draft Final Report**





SCOPE OF WORK  
FOR  
THE STUDY FOR THE WATER RESOURCES MANAGEMENT  
AND RURAL WATER SUPPLY IMPROVEMENT  
IN  
THE REPUBLIC OF YEMEN

AGREED UPON BETWEEN  
THE MINISTRY OF WATER AND ENVIRONMENT  
AND  
THE JAPAN INTERNATIONAL COOPERATION AGENCY


SANA'A, JULY 2<sup>ND</sup>, 2005

  
Mr. Ali Al-Suremi  
The Chairman  
General Authority for Rural Water Supply  
Projects

  
Mr. NAGATA, Kenji  
The Leader  
Preparatory Study Team  
Japan International Cooperation  
Agency

  
Mr. Hisham Sharaf Abdulla  
Deputy Minister for International  
Cooperation  
Ministry of Planning and International  
Cooperation

Approved by

  
Dr. Mohamed Lotfi Al-Eryani  
Minister  
Ministry of Water and Environment

## I INTRODUCTION

In response to the official request of development studies from the Government of Republic of Yemen (hereinafter referred to as "the Government of Yemen"), the Government of Japan decided to conduct technical cooperation on the Study for the Water Resources Management and Rural Water Supply in the Republic of Yemen ("hereinafter referred to as "the Study") through the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA dispatched the Preliminary Study Team to Yemen from 28<sup>th</sup> February to 17<sup>th</sup> March 2005 to confirm the contents of the request and to discuss the possible technical cooperation by JICA.

From June 25<sup>th</sup> to July 22<sup>nd</sup> 2005, JICA has dispatched the preparatory study team to Yemen (hereinafter referred to as "the Team") and signed on the minutes of meetings on the Scope of Work for the Study on July 2<sup>nd</sup> 2005.

Accordingly, JICA, the official agency responsible for the implementation of the technical cooperation projects of the Government of Japan, will undertake the Study in close cooperation with the authorities concerned of the Government of Yemen.

On the parts of the Government of Yemen, General Authority for Rural Water Supply Projects (hereinafter referred to as "GARWSP") under Ministry of Water and Environment, shall act as the counterpart agencies to the Japanese team for the Study and also as the coordinating body in relation to other governmental and non-governmental organizations concerned for the smooth implementation of the Study.

The present document sets forth the Scope of Work with regard to the Study and will be valid after the notification of approval by the JICA headquarters through the JICA Egypt office to the Yemeni side.

## II OBJECTIVES OF THE STUDY

The objectives of the Study are:

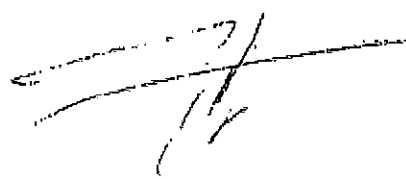
### Component A: "Rural Water Supply Improvement"

1. to plan rural water supply projects for candidate villages
2. to implement the pilot project(s) in the selected villages
3. to carry out institutional strengthening and capacity building for GARWSP through the above study activities

## III STUDY AREA

The Study area covers the following regions:

- Component A: "Rural Water Supply": Candidate villages in the governorates of Sana'a, Dhamar, Ibb, Taiz, and Al Mahwit as shown in Annex-1(a)



## IV SCOPE OF THE STUDY

### Component A: "Rural Water Supply Improvement"

The Study is divided into the following two (2) phases; Phase I is for formulation of rural water supply projects, and Phase II is for Supporting for the Capacity Development. Before the commencement of the Phase I study, the long list and attached data, which includes about 30 candidate villages that need rural water supply in priority, shall be prepared by the Government of Yemen.

#### PHASE I: Formulation of Rural Water Supply Projects

##### (1) Inventory survey for the candidate villages

Based on the following information, the inventory of the candidate villages shall be formed, which includes the information of the villages such as a name, a location, population, socio-economic conditions, natural conditions, existing and expected water resources, existing water supply system, water use conditions, and so on.

- ✓ the long list and attached data for the candidate villages which are prepared by the Government of Yemen
- ✓ Supplementary data that are collected through the Study

##### (2) Screening of the candidate villages

Technical assistance on initial environmental evaluation (IEE) for environmental and social consideration (including public consultation with communities and stakeholders) shall be conducted for the candidate villages.

Then, the villages for the detailed study shall be selected based on the above inventory survey result.

##### (3) Collection and review of existing data

###### For the Selected Villages

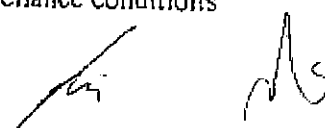
- (a) Socio-economic conditions
- (b) Natural conditions (hydrogeology, meteorology, hydrology and so on)
- (c) Present water use conditions (domestic, industrial and agricultural uses)
- (d) Present conditions of existing water supply system (system characteristics, O&M conditions and water demand/supply)
- (e) Existing and expecting water resources (groundwater, surface water, rainwater, etc.)
- (f) Groundwater potential and present abstraction amount

###### For the state and local governments

- (g) Conditions of the institutions and personnel of GARWSP and its branch offices
- (h) Socio-economic development plans, and other development policies/ plans
- (i) Existing legal framework for water resources development and management as well as water supply and sanitation
- (j) Existing institutional framework for operation, maintenance and management

##### (4) Field survey

- (a) Survey for existing water resources (wells, springs, water harvesting, etc.)
- (b) Existing water supply system and its operation and maintenance conditions



- (c) Water quality
- (d) Water tariff and management condition of water supply systems
- (e) Social survey (condition of water use, access to water, people's awareness)
- (5) Capacity assessment for the institutions and personnel of GARWSP and its branch offices
- (6) Evaluation of water demand and water resources potential
  - (a) Water demand projection
  - (b) Evaluation of water resources potential
  - (c) Water balance between demand and potential
- (7) Formulation of rural water supply projects for the selected villages
  - (a) Plan and design of water supply systems
  - (b) Plan of operation, maintenance and management of water supply systems
  - (c) Programs on institutional strengthening and capacity building for GARWSP and its branch offices
  - (d) Improvement plans of institutional framework of the water committee
  - (e) Formulation of community education plan
  - (f) Estimation of the project cost
  - (g) Technical assistance for the environmental impact assessment (EIA) (including public consultation with communities and stakeholders), if necessary
  - (h) Project evaluation from economic, financial, technical and environmental aspects
  - (i) Formulation of project implementation plan
- (8) Capacity building on planning skills for the staff of GARWSP and its branch offices through the on-the-job training

#### **PHASE II: Supporting for the Capacity Development**

- (1) Support to organize water committee(s) in priority villages
- (2) Training to the water committee(s) on operation, maintenance and management of the water supply system(s)
- (3) Capacity building on implementation of a rural water supply project for the staff of GARWSP and its branch offices through the implementation of pilot project(s)
- (4) Implementation of pilot project(s)

#### **V SCHEDULE OF THE STUDY**

The Study will be carried out in accordance with the tentative schedule as attached in Annex-2.

#### **VI REPORTS**

JICA shall prepare and submit the following reports to the Government of Yemen.

##### **[Rural Water Supply Improvement]**

1. Inception Report: at the commencement of the Phase-I work (This report will contain the schedule and methodology of the Study.)

English: Twenty (20) copies

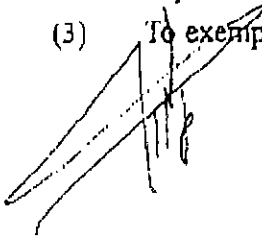
Arabic: Twenty (20) copies

2. Progress Report (1): in the middle of the Phase-I work (This report will summarize the findings in the first half of the phase-I study.)  
English: Ten (10) copies  
Arabic: Twenty (20) copies
3. Interim Report: at the end of the phase-I work (This report will contain the results of the phase-I work.)  
English: Ten (10) copies  
Arabic: Twenty (20) copies
4. Progress Report (2): in the middle of Phase-II work (This report will summarize the findings in the first half of the phase-II study )  
English: Ten (10) copies  
Arabic: Twenty (20) copies
5. Draft Final Report: at the end of the study work (The Government of Yemen shall submit its comments within one (1) month after receipt of the Draft Final Report.)  
English: Ten (10) copies  
Arabic: Twenty (20) copies
6. Final Report: with digital archive within about two (2) month after JICA's receipt of the comments on the Draft Final Report.  
English: Twenty (20) copies  
Arabic: Twenty (20) copies

## VII UNDERTAKINGS OF THE GOVERNMENT OF YEMEN

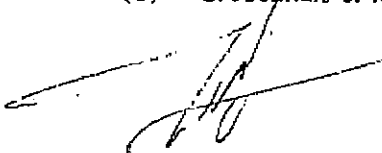
The Team explained that the Government of Yemen shall take responsibilities the following items in case that a JICA development study, hereinafter referred to as "the Study", would be implemented under the JICA's technical cooperation scheme.

1. To facilitate the smooth conduct of the technical cooperation, the Government of Yemen shall take necessary measures as followings;
  - (1) To permit the members of the JICA study team to enter, leave and sojourn in Yemen for the duration of their assignments therein and exempt them from foreign registration requirements and consular fees
  - (2) To exempt the members of the JICA study team from taxes, duties and any other charges on equipment, machinery and other material brought into Yemen for the implementation of the Study
  - (3) To exempt the members of the JICA study team from income tax and charges of any

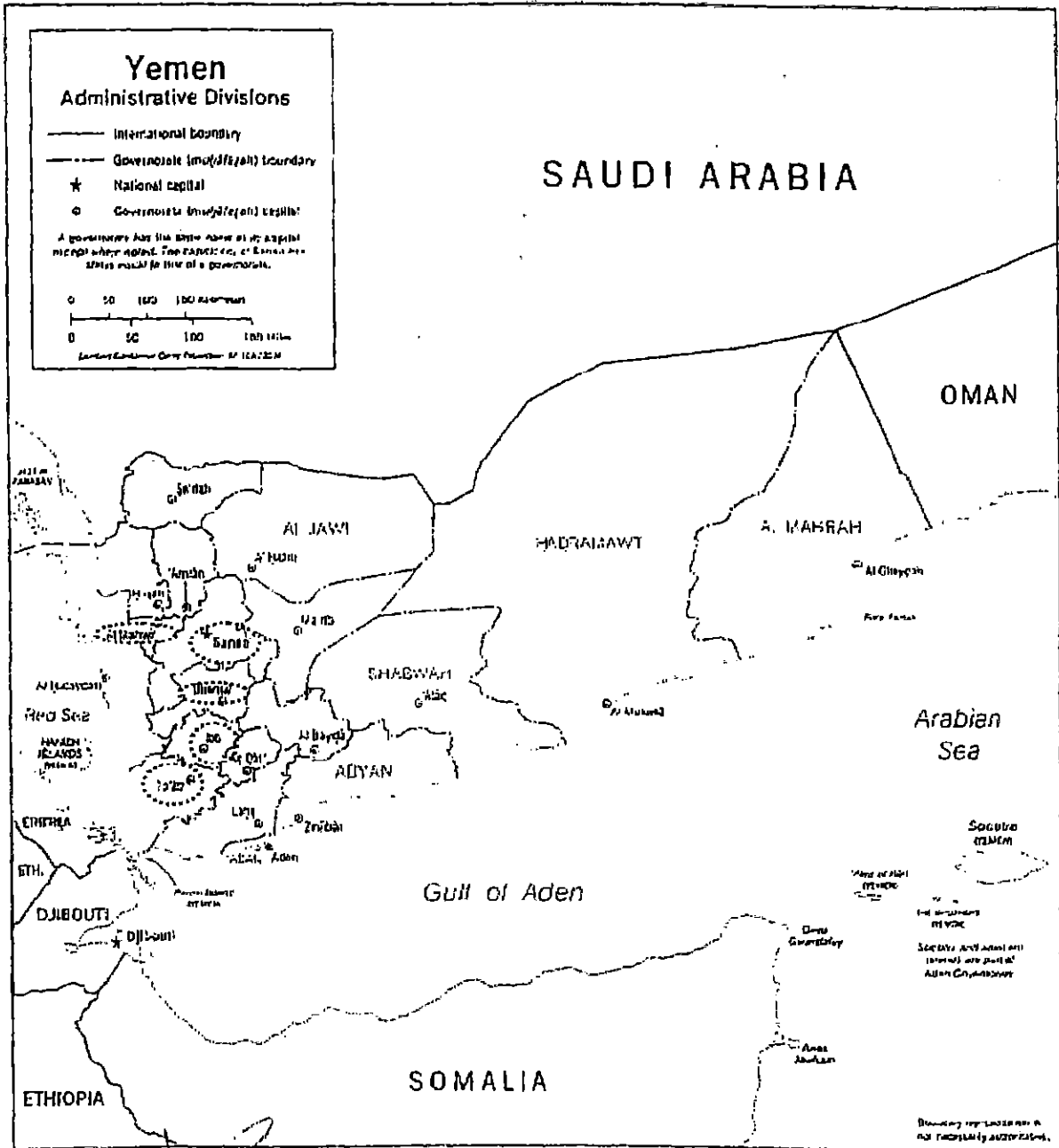


kind imposed on or in connection with any emoluments or allowances paid to the members of the JICA study team for their services in connection with the implementation of the Study

- (4) To provide necessary facilities to the JICA study team for the remittance as well as utilization of the funds introduced into Yemen from Japan in connection with the implementation of the Study
2. The Government of Yemen shall bear claims, if any arises, against the members of the JICA study team resulting from, occurring in the course of, or otherwise connected with, the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the JICA study team.
  3. The Ministry of Water and Environment shall, at its own expense, provide the JICA study team with the following, in cooperation with other organizations concerned;
    - (1) Security-related information on as well as measures to ensure the safety of the JICA study team
    - (2) Information on as well as support in obtaining medical service
    - (3) Available data (including maps and photographs) and information related to the Study
    - (4) Counterpart personnel from concerned authorities
    - (5) Suitable office space with necessary equipment
    - (6) Credentials or identification cards



Annex-1(a) Study Area for Component A: "Rural Water Supply"



Date: 10/28/94 (10/27/94) 7-03

Tentative Schedule

The Study for the Water Resources Management and Rural Water Supply Improvement in the Republic of Yemen

Component	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Component 1A	Phase	Phase I																			
	Work Schedules	Phase II																			
Report		▲			▲															▲	
		ICR	PRR(1)					ITR				PRR(2)								DFR	FR

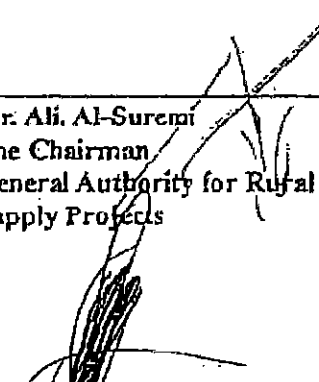
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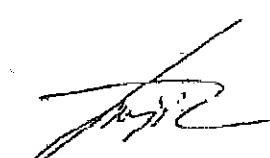
- ICR: Inception Report
- ITR: Interim Report
- PRR: Progress Report
- DFR: Draft Final Report
- FR: Final Report

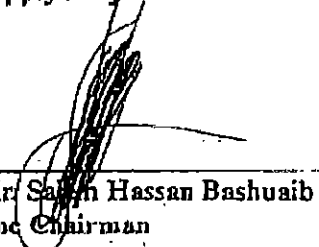



MINUTES OF MEETINGS  
ON  
THE SCOPE OF WORK  
FOR  
THE STUDY FOR THE WATER RESOURCES MANAGEMENT  
AND RURAL WATER SUPPLY IMPROVEMENT  
IN  
THE REPUBLIC OF YEMEN  
AGREED UPON BETWEEN  
THE MINISTRY OF WATER AND ENVIRONMENT  
AND  
THE JAPAN INTERNATIONAL COOPERATION AGENCY

SANA'A, JULY 2<sup>ND</sup>, 2005


  
\_\_\_\_\_  
Mr. Ali Al-Suremi  
The Chairman  
General Authority for Rural Water  
Supply Projects

  
\_\_\_\_\_  
Mr. NAGATA, Kenji  
The Leader  
Preparatory Study Team  
Japan International Cooperation  
Agency

  
\_\_\_\_\_  
Mr. Salem Hassan Bashuaib  
The Chairman  
National Water Resources Authority

  
\_\_\_\_\_  
Mr. Hisham Sharaf Abdulla  
Deputy Minister for International Cooperation  
Ministry of Planning and International Cooperation

Approved by

  
\_\_\_\_\_  
Dr. Mohamed Lotfi Al-Eryani  
Minister  
Ministry of Water and Environment

In response to the request of the Government of the Republic of Yemen (hereinafter referred to as "the Government of Yemen"), the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Preparatory Study Team, headed by Mr. NAGATA Kenji (hereinafter referred to as "the Team") to Yemen from June 25th to July 22nd 2005 to discuss the Scope of Work (hereinafter referred to as "the S/W") for "the Study for the Water Resources Management and Rural Water Supply Improvement in the Republic of Yemen" (hereinafter referred to as "the Study").

The Team carried out field surveys and held a series of discussions with the Ministry of Water and Environment (hereinafter referred to as "MWE"), National Water Resources Authority (hereinafter referred to as "NWRA") and General Authority for Rural Water Supply Projects (hereinafter referred to as "GARWSP"), and other organizations concerned. The list of the attendants is shown in Appendix-1.

The Minutes of Meetings have been prepared on July 2nd, 2005 for better understanding of the S/W agreed upon between the Yemeni side, which consists of MWE and GARWSP, and the Team. The main items, which were discussed and agreed by the Yemeni side and the Team (hereinafter referred to as "the Both Sides"), are as follows.

1. Postpone to conclude of Component B in the Scope of Works

The Yemeni side proposed the terms of references of Component B, which is the Water Resources Management, as attached in the Appendix-2. The Team, however, reserved the discussion on the proposal, because the development of a computerized planning model was out of the scope of the Team, which the Team had prepared and agreed in Japan according to the report of the preliminary study team.





Therefore the Team will convey the proposal to review the possibility of cooperation in JICA headquarters.

2. Study implementation framework

- ✓ The Both Sides confirmed that the MWE would take responsibility for coordination between NWRA and GARWSP in order for the smooth implementation of the Study.
- ✓ The Team proposed the study implementation framework as shown in the Appendix-3. The Yemeni side promised to formulate the steering committee and the working groups before the commencement of the Study.
- ✓ The Team requested that the GARWSP would assign a responsible officer and counterparts in each governorate of Sana'a, Dhamar, Ibb, Taiz and Al Mahwit in order to carry out the Study smoothly. The Yemeni side agreed with this request.
- ✓ The Yemeni side mentioned that Sana'a branch under the supervision of NWRA headquarters is responsible for the component B, which is water resources management.

3. The Support of Capacity Development

JICA would support capacity building of GARWSP and NWRA through the on-the-job training during the study period. Some pilot projects would be implemented in order to facilitate the capacity building of GARWSP branch offices at priority sites in Sana'a, Dhamar and/or Al Mahwit. In response to the Team's request, the Yemeni side agreed to assign appropriate counterpart personnel at the



commencement of the Study in order to work with the JICA study team and to accept technical transfer.

#### 4. Long list with necessary information for priority villages for the rural water supply improvement

The Team requested that the long list with necessary information, which includes about 30 candidate villages that need construction/rehabilitation of rural water supply facilities in priority, should be prepared by GARWSP and should be submitted to the Team by 6<sup>th</sup> July 2005. GARWSP promised to submit it in time.

#### 5. Stakeholder meeting

The Team requested that the responsible officers of the GARWSP branch offices should lead stakeholder meetings in preparing rural water supply projects at the candidate villages, and JICA would support them in holding stakeholder meetings. GARWSP agreed with it, and express the positive leading of the stakeholder meetings.

#### 6. Disclosure of information

The Both Sides confirmed the disclosure of information such as the study reports is necessary to ensure the participation and dialogues with various stakeholders, in order to achieve appropriate environmental and social considerations.

#### 7. Coordination with other projects

The Team requested that the Yemeni side should take responsibility on the coordination with other donors and the JICA study team regarding with the Study, and should make the best efforts toward sharing the information among donors including JICA in order to avoid duplications and to make the Study complementary to the water sector strategy.

Especially, the Team stressed the importance of the coordination with Sana'a Basin Water Management Project because the outcome of this project is essential to formulate a Sana'a Basin Water Resources Management Action Plan. MWE and NWRA promised to supply any information and data needed for the Study.

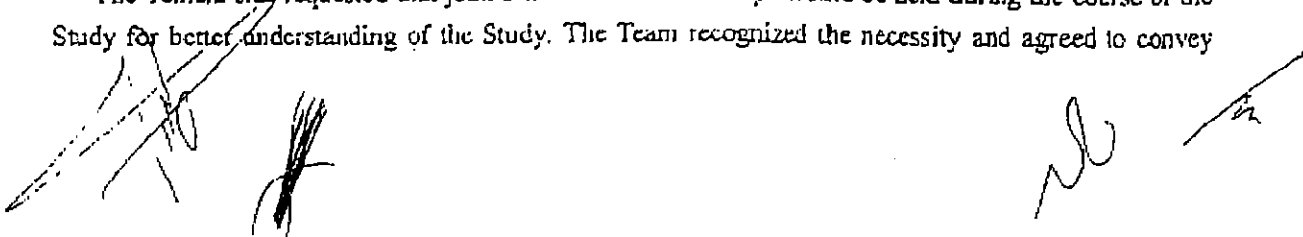
As for the rural water supply, GARWSP informed that the capacity building of the Taiz and Ibb branch offices could be supported by the other donor. The Team will consider the necessary arrangement during the implementation of the Study to avoid duplications.

#### 8. Training of counterpart personnel in Japan

NWRA and GARWSP requested JICA to conduct training of 5 to 10 persons of counterpart personnel in Japan for the effective technology transfer. The Team admitted the needs of the counterpart training in Japan and promised to convey the request to the JICA Headquarters though the number to be accepted should be adjusted. The Team also suggested to the Yemeni side that the Government of Yemen should apply the request to the Government of Japan through the diplomatic channel.

#### 9. Seminars/Workshops

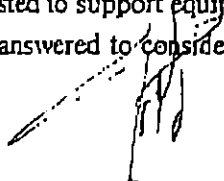
The Yemeni side requested that joint seminars and workshops would be held during the course of the Study for better understanding of the Study. The Team recognized the necessity and agreed to convey



this request to the JICA Headquarters.

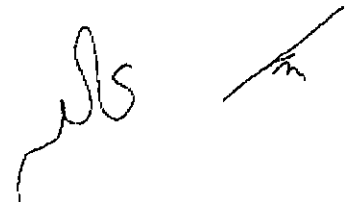
10. Equipment for the Study

GARWSP requested to support equipment to the headquarters and branch offices to strengthen their capacity. The Team answered to consider supply of equipment that is needed for the implementation of the Study.



The list of attendants in the meetings with JICA study team

1. Ministry of Water and Environment  
Dr. Mohamed Lotf Al-Eryani, Minister  
Dr. Mohamed I. Al-Hamdi, Deputy Minister for Water  
Mr. Abdul Qadir A. Hanash, Assistant Deputy Minister for Water
  
2. National Water Resources Authority  
Mr. Abdulla Al Dhary, Deputy Chairman  
Mr. Gordon Stanger, Chief Technical Adviser of NWRA Head Quarter
  
3. National Water Resources Authority, Sana'a Branch  
Mr. Saleh Al-Dubby, Sana'a Branch Director  
Mr. Amin A. Mahyoub, Hydrogeologist
  
4. General Authority of Rural Water Supply Projects  
Mr. Ali M. Al-Suremi, Chairman  
Mr. Ali Al-Emad, Deputy Chairman  
Mr. Yahya Alshami, General Director of Survey and Study  
Eng. Ali A. Al-Raboei, General Director of Planning & International Cooperation  
Mr. Fawzi A. Al-Khribash, Deputy Director of Planning & International Cooperation  
Mr. Kaid Darwish, Secretary for Technical Office
  
5. Ministry of Planning and International Cooperation  
Mr. Hisham Sharaf Abdalla, Deputy Minister for International Cooperation  
Mr. Omar A. Abdulghani, General Director of Bilateral Cooperation with the States of Asia & Australia
  
6. Sana'a Basin Water Management Project  
Eng. Salem Hassan Bashuaib, Chairman



## Proposed terms of references of Component B

## I OBJECTIVES OF THE STUDY

The objectives of the Study are:

1. to formulate a water resources management action plan for Sana'a Basin based on existing data and information
2. to transfer technology and knowledge on water resources management to the counterpart personnel through their direct participation into the Study

*The overall objective of this component is to develop a computerized planning model for the Sana'a Basin which can be used for Scenario-analysis and subsequent formulation of action plans. Both parties realize that such a planning model is a major undertaking which requires extensive work to develop the component models (modules) of groundwater, surface water, demand forecasting for the three main water-use sectors (domestic, agriculture, industry), water quality aspects, etc. Hence, it is realized by both parties that limitations in term of data availability, time and financial resources may hinder developing such model to the operational phase. However, the Team which will implement this component will use their allocated time and resources to organize and integrate existing data into an electronic database, develop to the maximum extent possible the various modules or models of this planning model, identify data gaps and make recommendations on acquisition of such data. What will be delivered at the end of work could possibly be a partially operational planning model which NWRA can build-upon and complete in the future.*

## II STUDY AREA

The Study area covers the following regions:

Component B: "Water Resources Management": Sana'a Basin

## III SCOPE OF THE STUDY

1. Understanding and Studying of the Present Conditions
  - (1) Collection and review of existing data
    - (a) Socio-economic conditions
    - (b) Natural conditions (hydrogeology, meteorology, hydrology and so on)
    - (c) Socio-economic development plans, and other development policies/ plans
    - (d) Existing legal framework for water resources development and management as well as water supply and sanitation
    - (e) Existing institutional framework for operation, maintenance and management
    - (f) Existing database related to water resources management including existing wells
    - (g) Groundwater potential and present abstraction amount
    - (h) Present water use
    - (i) Agriculture and irrigation
    - (j) Planned water projects

(k) Identification of data gaps

(l) Integration of the existing data into a GIS system (and user manual) that can be accessed for modelling purposes

(2) Study on water resources potential

- (a) Groundwater
- (b) Surface water
- (c) Treated waste water
- (d) Water quality
- (e) Hydrological water balance
- (f) Water resources potential

(g) Integration of findings of this study into computer models which are linkable to the GIS system (I-I)

(3) Water demand projection

- (a) Domestic use
  - (b) Agricultural use
  - (c) Industrial use
  - (d) Others (such as tourism)
- (e) Development of a computer module for demand projection

(4) Water balance study between water demand and supply potential

(5) Study on the negative impacts caused by over abstraction and effluent discharge

- (a) Groundwater level declination
- (b) Depletion of Groundwater potential
- (c) Deterioration of groundwater quality
- (d) Drying out of the existing wells
- (e) Others

(f) Impact assessment through a computer model for groundwater in the Sonu'a Basin, linkable to the GIS system, subject to data availability

2. Formulation of Water Resources Management Action Plan

- (a) Setup of water resources management strategy
- (b) Water resources development plan (groundwater, surface water, rainwater and treated waste water)
- (c) Water supply and sanitation plan for urban and rural areas
- (d) Plan for development and operation of water information systems
- (e) Plan for capacity development of NWRA
- (f) Plan for regulatory framework for water resources management (conserving groundwater for sustainable use, rural-urban transfers of water, and others)
- (g) Plan for public participation (communication and co-ordination among the stakeholders, raising general awareness on water problems and solutions)
- (h) Plan for water demand management
- (i) Plan for saving irrigation water use (improvement of irrigation efficiency, creating non-agriculture employment opportunities)

### Study implementation framework

**[Component A: Rural Water Supply Improvement]**

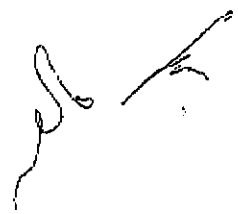
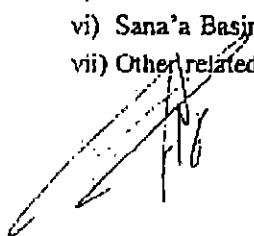
To set up a working group under the chairman of GARWSP consisting of the necessary personnel from the headquarters; the branch offices of Sana'a, Al Mahwit, Dhamar, Ibb and Taiz.

**[Component B: Water Resources Management]**

To set up a steering committee and a working group consisting of the following organizations under the chairmanship of NWRA

**Member list (just for discussion)**

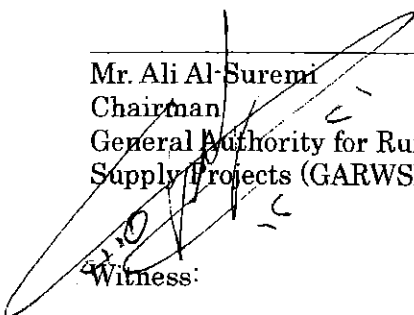
- i) Governorate of Sana'a
- ii) Ministry of Water and Environment
- iii) Ministry of Agriculture and Irrigation
- iv) Environment Protection Agency
- v) Sana'a Water Supply and Sanitation Corporation
- vi) Sana'a Basin Water Management Project
- vii) Other related organization ( research institute, NGOs)





MINUTES OF MEETINGS  
ON  
INCEPTION REPORT  
FOR  
RURAL WATER SUPPLY COMPONENT  
OF  
THE STUDY FOR THE WATER RESOURCES MANAGEMENT AND  
RURAL WATER SUPPLY IMPROVEMENT  
IN  
THE REPUBLIC OF YEMEN  
AGREED UPON BETWEEN  
GENERAL AUTHORITY FOR RURAL WATER SUPPLY PROJECTS  
THE MINISTRY OF WATER AND ENVIRONMENT  
AND  
JAPAN INTERNATIONAL COOPERATION AGENCY

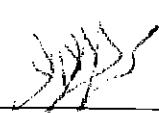
SANAA, 21 DECEMBER 2005



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Mr. Ali Al-Suremi  
Chairman  
General Authority for Rural Water  
Supply Projects (GARWSP)

Witness:



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Dr. Mohamed Lotf Al-Eryani  
Minister  
Ministry of Water and Environment  
(MWE)



---

Mr. Shoji Fujii  
Team Leader  
JICA Study Team

Witness:



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Mr. Kenji Nagata  
Leader of Advisory Committee  
Japan International Cooperation Agency  
(JICA)

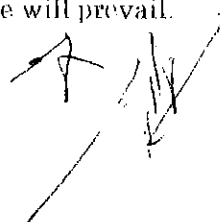
Discussions were made from 17<sup>th</sup> to 21<sup>st</sup> December 2005 on the Inception Report for the Rural Water Supply Component of the Study for the Water Resources Management and Rural Water Supply Improvement in the Republic of Yemen, and the contents of the Inception Report were agreed upon, in principle, between General Authority for Rural Water Supply Projects (hereafter referred to as "GARWSP") and JICA Study Team (hereafter referred to as "the Study Team"). Additionally, the following points were mutually agreed upon.

1. GARWSP and the Study Team (hereafter referred to as "Both Sides") agreed that assistance for capacity assessment and capacity development will target GARWSP headquarters and GARWSP branch offices in Al-Mahwit, Sana'a and Dhamar. Also, for GARWSP branch offices in Ibb and Taiz, Both Sides agreed that the present capacity and future plans for capacity development will be reviewed and necessary further assistance will be considered by the Study Team.
2. Concerning the pilot project, the Study Team explained that about 3 sites were conceived for the pilot project. In response, GARWSP requested the implementation of 5 sites to cover the 5 governorates of Al-Mahwit, Sana'a, Dhamar, Ibb and Taiz targeted for this study. Both Sides understood that the number of pilot project sites will be determined depending on factors such as the study results, the allotted implementation period and budget constraints.
3. GARWSP agreed to assign counterpart staff corresponding to each member of the Study Team to work in close cooperation with the Study Team and coordinate the study activities. Also, counterparts from the 5 GARWSP branch offices targeted for this study will be allocated to receive OJT while working with the Study Team. The Chairperson of GARWSP will be the overall supervisor having top responsibility for the Yemeni counterpart team. The member list of the Yemeni counterpart team is attached in Annex 1.
4. The Study Team pointed out that 4 sites out of the 36 candidate sites have no existing water source, according to the list submitted by GARWSP before the commencement of this Study. GARWSP informed that two sites (Qamlan and Bait Al Hadrami) have already boreholes drilled. Drilling at one site (Dajah-Sarfah) is under construction and scheduled for completion before the middle of January. Drilling at another site (Al Jaara) is scheduled for completion before the end of



February, and GARWSP agreed to submit a definite implementation plan for drilling of this site. Also, GARWSP requested to replace one site (Elow Dulaa) with another (Bani Waleed and Alasboor) and the Study Team agreed. The final list of candidate sites for the study as agreed by Both Sides will be as shown in Annex-2.

5. GARWSP strongly requested early project implementation of the candidate sites of the Study. The Study Team realizes the urgency and agreed to convey this request to JICA headquarters.
6. An official request for counterpart training in Japan (five to ten persons) for GARWSP staff from each of the 5 target branch offices was submitted by the Ministry of Foreign Affairs of Yemen to the Japanese Embassy in Sana'a on 29 November 2005. Additionally, GARWSP requested to include staff from GARWSP headquarters for the counterpart training. The Study Team agreed to ask JICA headquarters to confirm the present situation of this request.
7. Both Sides agreed that any submitted reports in the Arabic language are to be used as reference and those reports in the English language will prevail.



## ANNEXES

Annex-1 Counterpart List

Annex-2 Final List of Candidate Sites

Annex-3 List of Attendants

Annex-1-a Counterpart List (GARWSP Headquarters)

**MEMBERS OF STUDY TEAM ( JAPAN-- YEMEN )**  
**HEADQUARTERS -- GARWSP**

No	Function	JICA Study Team	GARWSP COUNTERPARTS	REMARKS
1	Team Leader / Water Supply Plan	Mr. Shoji FUJII	Mr. Ali ALRABOI	Civil Eng.
2	Hydrogeology /Groundwater Development	Mr. Yusuke OSHIKA	Mr. Fawzi ALKHIRBASH	Hydrogeologist
3	Socio-Economic Analysis	Ms. Mikiko AZUMA	Mr. Kaid ALDARWISH	Hydrogeologist
4	Pumping Test / Water Quality Analysis	Mr. Masao UEMATSU	Mr. Abdullah ABDULMALEK	Hydrogeologist
5	Facilities Design	Mr. Akinori MIYOSHI	Mr. Abdulkarim ABDULNOR	Financial Analysis
6	Operation and Maintenance (Institutional / Community Development )	Mr. Naoki MORI	Mr. Hussien ALSHAABI	Geologist
7	Operation and Maintenance (Technical )	Mr. Tetsuji NIWANO	Mr. Abdulnaser ALMAKHLAFY	Civil Eng.
8	Environmental Analysis	Mr. Keiji NIJIMA	Ms. Namat ALMAJTHOB	Civil Eng.
			Mr. Abdulqaher ALI AHMED	Mechanical Eng.
			Mr. Ali TAHER	Geo- Chemist

Annex 1-b Counterpart List (GARWSP Branch Offices)

Branch	Name	Position
Al-Mahwit	Mohamed Alnuzayli	General Director
	Fath Ali Alanisi	Geologist
	Abdul Salam Almadhaji	Civil Technician
	Abdul Rahaman Aldaylami	Civil Engineer
Sana'a	Abdul Ghani Algazali	General Director, Civil Engineer
	Ahmed Albudayji	Civil Engineer
	Ibrahim Algabri	Geologist
Dhamar	Abdul Malek Fare	General Director, Civil Engineer
	Abdul Ghani Hajar	Geologist
	Yahya Husain Alshehari	Civil Engineer
Ibb	Najeeb Damag	General Director, Civil Engineer
	Abdul Hamid Algazali	Civil Technician
	Abdul Mogni Albashiri	Geologist
	Samir Al-Shahsi	General Director
Taiz	Khaled Mohamed Said	Geologist
	Said Hasan	Mechanical Engineer

Annex-2 Final List of Candidate Sites

Governorate	District	No.	No. by Governorate	Site Name
Al Mahwit	Al Khabt	1	A-01	Upper & Lower Al Shaafel
	Al Mahwit	2	A-02	Jabal Al Taraf
	Al Rujum	3	A-03	Islat Al Jaradi
	Bany Saad	4	A-04	Al Khamis - Bany Ali
Sana'a	El-Haima	5	S-01	*Bani Waleed and Alasboor
	Hamdan	6	S-02	Jarban
	Bany Matar	7	S-03	Al Khrabah
		8	S-04	Qamlan
	Belad Al Rows	9	S-05	Aaqish
	Sanhan & Bany Behlowl	10	S-06	Al Legam
		11	S-07	Bait Al Hadrami
		12	S-08	Dajah - Sarfah
		13	S-09	Ruhm
	Al Hasn	14	S-10	Tawaar
	Jahanah	15	S-11	Al Hesn Al Abiadh
		16	S-12	Mahdah
	Al Tiul	17	S-13	Al Jaara
	Nehm	18	S-14	Al Ghail
Dhamar	Jabal Al Sharq	19	D-01	Elow Al Meklaf
		20	D-02	Hamel Bait Al Jabal
		21	D-03	Hejrat Al Asham
	Dhuran	22	D-04	Al Kab
	Anse	23	D-05	Maifat Yaar
		24	D-06	Wardasan
	Maifaa	25	D-07	Al Asakera
		26	D-08	Masnat Abdalaziz
Ibb	Al Gafr	27	I-01	Asfal Bany Saba
	Al Makhader	28	I-02	Al Sana
		29	I-03	Mamsa - Al Margab
	Ibb	30	I-04	Al Jahlah - Al Mishraf
Taiz	Mawyah	31	T-01	Al Muayteeb
	Al Maafer	32	T-02	Bany Surwr - Al Nashamah
		33	T-03	Shab Humran
		34	T-04	Yafeq Bany Hamad
	Al Shamtain	35	T-05	Al Azaiz
	Al Wazah	36	T-06	Al Khunah

\* Replaced Site

Annex-3 List of Attendants

MWE: Ministry of Water and Environment

Dr. Mohamed L. Al-Eryani Minister of Water & Environment  
Dr. Mohamed I. Al-Hamdi Deputy Minister for Water

GARWSP: General Authority for Rural Water Supply Projects

Mr. Ali M. Al-Suremi Chairman  
Mr. Ali Ahmed Al-Rabwae General Director of Planning and International Cooperation  
Mr. Fawzi A. Alkhirbash Deputy General Director of Planning and International Cooperation  
Director of International Cooperation Department  
Mr. Abdulatif Ahmed Salah General Director of Public Relations and Information  
Mr. Abdullah Abdulmalek Badr Head of Technical Office  
Mr. Kaid A. Al-Darwish Deputy of Technical Office  
Coordinator of Dutch Technical Support Project  
Mr. Hussien Alshaabi Laboratory Director of Geology and Chemistry  
Mr. Ali Mohamied Tahir Laboratory Director of Geography and Environment Sector  
Mr. Abdul Kaher Ali Ahmed Mechanical Engineer, Technical Office  
Mr. Abdul Galil Algradi Director of Account Department  
Mr. Abdul Kalim A. Alnoor Social and Financial, Technical Office  
Mr. Abdul Ghani al Gazali Director of Sana'a Branch  
Ms. Nemat Mohamed Al-Magdoob Staff, Engineering Section  
Mr. Abdulkaher Aliff Mechanic Engineer, Technical Office

NWRA: National Water Resources Authority

Eng. Salem Hassan Bashuaib Chairman

Embassy of Japan in Yemen

Mr. Yuichi Ishii Ambassador of Japan  
Mr. Yoji Hattori First Secretary

JICA Advisory Committee

Mr. Kenji Nagata Leader of Advisory Committee  
Ms. Izumi Shoji Member  
Mr. Kentaro Nagai Member

JICA Study Team

Mr. Shoji Fujii Team Leader/Water Supply Plan  
Mr. Yusuke Oshika Hydrogeology/Groundwater Development Plan  
Ms. Mikiko Azuma Socio-Economic Analysis  
Mr. Naoki Mori Operation and Maintenance  
(Institutional/Community Development)  
Mr. Takafumi Ohashi Coordinator

NOTE OF AGREEMENT  
FOR  
RURAL WATER SUPPLY COMPONENT OF  
THE STUDY FOR WATER RESOURCES MANAGEMENT AND  
RURAL WATER SUPPLY IMPROVEMENT IN  
THE REPUBLIC OF YEMEN

Between  
GENERAL AUTHORITY FOR RURAL WATER SUPPLY PROJECTS  
THE MINISTRY OF WATER AND ENVIRONMENT  
And  
JICA (JAPAN INTERNATIONAL COOPERATION AGENCY) STUDY TEAM

In accordance with the Inception Report submitted on 17 December 2005 and the Minutes of Meetings signed on 21 December 2005, the JICA Study Team is conducting field surveys at the candidate sites. As a result of the study up to 8 February 2006, the following points were additionally agreed upon.

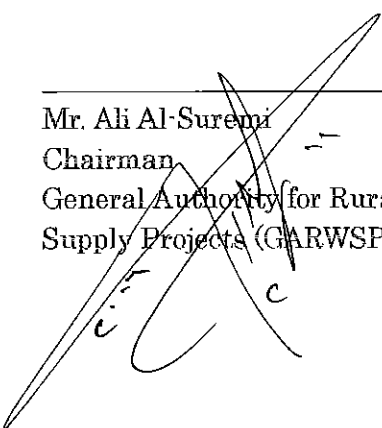
1. During the field survey at the candidate sites, the Study Team encountered problems at security check points in the northern, eastern and southeastern parts of Sana'a Governorate. If this problem cannot be solved, which means if the Study Team cannot go freely to the site and return from the site without any security guard escorts, and unless security is completely assured before the end of February 2006, GARWSP agreed that sites located in the problem areas will be cancelled from the candidate list, and replacement of sites will not be made.
2. Upon confirmation of the water source to be used for the study at the site of Wardasan (D06) in Dahmar Governorate, the proposed borehole was found to be a private well. The Dahmar branch office of GARWSP explained that this private well was handed over to the village, and the branch office promised to submit the legal documents to confirm this fact to the Study Team. However, if documents approved by the well owner, the village, local council and GARWSP are not submitted by 8 February 2006 and any problems with ownership is foreseen, then this well cannot be used as the water source for the site, and if a new borehole cannot be drilled before the end of February 2006, then a water source would not be available for that site. In this case, Both Sides agreed that this site will be cancelled from the list of candidate sites for the above-mentioned study, and that the site cannot be replaced by an alternative site.
3. The Study Team explained that pumping tests will be conducted at wells to be used as water sources for the candidate sites. For sites which presently have a pump installed in the target borehole, the Study Team requested that the village or GARWSP must take responsibility to remove and reinstall the pump so that



pumping tests can be properly carried out. GARWSP agreed to complete removal of the pumps before the middle of April 2006. If removal of pumps is not completed by the middle of April, the Study Team will remove and reinstall the pumps but will not take any responsibility for any problems related to the removal and reinstallation, such as damaging the pump, dropping the pump in the well, damaging the well casing and other accidents which can result in the borehole being unusable, in which case that borehole cannot be used as a water source for the study.

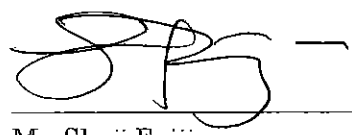
4. GARWSP requested changes in the list of counterpart staff which was agreed in the Minutes of Meetings. Since the changes will enhance the survey and not affect the survey activities of the Study Team, the Study Team agreed to the changes. The changes are shown in the attached list.

Sana'a, 11 February 2006



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Mr. Ali Al-Sureni  
Chairman  
General Authority for Rural Water  
Supply Projects (GARWSP)



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Mr. Shoji Fujii  
Team Leader  
JICA Study Team

Attachment: List of Changes in Counterpart Staff

GARWSP Headquarters

JICA Study Team		Counterpart Staff according to Minutes of Meetings		New List of Counterpart Staff	
Name	Function	Name	Function/Position	Name	Function/Position
FUJII	Team Leader/ Water Supply Plan	Mr. Ali Ahmed ALRABWAE	Civil Engineer/G.D. of P.I.C.	Mr. Fawzi ALKHIRBASH	Hydrogeologist/Deputy G.D of P.I.C
OSHIKA	Hydrogeology/ Groundwater Development	Mr. Fawzi ALKHIRBASH	Hydrogeologist/Deputy G.D of P.I.C	Mr. Abdullah ABDULMALEK	Hydrogeologist
AZUMA	Socio-Economic Analysis	Mr. Kaid ALDARWISH	Hydrogeologist/Deputy of Tech. Office	Mr. Kaid ALDARWISH	Hydrogeologist/Deputy of Tech. Office
UEMATSU	Pumping Test/ Water Quality Analysis	Mr. Abdullah ABDULMALEK	Hydrogeologist	Mr. Abdulkarim ABDULNOR	Financial Analysis/Tech. Office
MIYOSHI	Facilities Design	Mr. Abdulkarim ABDULNOR	Financial Analysis/Tech. Office	Mr. Hussien ALSHAABI	Geologist
MORI	Operation & Maintenance (Institutional/Community Development)	Mr. Hussien ALSHAABI	Geologist	Mr. Abdulnaser ALMAKHLAFY	Civil Engineer/V.G.D of S.S.F/D. of Studies Dep.
NIWANO	Operation & Maintenance (Technical)	Mr. Abdulnaser ALMAKHLAFY	Civil Engineer/V.G.D of S.S.F/D. of Studies Dep.	Ms. Namat ALMAJTHOB	Civil Engineer
NIJIMA	Environmental Analysis	Ms. Namat ALMAJTHOB	Civil Engineer	Mr. Abdulqaher ALI AHMED	Mechanical Engineer
OHASHI	Coordination	Mr. Abdulqaher ALI AHMED	Mechanical Engineer	Mr. Ali TAHER	Geo-Chemist
		Mr. Ali TAHER	Geo-Chemist	Mr. Mohammed Ali RAWEH	Accountant/Chief of Regis. & Expen. Div.

GARWSP Branch Offices

Counterpart Staff according to Minutes of Meetings		New List of Counterpart Staff		
Branch Name	Name	Function/Position	Name	Function/Position
Al-Mahweet	Mohamed Alnuzayli	General Director	Mohamed Alnuzayli	General Director
	Fath Ali Alanisi	Geologist	Fath Ali Alanisi	Geologist
	Abdul Salam Almadhaji	Civil Technician	Abdul Rahman Aldaylami	Civil Engineer
	Abdul Rahman Aldaylami	Civil Engineer		
Sana'a	Abdul Ghani Algazali	General Director, Civil Engineer	Abdul Ghani Algazali	General Director, Civil Engineer
	Ahmed Albudayji	Civil Engineer	Ahmed Albudayji	Civil Engineer
	Ibrahim Algabri	Geologist	Ibrahim Algabri	Geologist
Dahmar	Abdul Malek Fare	General Director, Civil Engineer	Nazer Al Maktari	Socio-Economist
	Abdul Ghani Hajar	Geologist	Abdul Malek Fare	General Director, Civil Engineer
	Yahya Husain Alshehri	Civil Engineer	Aref Saeed Muhsen	Geologist
Ibb	Najeeb Damag	General Director, Civil Engineer	Yahya Husain Alshehri	Civil Engineer
	Abdul Hamid Algazali	Civil Technician	Abdulaziz Al-Kibsi	Accountant, Financial Director
	Abdul Mogni Albashiri	Geologist	Najeeb Damag	General Director, Civil Engineer
Taiz	Samir Al-Shahsi	General Director	Abdul Hamid Algazali	Civil Technician
	Khaled Mohamed Said	Geologist	Abdul Mogni Albashiri	Geologist
	Said Hasan	Mechanical Engineer	Samir Al-Shahsi	General Director
			Khaled Mohamed Said	Geologist
			Said Hasan	Mechanical Engineer

**NOTE OF AGREEMENT 2**  
**FOR**  
**RURAL WATER SUPPLY COMPONENT OF**  
**THE STUDY FOR WATER RESOURCES MANAGEMENT AND**  
**RURAL WATER SUPPLY IMPROVEMENT IN**  
**THE REPUBLIC OF YEMEN**  
 Between  
**GENERAL AUTHORITY FOR RURAL WATER SUPPLY PROJECTS**  
**THE MINISTRY OF WATER AND ENVIRONMENT**  
 And  
**JICA (JAPAN INTERNATIONAL COOPERATION AGENCY) STUDY TEAM**

With reference to the following documents, in succession to the First Fiscal Year Study, the Second Fiscal Year Study is on-going by the JICA Study Team.

- Inception Report submitted on 17 December 2005
- Minutes of Meetings signed on 21 December 2005
- Note of Agreement signed on 12 February 2006

As a result of the study up to the middle of October 2006, the following points were additionally agreed upon.

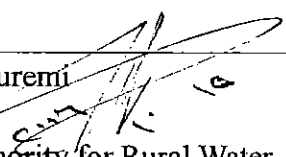
1. According to information from the Japanese Embassy and other sources, and instructions from JICA, Japanese nationals, including the JICA Study Team members, are restricted from entering areas designated as having security risks. As a consequence, JICA Study Team members are not allowed to enter sites located in the designated areas to make further field surveys. Therefore, GARWSP has agreed that the Study Team cannot take any responsibilities for questionable information concerning these sites and priorities of these sites will be lowered due to this reason. The study sites located in the security-risk designated areas are as follows.

Governorate	District	Site Name	Code No.
Sana'a	Al Hesn	Tawa'ar	S-10
	Jehana	Al Hesn-Al Abyad	S-11
	Jehana	Mahdah	S-12
	Alteyal	Al Ga'ra	S-13
	Nehm	Al Ghail	S-14

2. The Study Team explained that screening and ranking of candidate sites will be carried out during the Second Fiscal Year Study using criteria which were discussed between GARWSP and the Study Team. The attached conditions and criteria for screening and ranking were agreed between GARWSP and the Study Team.


3. The Study Team discussed with GARWSP on design standards for rural water supply plan including water quality standards to be adopted for this study. GARWSP agreed to these standards, and for water quality, GARWSP agreed to adopt Yemeni standards for drinking water. The agreed design standards are listed in Attachment 3.
4. The Study Team further explained that a pilot project is scheduled to be implemented during the Third Fiscal Year Study. GARWSP has agreed on the concept for pilot project implementation which was presented by the Study Team as shown in Attachment 4.
5. Concerning the counterpart training in Japan of GARWSP staff members, GARWSP inquired the Study Team on the progress of its acceptance. The Study Team agreed to convey the message to JICA headquarters to confirm the present situation.

Sana'a, 15 October 2006



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Mr. Ali Al-Suremi  
Chairman  
General Authority for Rural Water  
Supply Projects (GARWSP)



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Mr. Shoji Fujii  
Team Leader  
JICA Study Team

Attachments:

- Attachment 1: Screening and Ranking of Candidate Sites
- Attachment 2: Design Standards to be Adopted for the Study
- Attachment 3: Pilot Project Concept

## Attachment 1: Screening and Ranking of Candidate Sites

### Criteria for Selection of Sites for Formulation of Rural Water Supply Improvement Plan

Parameter	Selection Criteria
1. Availability of Water Source	1) Reliable water source is available 2) Target water source has a minimum yield of 25 gal/min (1.5 l/sec) 3) Quality of water source complies with Yemeni standards for drinking water
2. Water Supply Situation	1) Existing water supply facilities cannot meet demand of beneficiaries
3. Contribution from Beneficiary	1) Water committee is existent or residents are willing to form one 2) Residents are willing to contribute to construction of water supply facilities 3) Residents are willing to pay operation and maintenance fees
4. Similar Projects	1) No duplication of sites with similar plans of other donors
5. Land Use and Water Rights	1) Public ownership of target water source and land for storage tanks and pump houses is confirmed by target community, GARWSP and District council 2) Conflicts over water rights or land use are non-existent within the site or with neighboring villages
6. Accessibility	1) Construction machinery and equipment can access site

Sites screened in the above process are ranked according to grades assigned to the parameters shown below.

### Parameters for Ranking of Screened Sites

Parameter	Comparative Factor
1. Difficulty for Water Procurement	1) Whether protected water source within site is available to community 2) Conditions for presently accessible protected water source within or outside site: a. Average water consumption rate per day per household b. Average time required to fetch water per day per household
2. Needs for Water Supply Improvement	1) Needs ranking for water supply in relation to improvement of living environment
3. Water Source Potential	1) Ratio of coverage population with target water source to total population
4. Capacity for Payment of Operation and Maintenance Fees	1) Ratio between amount payable per household per 1 m <sup>3</sup> of water and cost to supply 1 m <sup>3</sup> of water

### Preconditions for Project Implementation (in case of assistance from Japanese Government such as grant aid)

- Land required for construction including water source are publicly owned and necessary legal procedures are taken.
- The site is not located within a "restricted area for Japanese citizens".

## Attachment 2: Design Standards to be Adopted for the Study

### Design Standards for Rural Water Supply Plan

Parameter		Standard
Unit Water Supply Rate		Maximum: 40 lit/capita/day Minimum: 25 lit/capita/day
Design Year		10 years
Storage Tank Capacity (m <sup>3</sup> )	Ground Tank	25, 50, 75, 100, 150, 200, 250
	Elevated Tank	25, 50, 60, 100
Successful Yield for Borehole		25 - 40 gal/min (1.5 - 2.5 lit/sec)
Water Quality Standard		Maximum Value of Acceptable Limits of Yemeni Standards for Drinking Water based on WHO Guidelines for Drinking Water (refer to table below)

### Water Quality Standards

Parameter	Quality Standard		
	Value	Source	
pH	6.5-9.0	Yemeni Max. Value	
Coliform Group Count	—	—	
Electric Conductivity	—	—	
Temperature	—	—	
TDS (Total Dissolved Solids)	1,500 mg/l	Yemeni Max. Value	
Sodium	Na <sup>+</sup>	400 mg/l	Yemeni Max. Value
Potassium	K <sup>+</sup>	12 mg/l	Yemeni Max. Value
Magnesium	Mg <sup>+2</sup>	150 mg/l	Yemeni Max. Value
Calcium	Ca <sup>+2</sup>	200 mg/l	Yemeni Max. Value
Iron	Fe <sup>+2</sup>	1.0 mg/l	Yemeni Max. Value
Manganese	Mn <sup>+2</sup>	0.2 mg/l	Yemeni Max. Value
Bicarbonates	HCO <sub>3</sub> <sup>-</sup>	600 mg/l	Yemeni Max. Value
Chloride	Cl <sup>-</sup>	600 mg/l	Yemeni Max. Value
Sulphate	SO <sub>4</sub> <sup>-2</sup>	600 mg/l	Yemeni Max. Value
Fluoride	F <sup>-</sup>	1.5 mg/l	Yemeni Max. Value
Phosphate	P <sub>2</sub> O <sub>5</sub>	5.0 mg/l	Yemeni Max. Value
Ammonium	NH <sub>4</sub> <sup>+</sup>	0.5 mg/l	Yemeni Max. Value
Nitrate	NO <sub>3</sub> <sup>-</sup>	50 mg/l	Yemeni Max. Value
Nitrite	NO <sub>2</sub> <sup>-</sup>	2.0 mg/l	Yemeni Max. Value

**Attachment 3: Pilot Project Concept**

A pilot project is scheduled for implementation during the Third Fiscal Year. About 3 sites will be selected from the screened sites. The pilot project will include technology transfer on supervision of construction works, and contributions by the residents, such as distribution of pipes and other materials from the stock yard to the construction areas, and pipe connections to individual households. The Governorates of Al Mawheet, Sana'a and Dahmar are planned as target areas for capacity development of GARWSP branch offices in these governorates if the following conditions are satisfied.

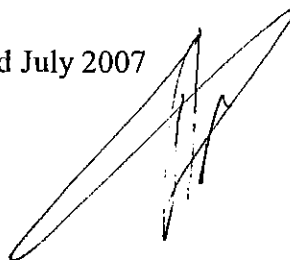
- A site appropriate for pilot project is available
- The branch office is sufficiently prepared for capacity development

The pilot project sites will be selected in accordance with the following conditions.

Parameter	Condition
Existing Water Supply Facilities	Reliable water source such as borehole is available
Required Work	Small scale construction or rehabilitation
Willingness of Beneficiaries	Willing to contribute to water supply facilities construction and to operation and maintenance of the completed facilities. Willing to form a community-based water committee or improve an existing one.
Capacity of responsible GARWSP Branch Office	Requires capacity building, and possesses staff and budget sufficient for implementation

Proposal for implementation of the pilot project is expected to be as follows in consideration of constraints in budget and allotted construction time.

- Number of sites: 2 or 3 sites
- Construction span: 2 to 3 months
- Scheduled Period: Between April and July 2007

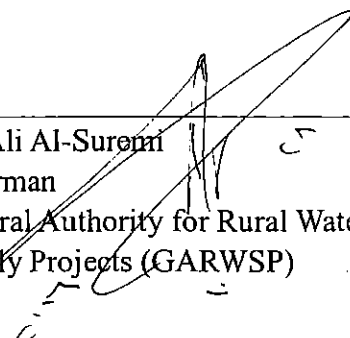




**ADDITION TO  
NOTE OF AGREEMENT 2  
FOR  
RURAL WATER SUPPLY COMPONENT OF  
THE STUDY FOR WATER RESOURCES MANAGEMENT AND  
RURAL WATER SUPPLY IMPROVEMENT IN  
THE REPUBLIC OF YEMEN**  
Between  
**GENERAL AUTHORITY FOR RURAL WATER SUPPLY PROJECTS  
THE MINISTRY OF WATER AND ENVIRONMENT**  
And  
**JICA (JAPAN INTERNATIONAL COOPERATION AGENCY) STUDY TEAM**

Based on the Note of Agreement 2 signed on 15 October 2006, we agreed on the following.

The Study Team explained that 23 sites as listed in Attachment A-1 were selected through the screening procedure agreed as Attachment 2 in the Note of Agreement 2 with reasons for their screening shown in Attachment A-2. GARWSP agreed on the results of this screening.

Sana'a, 28 October 2006

  
\_\_\_\_\_  
Mr. Ali Al-Suremi  
Chairman  
General Authority for Rural Water  
Supply Projects (GARWSP)

  
\_\_\_\_\_  
Mr. Shoji Fujii  
Team Leader  
JICA Study Team

Attachment A-1: List of Screened Sites for Formulation of Rural Water Supply Improvement Plan  
Attachment A-2: Reasons for Screening Out of Sites



**Attachment A-1: List of Screened Sites for Formulation of Rural Water Supply Improvement Plan**

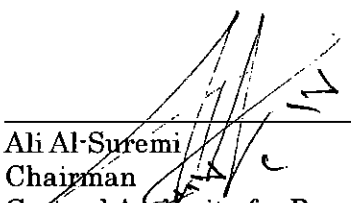
No.	Code	Site Name	Governorate	District
1	A-02	Jabal Al Taraf	Al Mawheet	Al Mawheet
2	A-03	Ozlat Al Jaradi		Al Rujum
3	S-02	Jarban	Sana'a	Hamdan
4	S-03	Al Kharaba		Bani Matar
5	S-04	Qamlan-Bait Al Najrani		
6	S-05	Afesh		Belad Al Rous
7	S-07	Bait Al Hadrami		Sanhan & Bani Bahlool
8	S-09	Ruhm		
9	S-11	Al Hesn-Al Abyad		Jehana
10	D-01	Elow Al Mikhlaf	Dahmar	Jabal Al Sharq
11	D-02	Hamal Bait Al Jabar		
12	D-03	Hegrat Al A'asham		
13	D-05	Mayfa'at Yaer		Ans
14	D-07	Al Asakera		Mayfa'a
15	D-08	Masneat Abdul Aziz		
16	I-01	Asfal Bani Saba	Ibb	Al Qafir
17	I-02	Al Sana		Al Makhader
18	I-04	Al Jahlah & Al Meshraq		Ibb
19	T-02	Bani Al Suror	Taiz	Al Ma'afer
20	T-03	Sheb Humran		
21	T-04	Yafoq Bani Hamad		Al Mawaset
22	T-05	Al Azaez		Al Shamayaten
23	T-06	Al Khunha		Al Wazieyah

**Attachment A-2: Reasons for Screening Out of Sites**

Gov.	No.	Code	Site Name	Water Quantity	Water Quality
Al Mawheet	1	A-01	Al Sha'afel Al Olyah & Al Suffa	Slow water level recovery High ratio of discharge to recharge	—
	2	A-04	Al Khamis- Bani Ali	—	TDS=1,742 mg/l Mn=0.25 mg/l F=1.8 mg/l
Sana'	3	S-01	Bani Waleed - Al Asboor	Very slow water level recovery	Mn=0.24 mg/l for one well
	4	S-06	Al Lejam	—	pH=9.3
	5	S-08	Dajah & Sarfah	Could not make pumping test due to low water level	F=4.46 mg/l
	6	S-10	Tawa'ar	High ratio of discharge to recharge	pH=9.4 for one well
	7	S-12	Mahdah	—	pH=9.5
	8	S-13	Al Ga'ra	High ratio of discharge to recharge Could not make pumping test due to low water level	—
	9	S-14	Al Ghail	Well collapsed and filled with mud	—
Dahmar	10	D-04	Al Kuob	Low yield	—
	11	D-06	Wardasan	Low yield	—
Ibb	12	I-03	Mamsa Al Marqab	Slow water level recovery	F=1.9 mg/l
Taiz	13	T-01	Al Muayteeb	Could not make complete pumping test due to high temperature	Mn=0.2 mg/l Na=407 mg/l K=25 mg/l Cl=600 mg/l Temp. = 61°C

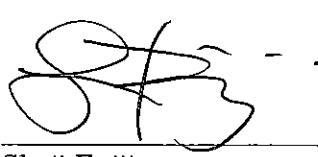
MINUTES OF MEETINGS  
ON  
INTERIM REPORT  
FOR  
RURAL WATER SUPPLY COMPONENT  
OF  
STUDY FOR WATER RESOURCES MANAGEMENT AND  
RURAL WATER SUPPLY IMPROVEMENT  
IN  
REPUBLIC OF YEMEN  
AGREED UPON BETWEEN  
GENERAL AUTHORITY FOR RURAL WATER SUPPLY PROJECTS  
MINISTRY OF WATER AND ENVIRONMENT  
AND  
JAPAN INTERNATIONAL COOPERATION AGENCY

SANA'A, 17 FEBRUARY 2007



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Ali Al-Suremi  
Chairman  
General Authority for Rural Water  
Supply Projects (GARWSP)



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Shoji Fujii  
Team Leader  
JICA Study Team

Witness:



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Kenji Nagata  
Leader of Advisory Committee  
Japan International Cooperation Agency  
(JICA)

Discussions were made on the Interim Report for the Rural Water Supply Component of the Study for Water Resources Management and Rural Water Supply Improvement in the Republic of Yemen, and the contents of the Interim Report were presented at the seminar held on 13<sup>th</sup> February 2007. As a consequence, the contents of the Interim Report were agreed upon, in principle, between General Authority for Rural Water Supply Projects (hereafter referred to as "GARWSP") and JICA Study Team (hereafter referred to as "the Study Team") in the presence of JICA Advisory Committee. Additionally, the following points were mutually agreed upon.

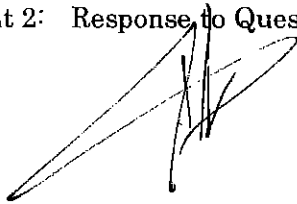
1. The Study Team explained that the screened sites, which were agreed in "Addition to Note of Agreement 2" signed on 28 October 2006, were given ranking according to the conditions agreed in "Note of Agreement 2" signed on 15 October 2006. GARWSP agreed to the screened sites with ranking shown in the Attachment 1.
2. The Study Team explained that the Rural Water Supply Improvement Plan and the Draft Action Plan for Capacity Development will be finalized in the Draft Final Report upon reflecting the results of the Pilot Project, and GARWSP agreed.
3. The JICA Advisory Committee suggested that GARWSP should consult with the Ministry of Planning and International Cooperation (MPIC) to confirm if GARWSP needs to renew the site list of the official request submitted in 2006 for Japan's Grant Aid to the Embassy of Japan through MPIC. The Study Team recommended the implementation of the attached site list in the course of this study. GARWSP agreed to proceed with this suggestion as early as possible.
4. The Study Team explained that about 3 sites from the screened sites will be selected for the Pilot Project in accordance with conditions agreed in "Note of Agreement 2" signed on 15 October 2006. Furthermore, the Study Team explained that the Pilot Project is scheduled to be implemented during the next fiscal year, tentatively from April 2007. GARWSP agreed to initiate the implementation and procedures for capacity development of the Pilot Project.
5. GARWSP explained that they will continue to initiate and encourage institutional strengthening, and at the same time, requests the Japanese side to provide necessary assistance for smooth facilitation and acceleration of the capacity development procedures. The Study Team agreed to consider this issue.

6. During the discussion session of the Seminar held on 13<sup>th</sup> February 2007, various points and issues were brought up by the participants, and the Study Team and GARWSP counterpart responded as listed in Attachment 2.

#### ATTACHMENTS

Attachment 1: List of Screened Sites with Ranking

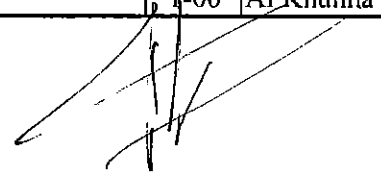
Attachment 2: Response to Questions asked during the Seminar



**Attachment 1: List of Screened Sites with Ranking**

No.	Governorate	Code	Site	District	Ranking
1	Al Mawheet	A-02	Jabal Al Taraf	Al Mahweet	19
2		A-03	Ozlat Al Jaradi	Al Rujum	16
3	Sana'a	S-02	Jarban	Hamdan	20
4		S-03	Al Kharaba	Bani Matar	17
5		S-04	Qamlan - Bait Al Najrani		10
6		S-05	Afesh	Belad Al Rous	12
7		S-07	Bait Al Hadrami	Sanhan & Bani	9
8		S-09	Ruhm	Behlowl	21
9		S-11	Al Hesn - Al Abyad	Jehana	13
10	Dahmar	D-01	Elow Al Mikhlaf	Jabal Al Sharq	1
11		D-02	Hamal Bait Al Jabar		7
12		D-03	Hegrat Al A'asham		4
13		D-05	Mayfa'at Yaer	Ans	3
14		D-07	Al Asakera	Mayfa'a	6
15		D-08	Masneat Abdul Aziz		2
16	Ibb	I-01	Asfal Bani Saba	Al Qafr	5
17		I-02	Al Sana	Al Makhader	11
18		I-04	Al Jahlah & Al Meshraq	Ibb	15
19	Taiz	T-02	Bani Al Suror	Al Ma'afer	22
20		T-03	Sheb Humran		18
21		T-04	Yafoq Bani Hamad	Al Mawaset	14
22		T-05	Al Azaez	Al Shamayaten	23
23		T-06	Al Khunha	Al Wazieyah	8

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Attachment 2: Response to Questions asked during the Seminar

Issue	Question	Response
1. Priority on the Key Capacity Areas for Development	It is questioned whether there is a particular priority among the key capacity areas identified in the Study for further development.	Priority is not yet determined, but it would be done through consultation with GARWSP and other development partners, taking consideration of availability of development resources required for undertakings.
2. Design Criteria for Target Period	Pumps last 10 years, but tanks and other structures last over 20 years. Why was 10 years selected as the design period instead of 20 years?	The design year set by GARWSP is 20 years. However, in consideration of uncertainties in growth predictions and area-wise growth differences if a long term planning is made, 20 years is considered to be too long. Therefore, upon discussions with GARWSP, 10 years was agreed as the design year for this study to facilitate necessary adjustments during this period. Also, pumps and engines last about 7 years, but structures do last more than 20 years, so after 10 years the plan can be adjusted to conform to the actual conditions.
3. Rehabilitation Sites	Why is rehabilitation necessary for the 9 sites? What are the countermeasures for their failure?	The causes for failure of water supply facilities are complex due to technical and managerial factors. The Study Team will consider measures for this issue.
4. Selection of Pumping Unit Suitable for the Locality	In mountainous areas, submersible pumps are better than vertical pumps. Why did you select vertical pumps?	We designed the water supply systems in accordance with the area, water level and other local conditions. Wherever, necessary, especially if the total head is very high, submersible pumps were planned. However, if both types are appropriate, then considerations on maintenance, availability of spare parts and operational cost performance were made, and vertical pumps will be selected.
5. Measures to Protect Water Sources, in Quality and Quantity	What measures do you recommend to protect water sources in quantity and quality	It is confirmed that the available borehole for the Study is well protected from surface contamination. However, it is strongly suggested in operation of the supply scheme that the pumping rates (safe yield calculated from results of pumping test) be kept as recommended by the Study Team in order to prevent deterioration of available water in quantity and quality. Also, periodically, water levels, pumping rates and operation hours should be monitored with appropriate equipment and recorded by the operator. Further, water quality should be periodically analyzed and recorded.

6. Measures for Sanitation Improvement	What procedures are you taking for sanitation improvement?	In case that water supply conditions are improved through the project, it is expected that the residents can use more water for domestic use, especially for the sites where they currently rely on the unprotected and seasonal sources. While their highest priority for usage of water as domestic use is drinking and cooking, they also have needs to allocate more water for personal and household hygiene, such as for toilet, ablution, and washing. In such case, sewage and wastewater from the households need to be properly controlled and managed to avoid negative impact on the environmental sanitation in the communities. Hygiene awareness promotion and education are required to address this kind of issue in the project.
7. Roles of Yemeni side (GARWSP Counterparts) in the Study	What roles do GARWSP counterparts play during the Study?	GARWSP counterparts conducted the surveys for the study together with the JICA Study Team as part of the capacity development program to acquire skills for development study and planning for project implementation. Also, the action plan for capacity development was drafted under the initiative of GARWSP. Furthermore, GARWSP will be the main facilitator for implementation of the pilot projet.



**TECHNICAL NOTE**  
ON  
**PROGRESS REPORT**  
FOR  
RURAL WATER SUPPLY COMPONENT OF  
STUDY FOR WATER RESOURCES MANAGEMENT AND  
RURAL WATER SUPPLY IMPROVEMENT  
IN  
REPUBLIC OF YEMEN

AGREED UPON BETWEEN

GENERAL AUTHORITY FOR RURAL WATER SUPPLY PROJECTS  
MINISTRY OF WATER AND ENVIRONMENT

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Discussions were made on the Progress Report for the Rural Water Supply Component of the Study for Water Resources Management and Rural Water Supply Improvement in the Republic of Yemen, and the contents of the Progress Report were agreed upon, in principle, between General Authority for Rural Water Supply Projects (hereafter referred to as "GARWSP") and JICA Study Team (hereafter referred to as "the Study Team"). Additionally, the following points were mutually agreed upon.

1. The Study Team explained the finalized Rural Water Supply Improvement Plan for screened sites, and GARWSP agreed to utilize the plan for project implementation through various funding sources.
2. Upon explanation of the Action Plan for Capacity Development by the Study Team, GARWSP agreed to initiate and accelerate capacity building and institutional strengthening of their organization. Also, GARWSP requests the Japanese side to provide necessary assistance to implement the procedures and activities proposed in the action plan for capacity development.

3. The Study Team explained the activities and progress of the Pilot Project. GARWSP mentioned that the implementation method used by the Study Team will greatly benefit GARWSP as one option within those of various assistance partners to be used as a model for further project implementation through the initiation of GARWSP.
  
4. The Study Team discussed with GARWSP on the date to hold the second seminar on presentation of the Draft Final Report scheduled to be held during Ramadan. As a result, the Study Team and GARWSP agreed that 1<sup>st</sup> October 2007 in the afternoon would be set as the tentative schedule, and GARWSP agreed to make every effort to initiate the preparation and presentation of the seminar.

SANA'A, 24 JULY 2007

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Ali Mohammed Al-Suraimi  
Chairman  
General Authority for Rural Water  
Supply Projects (GARWSP)

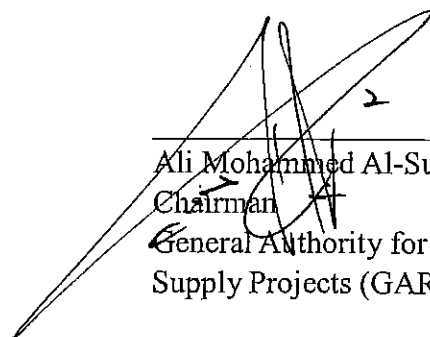


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Shoji Fujii  
Team Leader  
JICA Study Team

MINUTES OF MEETINGS  
ON  
DRAFT FINAL REPORT  
FOR  
RURAL WATER SUPPLY COMPONENT  
OF  
STUDY FOR WATER RESOURCES MANAGEMENT AND  
RURAL WATER SUPPLY IMPROVEMENT  
IN  
REPUBLIC OF YEMEN  
AGREED UPON BETWEEN  
GENERAL AUTHORITY FOR RURAL WATER SUPPLY PROJECTS  
MINISTRY OF WATER AND ENVIRONMENT  
AND  
JAPAN INTERNATIONAL COOPERATION AGENCY

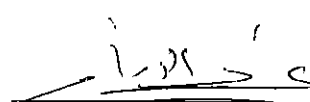
SANA'A, 2 October 2007



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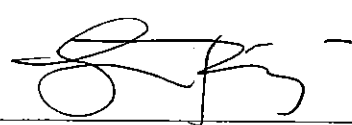
Ali Mohammed Al-Suraimi  
Chairman  
General Authority for Rural Water  
Supply Projects (GARWSP)

Approved by:



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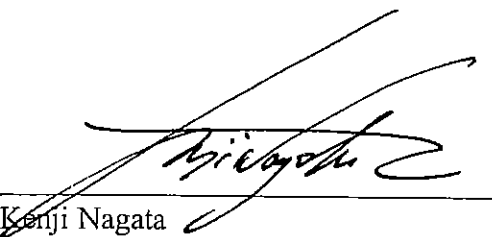
H.E. Abdulrahman Fadl Al Eryani  
Minister  
Ministry of Water and Environment  
(MWE)



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Shoji Fujii  
Team Leader  
JICA Study Team

Witness:



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Kenji Nagata  
Leader of Advisory Committee  
Japan International Cooperation Agency  
(JICA)

Discussions were made on the Draft Final Report for the Rural Water Supply Component of the Study for Water Resources Management and Rural Water Supply Improvement in the Republic of Yemen, and the contents of the Draft Final Report were presented at the second seminar held on 1<sup>st</sup> October 2007 in Sana'a. Consequently, the contents of the Draft Final Report were agreed upon, in principle, between General Authority for Rural Water Supply Projects (hereafter referred to as "GARWSP") and JICA Study Team (hereafter referred to as "the Study Team"). Additionally, the following points were mutually agreed upon.

1. GARWSP agreed to the contents of the finalized Rural Water Supply Improvement Plan for screened sites and Action Plan for Capacity Development of GARWSP.
2. GARWSP strongly requested early project implementation of all twenty (20) sites remaining after implementation of the 3 pilot project sites, and GARWSP explained that the official request for these sites was already made in August 2007 to the Embassy of Japan in Sana'a. The Study Team and JICA Advisory Committee agreed to convey this matter to JICA headquarters. (Refer to Attachment for List of Request Sites)
3. GARWSP explained that they will utilize the Action Plan for Capacity Development to promote capacity building and institutional strengthening of their organization. However, GARWSP requests the Japanese side to provide necessary support to facilitate the procedures for capacity development. The Study Team and JICA Advisory Committee agreed to convey this request to JICA headquarters.



ATTACHMENT: List of Sites Requested for Assistance



**ATTACHMENT: List of Sites Requested for Assistance**

No.	Governorate	Code	Site Name	District	Ranking	Design Population	Site Category*
1	Al Mawheet	A-03	Ozlat Al Jaradi	Al Rujum	15	27,584	Reh
2	Sana'a	S-02	Jarban	Hamdan	17	1,977	NC
3		S-04	Qamlan-Bait Al Najrani	Bani Matar	9	772	NC
4		S-05	Afesh	Belad Al Rous	11	4,517	Reh
5		S-07	Bait Al Hadrami	Sanhan & Bani Bahlowl	8	3,130	NC
6		S-09	Ruhm		18	5,605	NC
7		S-11	Al Hesn-Al Abyad	Jehana	12	2,911	Reh
8		Dahmar	D-01	Elow Al Mikhlaf	Jabal Al Sharq	1	1,249
9	D-02		Hamal Bait Al Jabar	6		3,339	NC
10	D-03		Hegrat Al A'asham	3		2,148	NC
11	D-05		Mayfa'at Yaer	Ans	2	2,044	NC
12	D-07		Al Asakera	Mayfa'a	5	2,623	NC
13	Ibb	I-01	Asfal Bani Saba	Al Qafir	4	11,884	NC
14		I-02	Al Sana	Al Makhader	10	7,691	NC
15		I-04	Al Jahlah & Al Meshraq	Ibb	14	13,359	NC
16	Taiz	T-02	Bani Al Suror	Al Ma'afer	19	11,978	Reh
17		T-03	Sheb Humran		16	30,290	Reh
18		T-04	Yafiq Bani Hamad	Al Mawaset	13	8,735	Reh
19		T-05	Al Azaez	Al Shamayaten	20	15,040	Reh
20		T-06	Al Khunha	Al Wazieyah	7	2,015	NC
<b>Total</b>						<b>158,891</b>	13 NC 7 Reh

\*NC: New construction site  
Reh: Rehabilitation site

## **11. COLLECTED REFERENCES**

# 11. COLLECTED REFERENCES

## Sector Policy and Strategy

Title	Form	Original/ Copy	Publisher	Year	Language
National Water Sector Strategy and Investment Program, 2005-2009 (NWSSIP), The way forward	CD		Ministry of Water and Environment	2005	English/ Arabic

## Sector Review Reports

Title	Form	Original/ Copy	Publisher	Year	Language
Ministry of Water and Environment, Quarterly Newsletter Issue No. 1, July 2005	News	Original	Ministry of Water and Environment	2005	English/ Arabic
Rural Water Supply and Sanitation Finance and Resource Flow Review	Report	Copy	Royal Netherlands Embassy	2005	English/ Arabic

## Statistics and Socio-Economic Study

Title	Form	Original/ Copy	Publisher	Year	Language
Statistical Year Book 2004	Report & CD	Original	CSO, Min. of Planning & International Cooperation	2005	English/ Arabic
Agricultural Statistics Year Book 2004	Report	Original	General Dept. of Agricultural Statistics & Documentation, Min. of Agriculture & Irrigation	2005	English
Land Tenure and Water Rights in the Central Highlands	Report	Copy	Daniel Martin Varisco	1985	English
Water Right Aspects of the Proposed Sources for Sana'a Water Supply	Report	Copy	Dr. Mohamed L. Al-Eryani (et al.)	1996	English
Details of the Social, Health and Technical Study for Al-Sha'athema Project, Nairah District, Hailah Governorate 2002 (First Phase)	Report	Original	Hajjah-IST, Rural Water Supply & Sanitation Project, Ministry of Local Administration	2002	English
Social Study for Water Project (Arabic, partially translated into English)	Report	Copy	GARWSP Sana'a Branch, Ministry of Water and Environment	2004	Arabic

## GARWSP Operation

Title	Form	Original/ Copy	Publisher	Year	Language
Yemen Rural Water Supply and Sanitation Database - User Manual	Manual/ CD	Copy	GARWSP	2005	Arabic
Rural Water Supply and Sanitation Sub-Sector Monitoring & Evaluation and Information System (MIS) - Implementation Action Plan	Report	Copy	GARWSP - RWSS-TA	2005	English
GARWSP Third Five Year Plan (2006-2010)	Report	Copy	GARWSP	2005	Arabic
Job Description for GARWSP Headquarters and Branch Offices (Draft)	Report	Copy	GARWSP	2005	Arabic
GARWSP Budget (Final Account) 2003	Report	Copy	GARWSP	2004	Arabic
GARWSP Budget (Final Account) 2004	Report	Copy	GARWSP	2005	Arabic

GARWSP Budget (Plan) 2005	Report	Copy	GARWSP	2005	Arabic
GARWSP Internal By-Law (Draft)	Report	Copy	GARWSP	2005	Arabic
Roles and Responsibilities (Job Description) of GARWSP Social Mobilization Team (Draft)	Report	Copy	GARWSP	2005	Arabic
GARWSP Human Resource Report 2005	Report	Copy	GARWSP	2005	Arabic

#### Water Resources

Title	Form	Original/ Copy	Publisher	Year	Language
GROUNDWATER RESOURCES	Report	Original	Ministry of Oil and Minerals		English
POTENTIAL EXPLOITATIONAL GROUNDWATER RESOURCES MAP	Map for above	Original	Ministry of Oil and Minerals		English
FACTUAL HYDROGEOLOGICAL DATA MAP	Map for above	Original	Ministry of Oil and Minerals		English
THE WATER RESOURCES OF YEMEN a summary and digest of available information	Report	Copy	NWRA		English

#### Maps

Title	Form	Original/ Copy	Publisher	Year	Language
GEOLOGICAL MAP (13G Taizz,14G Dhamar,15F As Salif,15G Sanaa)	Map	Original	Ministry of Oil and Minerals		English
HYDROGEOLOGICAL MAP (13G Taizz,14G Dhamar,15F As Salif,15G Sanaa)	Map	Original	Ministry of Oil and Minerals		English
TOPOGRAPHICAL MAP 1:50,000	Map	Original			English/ Arabic

#### Local Authority

Title	Form	Original/ Copy	Publisher	Year	Language
Law No. (4) of 2000 concerning the Local Authority		Original	Ministry of Legal Affairs and Parliamentary Affairs	2000	English/ Arabic
Financial By-Law of Local Authority		Original/ Copy	Ministry of Legal Affairs and Parliamentary Affairs	2000	English/ Arabic
Republican Decree No. (269) of 2000 concerning the Executive Regulation of the Local Authority Law		Original/ Copy	Ministry of Legal Affairs and Parliamentary Affairs	2000	English/ Arabic
Law No. (1) of 2001 regarding Non-Governmental Organization and Society		Original	Ministry of Legal Affairs and Parliamentary Affairs	2001	Arabic



### Other Donor Publications

Title	Form	Original/ Copy	Publisher	Year	Language
Public Works Project, Project Management Unit, "Targeting Poor Communities", An Efficient & Cost Effective Management Unit	Pamphlet	Original	Public Works Project		English/ Arabic
Rural Water Supply and Sanitation Project (Credit No. 3450-YEM), Mid-term Review, September 16-October 7, 2004, Aide Mémoire, Draft	Report	Copy	World Bank, RWSSP	2004	English
Participatory District Development Plans, Preparation Project	Pamphlet	Original	Ministry of Planning & International Cooperation, Public Works Project, Royal Netherlands Embassy		English/ Arabic
Evaluation Report Water and Sanitation Program (WSP-Yemen) Yemen Rural Water Supply and Sanitation Technical Assistance Project (RWSS-TA)	Report	Copy	Royal Netherlands Embassy	2005	English
GARWSP Branch Offices - World Bank RWSS Project Collaboration Program (Draft)	Report	Copy	Royal Netherlands Embassy	2005	English
Memorandum of Understanding Program Aid to the Water Sector (PAWS) (Draft)	Memorandum	Copy	Royal Netherlands Embassy	2005	English
Mission Report Review and Reformation Mission SURWAS	Report	Copy	Ministry of Foreign Affairs, Kingdom of Netherlands	1998	English
Netherlands Support Project for Rural Water Supply (SURWAS) Progress Report	Report	Copy	Ministry of Foreign Affairs, Kingdom of Netherlands	1998	English
Netherlands Support Project for Rural Water Supply (SURWAS) GAREW Planning and Management Advisory Interim Report	Report	Copy	Ministry of Foreign Affairs, Kingdom of Netherlands	1999	English
Summary Report for Internal Discussion, 2002-2006 Country Programme of Cooperation Mid Term Review	Report	Copy	Government of Yemen - UNICEF	2004	English
Rural Water Supply and Sanitation Project, Supervision Mission July 11 - 25, 2004 Aid Memoire	Report	Copy	World Bank	2004	English
Pilot Project Investment Cost Estimation	Report	Copy	RWSS-TA	2005	English
Yemen Social Fund for Development 2003 Impact Evaluation Study-Final Report	Report	Original	Social Fund for Development	2003	English
Community Training Manual for Rural Water Scheme Management	Report	Copy	Social Fund for Development	2003	Arabic
Project Appraisal Document for Social Fund for Development Project	Report	Copy	World Bank	2004	English
Project Appraisal Document for Third Public Works Project	Report	Copy	World Bank	2004	English
The Public Works Project Annual Report 2004	Report	Original	Public Works Project	2005	English
Social Fund for Development Annual Report 2004	Report	Original	Social Fund for Development	2005	English
Hygiene and Environmental Awareness Guide for Health Workers in Drinking Water Project	Report	Original	RWSS-TA	2005	Arabic

### Environment Protection

Title	Form	Original/ Copy	Publisher	Year	Language
Environment Protection By-Law	Report	Copy	Environment Protection Authority, Ministry of Water and Environment	2005	Arabic