No.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
URBAN WATER SUPPLY IN DEBUB REGION

JULY 2006

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)
GRANT AID MANAGEGEMENT DEPARTMENT

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PREFACE

In response to a request from the Government of the State of Eritrea, the Government of Japan decided to conduct a basic design study on Urban Water Supply in Debub Region and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Eritrea a study team from August 11 to December 7, 2005 and January 14 to March 16, 2006.

The team held discussions with the officials concerned of the Government of Eritrea, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Eritrea in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the State of Eritrea for their close cooperation extended to the teams.

July, 2006

Masafumi Kuroki
Vice President
Japan International Cooperation Agency

July, 2006

Letter of Transmittal

We are pleased to submit to you the basic design study report on Urban Water Supply in the Debub Region.

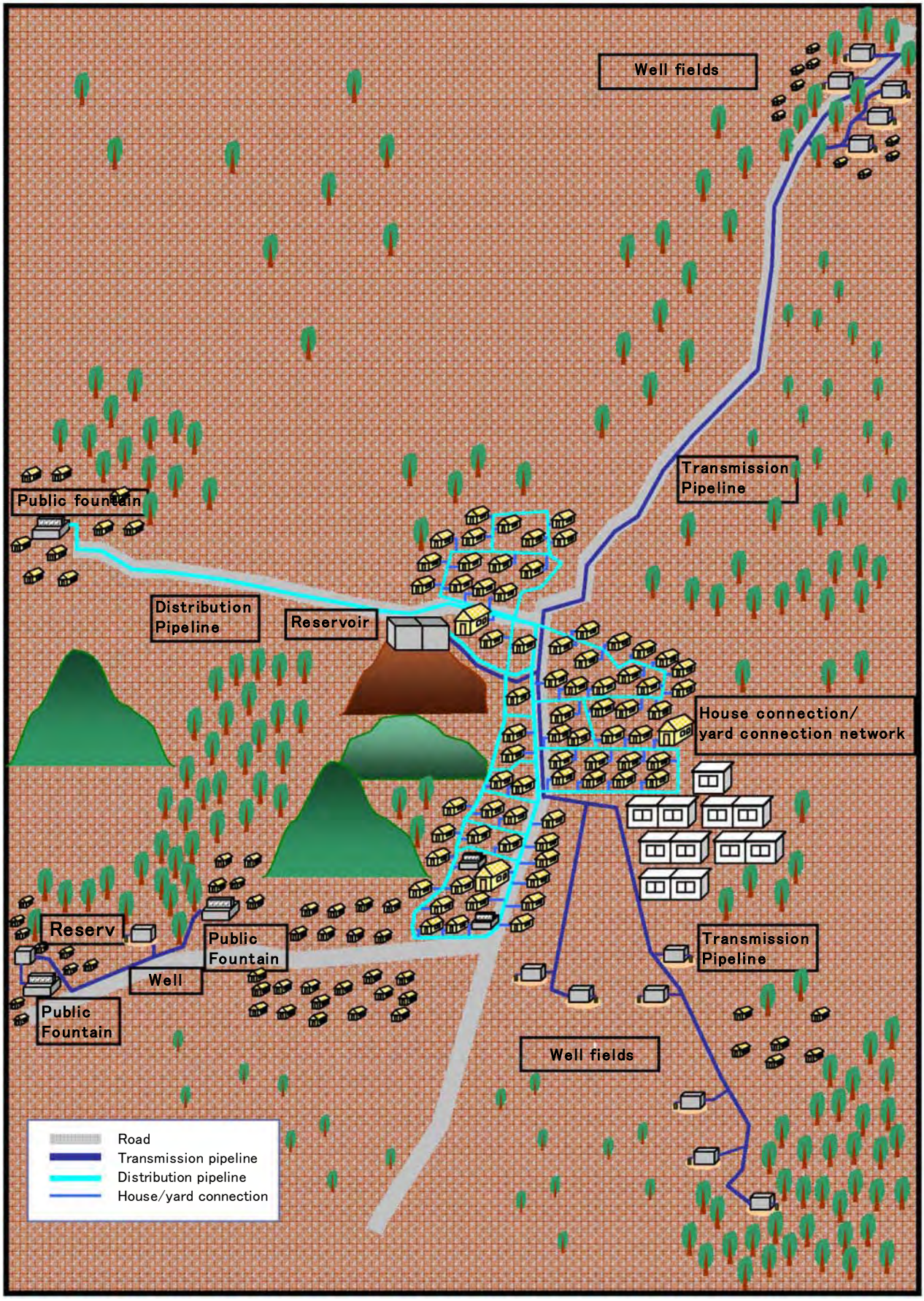
This study was conducted by Nippon Koei Co., Ltd., under a contract to JICA, during the period from August 11 to December 22, 2005 and from January 14 to March 16, 2006. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Eritrea and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Masanobu Sakamoto
Project Manager
Basic design study team on Urban Water Supply in Debub Region
Nippon Koei Co., Ltd.

Location Map



PERSPECTIVE

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Abbreviations

AfDB	African Development Bank
ECDF	Eritrean Community Development Fund
EDA	Eritrean Demining Authority
EE	Environmental Evaluation
EECF	Environmental Evaluation Clearance Form
EEQ	Environmental Evaluation Questionnaire
EU	European Union
E/N	Exchange of Notes
F/S	Feasibility Study
GTZ	Deutsche Gsellshaft fur Technische Zusammenarbeit
ICRC	International Committee of the Red Cross
IMAS	International Mine Action Standard
JICA	Japan International Cooperation Agency
KfW	Kreditansalt fur Wiederaufbau
LIS	Landmine Impact Survey
MACC	Mine Action Coordination Center
MDG	Millennium Development Goal
MoF	Ministry of Finance
MoLG	Ministry of Local Government
MoLWE	Ministry of Land, Water and Environment
MoND	Ministry of National Development
Nkf	Nakfa
NGO	Non-Governmental Organization
PMU	Project Management Unit
PRSP	Poverty Reduction Strategy Paper
TSZ	Temporary Security Zone
UNDP	United Nations Development Program
UNICEF	United Nations Children's Fund
UNMEE	United Nations Mission in Ethiopia and Eritrea
WRD	Water Resources Department
WSS	Water Supply Services

Unit

Length	mm	=	millimeter
	cm	=	centimeter
	m	=	meter
	km	=	kilometer
	ft	=	feet
Area	cm^2	=	square centimeter
	m^2	=	square meter
	km^2	=	square kilometer
Volume	cm^3	=	cubic centimeter
	m^3	=	cubic meter
	l or lit	=	liter
Weight	mg	=	milligram
	g	=	gram
	kg	=	kilogram
Tense	/s	=	per second
	/min	=	per minute
	/hr.	=	per hour
Currency	Nfa	=	Nakfa
Others	mg/L	=	milligram per liter
	%	=	percent
	Ph	=	potential of hydrogen
	°C	=	degrees Celsius
	ppm	=	parts per million
	micro S/cm	=	micro siemens per centimeter

Exchange Rate as of the end of February 2006

1 US$ = 15.00 Nakfa = 117.13 Japanese Yen

Summary

SUMMARY

1. Present Issues

The State of Eritrea, hereinafter referred to as Eritrea, is located in the north-eastern area of the African continent and faces the Red Sea and has an area of 117,600 km^2. The population is 4.3 million and GDP per capita was USD 1000 in 2005. Industry is made up of 8.7% primary industry, 26.3% secondary industry, and 65.0% tertiary industry.

The present water supply service rate in regional urban centers is approximately 50% on average, while the national average is 30%. However, around 80% of the rural area population still uses unhygienic water such as from hand dug wells.

Conflict with Ethiopia occurred from 1998 to 2000. Refugees moved from the border areas to regional urban centers and the population in those areas increased rapidly. As a result, the water supply situation has further deteriorated. In addition, there has been little rainfall since 1999 and the drought in 2002/2003 caused decreasing groundwater levels and this resulted in the existing wells drying up.

The Government of Eritrea formulated a "National Water Supply & Sanitation Action Plan (2004-2007)" to supply 15 liters/day/capita of safe water for 1.38 million people affected by the drought. UNICEF and the Water Resource Department (WRD) under the Ministry of Land, Water and Environment prepared urgent countermeasures. They purchased water tankers and conducted hydro-geological surveys (test drilling and electrical prospecting), rehabilitation and construction of ponds, reservoirs, and small dams, along with capability building for the WRD staff. The Eritrean Community Development Fund (ECDF) is constructing water supply facilities for the three towns excluding Dekemhare. However, the construction has not been completed due to fund deficiencies. The access rate for clean water in the four towns is 22.1%, which is low compared with other regional urban towns.

2. Background of the Project

Conflict with Ethiopia affected to serious impact for the Eritrean economy and industry. It also affected to the water supply and sanitation facilities in local areas, those facilities were remarkably deteriorated due to insufficient management. Under such situation, the Government of Eritrean requested the Government of Japan to implement the development study for seven towns in Debub Region. The Japan International Cooperation Agency (JICA) implemented the "Study on Groundwater Development and Water Supply for Seven Towns in Southern Region of Eritrea" between 1997 and 1998. These seven towns had water supply facilities that had been constructed in Italian administration days. However, these facilities had significantly deteriorated such that the water supply volume was now limited to between 4.9 to 13.5 liters/day/capita. The study team had prepared a water supply and sanitation facilities development plan for 2005, 2010, and 2015. The plan consisted of water source facilities, transmission and distribution pipeline facilities, public fountains, house connections, and sanitation facilities. The Government of Eritrea requested a grant aid project for water supply and sanitation facilities construction based on the development study results in October 1998. This request was suspended due to a conflict with Ethiopia at the southern border area. The area situation had been largely changed due to destroy of the water supply facilities, occurrence of refugees, acceptance of residence for retired solders, and heavy drought. JICA conducted the preliminary survey in February and March 2005 to confirm each town's situation and safety conditions such as mines and unexploded bomb.

Based on the preliminary study results, JICA dispatched the first basic design study mission from August

11th, 2005 to December 22nd, 2005 and the second mission from January 14th, 2006 to March 16th, 2006 respectively. The mission conducted the basic design work in Japan and they explained the draft final report in Eritrea from May 28th, 2006 and June 4th, 2006. They discussed with the Eritrean side about the report contents and the both sides agreed mutually.

3. Contents of the Requests and Determination of the Basic Design Study Contents

As the result of the study, the Study team excluded two towns that had a safety problem and other two towns where the necessity of the project had become low because of the assistance by the other donors. On the other hand, one town was added since the Eritrean side strongly requested and its necessity was recognized. Consequently, the basic design study was to be conducted in four towns. It was confirmed for four towns that safety problem was insignificant and water supply conditions were very poor, especially lack of water source was very serious. It was agreed with the Eritrean side that the target year set at 2015 with revision of the served population and access rate for clean water.

4. Project Contents

(1) Objectives

The Project objective is to improve the living environment for the local population in the four towns of Debarwa, Dekemhare, May-dima, and Adi Keyih with a target year of 2015. This will be achieved by providing clean and safe water and improving sanitary conditions through the construction of water supply facilities. Besides, the Project increases water access rate of the area from 22.1% to 100.0%.

(2) Design Policy

1) Design Water Supply Volume

The unit demand for domestic water for each type of water supply is: 1) house connections (50 liters/day/capita), 2) yard connections (30 liters/day/capita), and 3) public fountains (20 liters/day/capita). The industrial and commercial water demand has been calculated by multiplying the water demand in 2005 (estimated in the baseline survey) by the incremental population ratio. The rate of unaccounted for water applied is 15% of the domestic and other water demand.

Design Water Supply Volume

Item	Debarwa	Dekemhare	May-dima	Adi Keyih
Domestic water volume	1,061	1,226	529	1,632
Other water volume	628	1,159	58	1,002
Unaccounted for water (15%)	253	358	88	395
Total (m^3/day)	1,942	2,743	675	3,029

2) Water source development

Test drilling has been conducted at 40 sites in the four towns in order to determine the groundwater volumes in the project area. Boreholes with a yield of more than 5 m^3/hour are to be constructed for Debarwa, Dekemhare, and Adi Keyih for house and yard connections. A borehole with a yield of more than 2 m^3/hour is to be constructed for May-dima for a public fountain because May-dima is different from the other towns in that it has a different scale of served population, scattered houses, and a water fee is payable.

3) Project benefits by 2015

The Water Supply Service (WSS) in each town constructs the service pipes after completion of the Project. It is understood that it takes six to seven years to connect all customers through construction of the service pipes. The Project shall consider how local residents, who do not connect to the service pipe, can fetch water and how the project can provide a benefit to these residents. In order to overcome this issue, public fountains are to be provided such that residents can access water all the time.

4) Use of the commercial electricity for pumps

Fuel cost is extremely expensive, gasoline 295 Yen/lit, diesel oil 130 Yen/lit, and fuel supply may not be stable in Eritrea. Commercial power supply cost is approximately 44 to 63% less expensive, comparing with operation cost of pump equipment between diesel generator and commercial electricity supply for Debarwa, Dekemhare and Adi Keyih. Therefore, the commercial power supply is applied to this basic design.

5) Installation of disinfection equipment

The water source is required to have chlorination treatment. Disinfection equipment is provided in order to supply hygienic water. Chlorination is to be applied by using water flow injection, which does not use electricity.

6) Water supply facilities plan

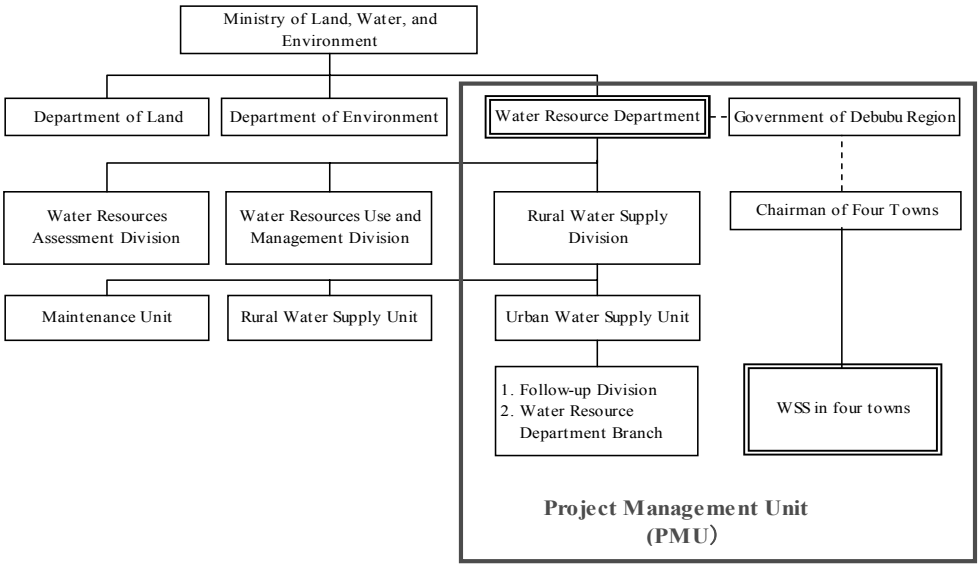
Water supply facilities of the four towns are designed to follow the design policies mentioned above.

Water Supply Facilities Plan under the Project

Facility	Unit	Debarwa	Dekemhare	May-dima	Adi Keyih
1) Test drilling deep-well and pump facilities	Number	4	4	1	4
2) Newly developed deep-well and pump facilities	Number	10	0	13	7
3) Replacement of the existing pumps	Number	0	4	1	0
4) Booster pump	Number	0	0	0	1
5) Transmission pipeline	km	25	24	15	20
6) Reservoir	Number m^3	2 500/50	1 1,100	1 300	2 700/50
7) Distribution pipeline	km	9	14	4	0
8) Public fountain	Number	9	16	9	10

(3) Project implementation system

A Project Management Unit (PMU) will be established so that WSS and related agencies can manage the sustainable water supply business in the construction stage, the technical support stage for operation and maintenance, and the monitoring stage of operation and maintenance work. The PMU will be composed of staff from WRD, Debub regional government, and WSS in the four towns. The WRD becomes the operational organization.



Project Implementation System

The Project is to be implemented under the supervision of the WRD director. WRD regional office staff will be responsible for the actual work as representatives of the director. The "soft" components of the scheme are to be conducted for WSS staff in the four towns. Experts will train WSS key staff and operation and maintenance staff for the substantial operation and maintenance work associated with the water supply facilities, under the supervision of MoLWE and Debub regional government.

(4) Soft-component scheme

House connections have already been implemented in Debarwa, Dekemhare, and Adi Keyih. However, the high rate of unaccounted for water is an important issue due to the inexperienced operation and maintenance of the system and the deterioration in the water supply facilities. The water supply service staff of each town performs the routine daily activities and has a basic knowledge of the system. However, they do not have an overall knowledge concerning the water supply business activities and financial management. It is important to develop the capacity of the staff in relation to trouble shooting and management improvement.

The soft-component scheme sets an objective to improve capability of staff of WSS in the respective towns, in order to cope with the aforesaid major issues; namely, 1) improvement of techniques for repair and replacement of service pipes for reduction of unaccounted for water, and 2) preparation of short and mid term business plans till 2015 after completion of the Project.

1) Training for strengthening the technical capabilities especially leakage control of the staff

In the course of the training, the following issues will be done through the workshop, using a manual to be prepared under the soft-component scheme:

1) Method for identifying leakage points along pipeline including including examples,
2) Reparing method,
3) Required materials and equipment, and their standard,
4) Requirements for customers data base relevant to secondary and services pipe network including pipe diameter, condition of water meter, and so on.,
5) Survey method for condition of pipelines, especially for deterioration of service pipes, and necessity of replacement, and

6) Check of irregal connection in the network.

2) Training and support for preparation of business plan after completion of the Project towards 2015

The training is carried out through the workshop. The workshop is planned to include; 1) analysis and study for problems about operational and financial aspects, 2) planning measures for improvement and countermeasures, 3) preparation of action plan, and 4) trainings based on the business plan preparation manual prior to the construction works. The expert also monitors the progress of the preparation and analizes problems between planned situation and actual one. The expert will recommend a countermeasures for improving situation.

(5) Project implementation period

The detailed design is to be implemented in 2006 and the construction work will commence from 2007. The deep-well development is to be carried out in the construction stage. Initially the water source is to be secured, and then construction of the main civil works, intake pump facilities, pipeline works, reservoir, and public fountain will be commenced. The implementation program is composed of detailed design/bidding preparation for 10 months after E/N signing, followed by construction and soft-component implementation for 22.5 months. The total project implementation period is 32.5 months.

5. Project Cost

The project cost is estimated to be approximately JPY 1,597 million under Japan's Grant Aid scheme. Japanese side bears approximately JPY 1,591 million and the Eritrean side bears JPY 6 million. The Government of Eritrea shall be responsible for provision of the counterpart staffs, coordination with other organizations, and provision of the land and material stock yard.

6. Project Effects

The served population is forecast to increase from 20,000 in 2005 to 150,000 in 2015, which is the target year of the Project. Further, the access rate for clean water is planned to increase from 22.1 % in 2005 to 100% in 2015.

Served population and access rate for clean water of each town in 2005 and 2015

Item	Town	Figures in 2005	Figures in 2015	
			Without project	With project
1. Served population	Debarwa	4,311	4,311	30,497
	Dekemhare	9,319	9,319	47,983
	May-dima	2,537	2,537	25,962
	Adi Keyih	4,236	4,236	46,459
	Total	20,403	20,403	150,901
2. Access rate for clean water	Debarwa	24.9%	14.1%	100.0%
	Dekemhare	32.8%	19.4%	100.0%
	May-dima	14.8%	9.8%	100.0%
	Adi Keyih	14.2%	9.1%	100.0%
	Total	22.1%	13.5%	100.0%

Operation and maintenance capabilities of the WSS in the four towns increase after the soft-component scheme activities.

a) Technical staffs of each WSS can solve leakage from distribution and service pipe promptly and properly.

b) The WSS staffs who make the business plan can formulate the adequate annual business plan including equipment investment and staff increasing.

THE BASIC DESIGN STUDY
ON
THE PROJECT
FOR
URBAN WATER SUPPLY IN DEBUB REGION

FINAL REPORT

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Chapter 1
Background of the Project

Chapter 1 Background of The Project

Conflict with Ethiopia has had a serious impact on the Eritrean economy and industry. It also affected the water supply and sanitation facilities in local areas and those facilities have deteriorated seriously due to insufficient management. The Government of Eritrea therefore requested that the Government of Japan implement a development study for seven towns in the Debub Region. The Japan International Cooperation Agency (JICA) implemented a "Study on Groundwater Development and Water Supply for Seven Towns in the Southern Region of Eritrea" between 1997 and 1998. These seven towns had water supply facilities that had been constructed during the days of Italian colonial administration. However, these facilities had significantly deteriorated such that the water supply volume was now limited to between 4.9 and 13.5 liters/day/capita. The study team had prepared a water supply and sanitation facilities development plan for 2005, 2010, and 2015. The plan consisted of water source facilities (groundwater development by 2010 and surface water or underground dam development by 2015 in some places), transmission and distribution pipeline facilities, public fountains, house connections, and sanitation facilities.

Based on the result of the above study, the Government of Eritrea requested that the Government of Japan provide a grant aid project. The contents of the request were as follows:

Request date	: August, 1998	
Request amount	: 23 billion Yen	
Requested facility	: Well construction	: 17
	Transmission pipe line	: 34 km
	Booster pumps	: 8
	Reservoirs	: 9
	Distribution pipe line	: 154 km
	House connections	: 10,348
	Public fountains	: 80

The request was suspended due to the conflict with Epiothia at the border areas of the Debub Region. Afterwards, each city's situation changed significantly because of the violation of water supply facilities through the conflict, the occurrence of refugees as well as the settlement of returned people and soldiers. In response to the request, JICA conducted a preliminary study in order to confirm the current situation of the seven object cities and safety conditions, such as the existence of landmines. As a result of the study, the Study team excluded two towns that had a safety problem and another two towns where the priority for a project had become low because of assistance by other donors. On the other hand, one town was added as the result of a strong request by the Eritrean side, and the necessity of a project there was recognized. Consequently, the basic design study was to be conducted in four towns. It was confirmed for the four towns that the safety problem was insignificant and that water supply conditions were very poor, and in particular, the lack of a water source was very serious.

Chapter 2
Contents of the Project

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

There are low water supply ratios in the four towns (22.1%), as shown in the table below. This is caused by insufficient groundwater development and a delay in the development of water supply facilities. Local residents pay high prices for water supplied by water tanker (seven times more expensive than house connection fees). Alternatively, local residents have to use river water which is unhygienic.

Table 2.1 Current Mode of Water Use in the Four Towns

Town	Item	Number of households and water supply ratio		
		House / Yard connection	Public fountain	Total
Debarwa	Number of Households	142	839	981
	Percentage (%)	3.6%	21.4%	24.9%
Dekemhare	Number of Households	737	1,419	2156
	Percentage (%)	11.2%	21.6%	32.8%
May-dima	Number of Households	0	577	577
	Percentage (%)	0.0%	14.8%	14.8%
Adi Keyih	Number of Households	919	3	922
	Percentage (%)	14.2%	0.0%	14.2%

Source：Baseline survey results conducted by the JICA Study Team in December 2005

The Government of Eritrea has formulated an urgent action plan for national water supply and sanitation (2004-2007) in order to supply water for approximately 1.38 million people who suffer from drought. The plan aims to supply safe water for 60% of whole rural area population, which is a part of the national development target. UNICEF and the Water Resource Department (WRD) of the Ministry of Land, Water and Environment (MoLWE) plan urgent countermeasures in order to improve the nationwide water shortage problem, especially in the regional district areas. The countermeasures consist of the procurement of water tankers, hydro-geological surveys (test drilling and electric prospecting), rehabilitation and construction of ponds, reservoirs, and small dams, rehabilitation and construction of transmission and distribution pipelines, and capacity building of the WRD staff. The Eritrean Community Development Fund (ECDF) formulated the projects in Debarwa, May-dima, and, Adi Keyih, however, these projects have not been implemented to their full scope due to a lack of project finance.

The Japan International Cooperation Agency (JICA) implemented the “Study on Groundwater Development and Water Supply for Seven Towns in Southern Region of Eritrea” between 1997 and 1998. These towns have water supply facilities that were constructed in Italian administration days. These facilities have significantly deteriorated such that the water supply volume is now limited to between 4.9 to 13.5 liters/day/capita. The study team has prepared a water supply and sanitation facilities development plan for 2005, 2010, and 2015. The plan consists of water source facilities (groundwater development by 2010 and surface water or underground dam development by 2015 in some places), transmission and distribution pipeline facilities (including public fountains and house connections), and sanitation facilities. A portion of the water supply facilities plan has been implemented by the ECDF, however not all of the facilities have been constructed.

The Project aims to improve the living environment for the local population in four towns in the Debub Region through groundwater development and the construction of water supply facilities. These factors are indispensable for the Government of Eritrea in order to complete the above plan, and therefore the appropriateness of the Project is very high.

The Project will involve the construction of water supply facilities as shown in the table below. In addition, technical training for the Water Supply Service (WSS) staff, through the soft-component scheme, will be implemented in order to realize the sustainable nature of the project. The Project will reinforce the operations and maintenance capabilities of the staff.

Table 2.2 Water Supply Facilities Plan under the Project

Facility	Unit	Debarwa	Dekemhare	May-dima	Adi Keyih
1) Deep-well and pump facilities	Number	14	4	14	11
2) Replacement of the existing pumps	Number	0	4	1	0
3) Booster pump	Number	0	0	0	1
4) Transmission pipeline	km	25	24	15	20
5) Reservoir	Number m^3	2 500/50	1 1,100	1 300	2 700/50
6) Distribution pipeline	km	9	14	4	0
7) Public fountain	Number	9	16	9	10

The Project Design Matrix (PDM) is shown in Table 2.3.

Table 2.3 Project Design Matrix (PDM)

Project Summary	Measurement indicators	Means of verification	External conditions
Overall Goal To improve the hygienic environment in Debarwa, Dekemhare, May-dima, and Adi Keyih Town	a) To decrease water-borne diseases in four towns b) To achieve a sustainable increase in the population served in the long term.	a) Monitoring survey results after project implementation b) Data from the Ministry of Health c) Statistical data	The Government of Eritrea does not change the operation and maintenance system and basic policies concerning the urban water supply project.
Project objectives To improve the water supply conditions in the project area	a) Served population b) Water supply volume c) Water supply ratio (Usage ratio of water supply facilities) d) Operation and maintenance situation of the agencies	a) Monitoring survey results after project implementation b) Annual reports of the water supply services in the four towns c) Operation records of the water supply facilities d) Financial and accounting records	The wells for water resources do not dry up.
Outputs a) Construction of water supply facilities in the project area b) Improvement of the operation and maintenance capacity in the four towns	a) Number of deep-wells b) Water supply area c) Financial indicators for the water supply services in the four towns	a) As-built drawings b) Annual reports of the water supply services in the four towns	WRD does not change the support system for the regional urban water supply project The trained WSS staffs do not resign their jobs.
Activities Japanese Side Facilities construction Construction of the water supply facilities for the four towns (Deep-wells, Pipelines, Reservoirs, Pump equipment, and Public fountain) Eritrean Side Facilities construction Land acquisition for the facilities construction, Tax exemption for the procurement of materials and equipment, Monitoring of the project, and Support for WSS	Input Japanese Side Basic design Team leader/Water supply plan : 3.1M/M Groundwater development expert : 3.2M/M Electrical prospecting/ test drilling survey expert : 3.3M/M Social surrey/ Operation and maintenance plan/ Social environment expert : : 2.7M/M Water supply facilities design/ Construction plan expert : 2.2M/M Cost estimator : 1.8M/M Facilities Water supply facilities for the four towns (Deep-well, Pipelines, Reservoir, Pump equipment, and Public fountain)	Eritrean Side Staff (WRD, WSS of four towns) a) Project manager (1 person) b) Project coordinator (4 persons) c) Hydro-geologist (4 persons) d) Water supply facilities designer (4 persons) Construction a) To secure the construction area (WSS) b) To support the operations and maintenance system (WRD)	Precondition The required amount of water resource is secured from the wells.

2-2 Basic Design of the Required Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Planning Principles (Water Supply Plan)

Test drilling was conducted at 40 sites in the four towns in order to determine the groundwater volumes in the project area. The sites were determined through an electrical prospecting study. It is confirmed that

more than 50% of the boreholes in Debarwa, Dekemhare, and Adi Keyih Towns have groundwater yield of more than 5 m^3/hour. Though a borehole with a groundwater volume of more than 5 m^3/hour could not be found in May-dima Town, it can have groundwater yield of more than 2 m^3/hour. The residential area in May-dima Town is scattered and the population served is around 15,000 persons so the project objective is to develop boreholes, which has a groundwater yield of 2 m^3/hour, and public fountains.

The water supply plan is based on the planning principles below.

(1) Principles for the target year

The Project objective is to improve the living environment for the local population in the four towns of Debarwa, Dekemhare, May-dima, and Adi Keyih with a target year of 2015. This will be achieved by providing clean and safe water and improving sanitary conditions through the construction of water supply facilities such as deep-wells, pump facilities, transmission pipelines, reservoirs, distribution pipelines and public fountains. Besides, the Project increases water access ratio from 22.1% to 100.0% of the area.

(2) Principles for domestic water supply demand and water distribution demand projection

The domestic water supply demand was determined based on the master plan study, which was conducted by the JICA in 1998, and the Mendefera Town master plan study, which was conducted by the KfW. The mode of water distribution is a combination of 1) house connection, 2) yard connection, and 3) public fountain.

(3) Principles for industrial and commercial water demand projection

The industrial and commercial water demand is calculated by multiplying the water demand in 2005 (estimated in the baseline survey) by the incremental population ratio. Large scale factories which have their own well are excluded from the industrial water demand.

(4) Anticipated project benefit by 2015

The main construction works are to be completed by June 2009 in Debarwa, August 2008 in Dekemhare, March 2009 in May-dima, and August 2008 in Adi Keyih. The WSS in each town will construct the service pipes after the completion of the Project. It is understood that it takes six to seven years to connect all customers through construction of the service pipes. The Project shall consider how local residents, who do not connect to the service pipe, can fetch water and how the project can provide a benefit to these residents. In order to overcome this issue, public fountains are to be provided such that residents can access water all the time.

(5) Use of the commercial power supply for pump equipment

Fuel cost is extremely expensive, gasoline 295 Yen/lit, diesel oil 130 Yen/lit, and fuel supply may not be stable in Eritrea. Commercial power supply cost is approximately 44 to 63% less expensive, comparing with operation cost of pump equipment between diesel generator and commercial electricity supply for Debarwa, Dekemhare and Adi Keyih. Therefore, the commercial power supply is applied to this basic design. The distribution power line is installed from the power line network for the existing pump facilities in Debarwa, Dekemhare and Adi Keyih. In case that the Eritrean side constructs the power distribution, the construction cost JPY 84 million is huge in comparison with annual budget of WRD (JPY 40 million) and each WSS (JPY 7

million each). As the result, it is difficult to complete the power distribution construction within the construction period and the project benefit may not appear clearly after the main construction works. It is therefore that the power distribution construction will be done by the Japanese side.

(6) Use of the disinfection equipment

Disinfection equipment will be planned to supply safe water. Chrolination is poured by water flow power, which does not use electricity.

2-2-1-2 Design Principles for Natural Conditions (Groundwater Development)

(1) Borehole drilling areas and the percentage of success

The groundwater development areas were decided based on the hydro-geological structure of the successful boreholes, the watershed, and the topographic conditions. The conditions are listed below:

1) Areas with thick alluvial soil used for agricultural land or pasture.
2) Areas where mountains and narrow path exists.
3) Areas which owns valley upstream and surrounded by several valleys

The drilling sites and the percentage of success for the borehole development were as follows:

Table 2.4 The Percentage of Success for the Borehole Development

Town	Drilling sites	Applied percentage during implementation
Debarwa	Shikety village area	80%
	Debarwa south-east area	60%
	Watot village area	80%
Dekemhare	Not necessary	―
May-dima	River basins at the May-dima Town	60%
Adi Keyih	Two valleys area at north-west of Adi Keyih Town	80%

(2) Principles for electrical prospecting

The basic design study used the “Pole-pole method” for two-dimensional electrical prospecting. This method has the following features:

1) The survey period is shorter than the other methods,
2) This method can measure up to 200 m depth, and
3) This method is not suitable for complicated geological conditions.

The basic design study used the pole-pole method because the study needed to complete 90 survey routes within a limited time and identify the areas where groundwater exists. It will be necessary to increase the percentage of success for the borehole development during the implementation stage. Therefore, in the implementation stage the “Wenner method” or the “Schlumberger method” will be applied for two-dimensional electrical prospecting. It is noted that the Wenner method or the Schlumberger method will take approximately three times longer than the pole-pole method. Therefore, a sufficient survey period or multiple survey teams will be required.

(3) Criteria for the successful borehole

The Project is required in order to construct water supply facilities for house connections or yard connections to secure a stable water source in terms of water quality and quantity in Debarwa, Dekemhare, and Adi Keyih Towns. May-dima Town is different from other towns in terms of population, residential area locations, and capability of paying water fees. Therefore, water will be supplied by public fountains in May-dima. The following yield criteria were set for the Study:

1)	Debarwa, Dekemhare, Adi Keyih	:	Standard yield	More than 5 m3/hour
2)	May-dima	:	Standard yield	More than 2 m3/hour

The WHO water quality standard was adopted as the water quality standard in Eritrea. The quality of the borehole water was analyzed in relation to the WHO standard. According to the water quality analysis results, all of the boreholes satisfy the chemical water quality requirements and can be used as water sources. It is noted that coliforms and bacteria were detected from the boreholes. Chlorination treatment, therefore, is planned to be conducted for the source water.

(4) Timing of pumping test

The drilling and pumping tests showed that the static groundwater level and yield fluctuated, largely as a result of the wet and dry seasons. Therefore, in the implementation stage the pumping test will be conducted at the end of the dry season between March and May.

2-2-1-3 Design Principles for Socio-economic Conditions

The birthrate in Eritrea is approximately 2.5% of the population per annum. The average population growth rates for the four towns range between 2.5% and 5.0% over the last five years as they are affected by social circumstances such as refugee movement. Each town progresses the housing development at peripheral area.

These conditions are taken into account in determining water supply areas and water demand projection.

2-2-1-4 Design Principles for the Construction Method and the Construction Period

The construction period for the Project is based on the following conditions:

(1) As each town is located 50 km from the neighboring town, there is potential for administration cost increases for managing construction work. Therefore, construction work shall be conducted for the closest pairs of towns (Debarwa & May-dima and Dekemhare & Adi Keyih). This will save transportation time and administration costs for the construction works and achieve more effective construction.

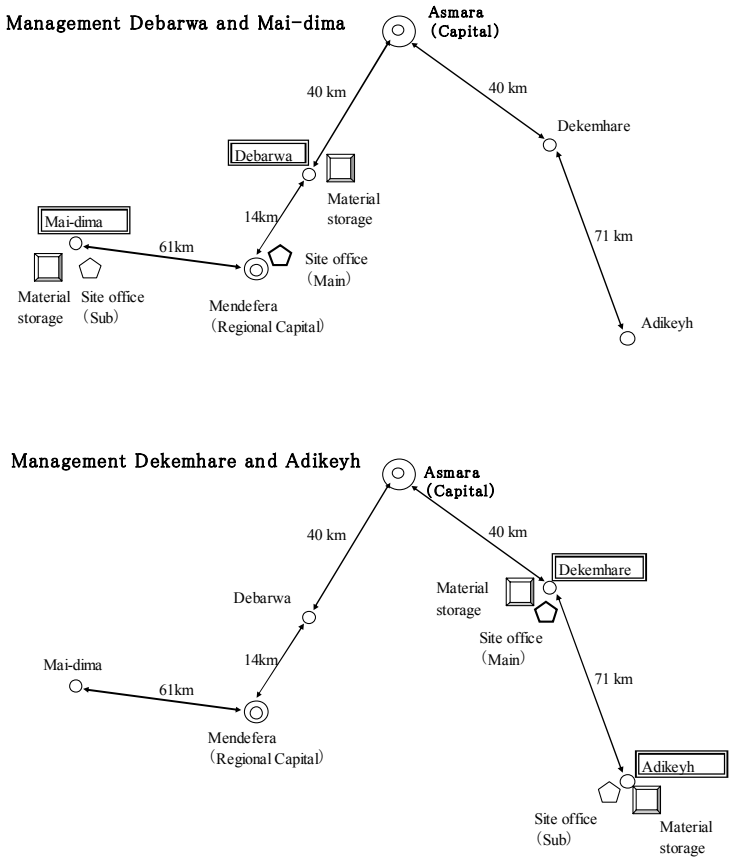


Figure 2.1 Construction Works Operation Plan

(2) The total length of transmission and distribution pipeline is around 20 km to 30 km in each town. Therefore this construction work becomes the critical path in the construction schedule. The construction period is based on four teams working in each town and the construction being carried out in two towns at the same time. The cost estimate follows the JICA guidelines. This is the best case taking into consideration the capabilities of the local contractor's.

(3) The rainy season is July and August in the Project area and the dry season starts around September. The pumping test shall be conducted at the end of the dry season from March to May in order to measure the yield and static water level in the dry season.

(4) The power supply to the pumping facility is the responsibility of Eritrea. Fuel is costly in comparison to electricity and therefore commercial electricity is adopted as the power supply source. May-dima does not have a power supply facility and there are no plans to construct one. Therefore, a diesel generator will be used in May-dima. Adi Keyih Town needs to reinforce their power supply capacity. According to the hearing survey, they plan to increase the power supply capacity by June 2008 including expansion of power supply area to Hawatsu. It is satisfactory if the Project is implemented after the power supply capacity has been increased.

The detailed design is to be implemented in 2006 and the construction works will commence from 2007. The deep-well development will be carried out in the construction stage. Initially the water source will be secured, and then construction of the main civil works, intake pump facilities, pipeline works, reservoir, and public fountain will be commenced.

2-2-1-5 Design Principles for Procurement of Equipment

The Project does not include the procurement of equipment for the purpose of operation and maintenance of the constructed facilities.

2-2-1-6 Design Principles for the Operations and Maintenance Capacity Building

The existing water supply facilities are operated and maintained by the Water Supply Service (WSS) in each town. Three of the towns (excluding May-dima) supply water by house connections, yard connections and public fountains. The water supply ratio is around 15% to 50% and a high ratio of unaccounted for water occurs due to deterioration of the facilities. Capacity building of the WSS staff is required in order to enable sustainable business operation and improve the water supply ratio by 2015. Although May-dima already has public water fountains in three locations, no training has been conducted by the donors. It is important for the May-dima WSS to strengthen their operation and maintenance techniques.

The WSS's (excluding May-dima) manage the customer data and conduct meter reading, water fee calculations, claims, receipts, financial management, and facilities repair. However, current management processes simply follow WRD specifications and do not conduct accounting management and financial management for the business. In addition, WSS engineers and technicians undertake facility repairs simply based on previous experience and need to develop their schematic knowledge. In May-dima, the WSS only carries out water fee collection and does not undertake any other management processes.

The Project will implement training programs under the soft-component scheme in order to improve the capabilities of the WSS staff especially for the following:

- technics for repair pipelines for the purpose of reduction of UFW and
- business management (financial management and annual business planning)

2-2-2 Basic Plan

2-2-2-1 Water Supply Area

The water supply areas are within approximately two to three kilometers of the existing town centers (refer to Figure 2.2 to Figure 2.5).

2-2-2-2 Population Served

The population to be served in each water supply area in 2015 is shown in the table below, which was estimated based on the baseline survey results:

Table 2.5 Design Population to be Served in 2015 in Each Town

Deberwa	Population	Dekemhare	Population	May-dima	Population	Adi Keyih	Population
Zone 01	8,521	Dekemhare	3,494	Adi Ghaba	21,615	Hadamu	6,095
Zone 02	4,119	Maiwerki	6,861	Hadish Adi	1,522	Haineba	11,839
Zone 03	12,880	Amhur	12,151	Milad-manta	1,970	Heshemele	8,834
Adi Gheda	3,030	Hadamu	8,819	Mai chew	855	Unabur	12,889
Adi Logo	1,846	Metsale	16,658			Ma'alewya	3,611
Halhale	101					Tekendae	3,191
Total	30,497	Total	47,983	Total	25,962	Total	46,459

Note: Each figure is the baseline survey result determined by the basic design study team

2-2-2-3 Supply Amount and Water Demand

(1) Domestic water

The domestic water supply demand was based on 1) house connection: 50 liters/day/capita, 2) yard connection: 30 liters/day/capita, 3) public fountain: 20 liters/day/capita based on the results of the "Study on Groundwater Development and Water Supply for Seven Towns in Southern Region of Eritrea" conducted by the JICA and the study of Mendefera Town in the Debub Region capital.

The mode of water distribution in each area was estimated from the results of the baseline survey. In principle May-dima supplies water by public fountain and yard connections are provided in the central area.

Table 2.6 Mode of Water Distribution in Each Town in 2015

Town	Type	Area	Percentages		
			House connection	Yard connection	Public fountain
Debarwa	Center area	Zone 01	43.0%	53.2%	3.8%
		Zone 02	39.0%	54.0%	7.0%
		Zone 03	40.0%	54.5%	5.5%
	Peripheral area	Adi Gheda	0.0%	0.0%	100.0%
		Adi Logo	0.0%	0.0%	100.0%
		Halhale	0.0%	0.0%	100.0%
Dekemhare	Center area	Dekemhare	61.7%	29.6%	8.7%
		Maiwerki	33.0%	26.2%	40.8%
	Peripheral area	Amhur	0.0%	0.0%	100.0%
		Hadamu	29.6%	30.6%	39.8%
		Metsale	0.0%	0.0%	100.0%
May-dima	Center area	Adi Ghaba	0.0%	4.3%	95.7%
		Hadish Adi	0.0%	2.0%	98.0%
	Peripheral area	Maichew	0.0%	0.0%	100.0%
		Milad-manta	0.0%	0.0%	100.0%
Adi Keyih	Center area	Hadamu	40.1%	50.5%	9.4%
		Haineba	35.0%	41.8%	23.2%
		Heshemele	33.5%	31.0%	35.5%
		Unabur	73.0%	21.2%	5.8%
	Peripheral area	Ma'alewya	0.0%	0.0%	100.0%
		Tekendae	0.0%	0.0%	100.0%

The result of domestic water demand projection is given as follows:

Table 2.7 Domestic Water Demand in 2015

Town	Water demand in 2015 (m3/day)				
	House connection	Yard connection	Public fountain	Total	Rate for access to water (%)
Debarwa					
Zone 01	183	136	6	325	100
Zone 02	80	67	6	153	100
Zone 03	258	211	14	483	100
Adi Gheda	0	0	61	61	100
Ade Logo	0	0	37	37	100
Halhale	0	0	2	2	100
Total	521	414	126	1,061	100
Dekemhare					
Dekemhare	108	31	6	145	100
Maiwerki	113	54	56	223	100
Amhur	0	0	243	243	100
Hadamu	131	81	70	282	100
Metsale	0	0	333	333	100
Total	352	166	708	1,226	100
May-dima					
Adi Ghaba	0	28	414	442	100
Hadish Adi	0	1	30	31	100
Milad-manta	0	0	39	39	100
Maichew	0	0	17	17	100
Total	0	29	500	529	100
Adi Keyih					
Hadamu	122	92	11	225	100
Haineba	207	149	55	411	100
Heshemele	148	82	63	293	100
Unabur	470	82	15	567	100
Ma'alewya	0	0	72	72	100
Tekendae	0	0	64	64	100
Total	947	405	280	1,632	100

(2) Commercial and industrial water demand

The baseline survey investigated the commercial, industrial, and other water demand. The water demand for each item was modified from the survey figures based on the following factors; 1) factories, which have their own water source, were excluded from the industrial water demand, and 2) hospital water demand was adjusted based on the number of beds.

The water demand in 2015 was calculated by multiplying the water demand in 2000 by the population ratio.

Table 2.8 Other Water Demand in 2015

Debarwa	m3/day	Dekemhare	m3/day	May-dima	m3/day	Adi Keyih	m3/day
Zone01	203	Dekemhare	249	Adi Ghaba	49	Hadamu	149
Zone02	96	Maiwerki	384	Hadish Adi	3	Haineba	272
Zone03	303	Amhur	20	Milad-manta	4	Heshemele	195
Adi Gheda	10	Hadamu	486	Mai chew	2	Unabur	376
Adi Logo	10	Metsale	20			Ma'alewya	5
Halhale	5					Tekendae	5
Total	628	Total	1,159	Total	58	Total	1,002

(3) The ratio of unaccounted for water

There is insufficient information to determine the existing unaccounted for water in each town. It appears to be more than 50% due to pipeline deterioration (excluding May-dima). The JICA Study in 1998 and ECDF projects set the unaccounted for water at 15% after the project implementation. This Project follows the existing plans and sets the unaccounted for water at 15%.

(4) Total water demand

The total water demand in 2015 is as follows:

Table 2.9 Design Water Supply Volume in 2015 (m3/day)

Town	Area	Domestic	Others	UFW (15%)	Total
Debarwa	Zone 01	325	203	79	607
	Zone 02	153	96	37	286
	Zone 03	483	303	118	904
	Adi Gheda	61	10	11	82
	Ade Logo	37	10	7	54
	Halhale	2	5	1	8
	Total	1,061	628	253	1,942
Dekemhare	Dekemhare	145	249	59	453
	Maiwerki	223	384	91	698
	Amhur	243	20	39	302
	Hadamu	282	486	115	883
	Metsale	333	20	53	406
	Total	1,226	1,159	358	2,743
May-dima	Adi Ghaba	442	49	74	565
	Hadish Adi	31	3	5	39
	Milad-manta	39	4	6	49
	Maichew	17	2	3	22
	Total	529	58	88	675
Adi Keyih	Hadamu	225	149	56	430
	Haineba	411	272	102	785
	Heshemele	293	195	73	561
	Unabur	567	376	141	1,084
	Ma'alewya	72	5	12	89
	Tekendae	64	5	10	79
	Total	1,632	1,002	395	3,029

2-2-2-4 Estimation of Water Development Volume

(1) The number of new water sources to be developed

The Project includes the development of the following new deep-wells based on the existing well yields and pumping test results.

Table 2.10 The Number of New Deep-wells Developed through the Project (Unit: m3/day)

Water source	Debarwa	Dekemhare	May-dima	Adi Keyih
(1) Existing deep-well water supply volume	571	1,553	194	648
(2) New deep-well yield (test drilling results)	551	1,753	36	2,036
(3) Total yield: (1)+(2)	1,122	2,777	230	2,684
(4) Total water demand	1,942	2,743	675	3,029
(5) Newly developed volume: (4)-(3)	820	-34	445	345
(6) Yield per one deep-well	90	90	36	90
(7) Number deep-wells necessary (places): (5)/(6)	10	0	13	4

Note: Pump operation period is set at 18 hours in item (6)

2-2-2-5 Groundwater Development Plan

(1) Debarwa Town

Groundwater development will be undertaken in 1) Shikety Village area, 2) Debarwa south-east area, and 3) Watot Village area in Debarwa Town. Information on the proposed drilling sites is as follows:

Table 2.11 Proposed New Well Drilling Sites in Debarwa Town

Possible deep-well sites	No.	North Latitude	East Longitude	Description
Eastern side of Shikety Village	PBH-1	15°08′28.2″	38°52′07.3″	Narrowed area, beginning of the canal
	PBH-2	15°08′21.9″	38°52′09.7″	Narrowed area, along the canal
	PBH-3	15°08′16.3″	38°52′10.3″	Narrowed area, along the canal
	PBH-4	15°08′05.2″	38°52′13.8″	Narrowed area, along the canal
	PBH-5	15°08′06.6″	38°52′14.7″	Narrowed area, along the canal
	PBH-6	15°07′54.8″	38°52′14.8″	Narrowed area, along the canal
Western side of Shikety Village	PBH-7	15°08′52.7″	38°51′26.6″	Narrowed area
	PBH-8	15°08′53.1″	38°51′22.0″	Narrowed area
	PBH-9	15°08′42.7″	38°51′25.4″	Narrowed area
	PBH-10	15°08′36.5″	38°51′24.9″	Narrowed area
	PBH-11	15°08′24.8″	38°51′35.7″	Narrowed area
South-eastern side of Debarwa	PBH-12	15°04′46″	38°50′36″	Plain area
	PBH-13	15°04′31″	38°50′20″	Plain area
	PBH-14	15°04′37″	38°50′09″	Plain area
	PBH-15	15°04′25″	38°50′10″	Plain area
Watot Village area	PBH-16	15°03′38.7″	38°50′54.8″	Low-lying area, along the road
	PBH-17	15°03′29.3″	38°50′50.4″	Low-lying area, along the canal
	PBH-18	15°03′23.8″	38°50′47.3″	Along the canal
	PBH-19	15°03′34.9″	38°51′04.1″	Low-lying area, along the canal
	PBH-20	15°03′19.9″	38°50′55.0″	Low-lying area, agricultural land
	PBH-21	15°03′10.3″	38°50′50.3″	Agricultural land
	PBH-22	15°03′19.8″	38°50′24.4″	Slope area
South of Watot village	PBH-23	15°03′03.8″	38°50′56.7″	Low-lying area
	PBH-24	15°02′41.3″	38°50′07.7″	Along the canal
	PBH-25	15°02′25.6″	38°50′10.1″	Along the canal
	PBH-26	15°02′19.2″	38°50′10.6″	Along the canal

Note: PBH stands for proposed borehole site

Shikety Village is located eight kilometers north of Debarwa Town and it is situated alongside the national road. A huge valley extends from eight kilometers north of Shikety Village towards Debarwa Town. The valley is steep for the first four kilometers and then changes to relatively flat agricultural fields. The gentle agricultural fields expand downstream and then become narrow again. Many small valleys connect to this valley. Erosion occurs in the narrow agricultural areas, but disappears in the wide flat areas.

Both sides of the valley are surrounded by mountains and there are no canals flowing out of the valley. It appears that rainwater flows into the valley, infiltrates into the ground in the agricultural fields, and becomes groundwater. It is expected that the potential for groundwater is high.

Out of six proposed sites, three deep-wells are to be drilled. The proposed drilling sites are located along the narrow canal area at intervals of 300 m. The deep-well depth is designed to be 50 m as this is the same as the borehole depth in the Debarwa south-east area.

A plain area expands out from the western side of Shikety Village and three valleys are located upstream of this plain. A dam is constructed in one valley; however no water exists in this dam in the dry season. Deep-wells and shallow wells have been developed in the downstream plain area. Domestic water is supplied from these wells. The groundwater level in the shallow wells reaches ground level even in dry season. The surrounding areas are grass fields and it appears that there is an abundance of groundwater. The drilling sites are proposed at five points at 300 m intervals where the valley is narrow and hills exist on the south side. Out of the five sites, three boreholes are to be drilled.

The Debarwa south-east area is surrounded by small hills and the Ruba Mereb River. BH-7 and BH-18, which do not dry up in the dry season, exist in this area. The three boreholes have enough groundwater and the potential for groundwater is high. Four drilling sites are proposed and one borehole is to be drilled.

Watot Village and its surroundings, and the area to the south which includes Adi Logo Village and Adi Gheda Village, consists an area of huge plain fields. Many ponds and shallow wells have been provided and irrigation is possible area in the dry season. This means that alluvial soil and weathered stone layers reserve water into the stratums and groundwater flows downstream into the Ruba Mereb River. Consequently, drilling work will be carried out further downstream and in the low-lying narrow area which is expected to have groundwater. Three drilling sites are planned in the implementation stage.

(2) May-dima

The following two points are concluded from the test drilling results.

1) The ECDF project has five deep-wells with 13 m depth and the yield ranges between 0.0 and 1.2 liters/sec. Another six deep-wells have a depth of 18 to 41 m and the capacity of these ranges between 0.0 and 0.83 liters/sec. The well with the largest capacity has a depth of 13 m and the test drilling shows that the aquifer does not extend to below a depth of 13 m. Therefore, the aquifer is within the 13 m depth.

2) The area, where large rocks are located several meters away from the riverside, is not expected to be an area with a wide aquifer. The aquifer is assumed to be approximately the same width as the river. Therefore, the Project will extract shallow groundwater within the 13 m depth and drilling points will be located near the river. The deep-well requires a 10 m depth margin so the total depth of the deep-well will be 23 m.

Table 2.12 Proposed New Well Drilling Sites in May-dima Town

Possible deep-well sites	No.	North Latitude	East Longitude	Description
The area in which the river width is narrows and a natural dam exists (approximately 7 km downstream from May-dima).	PBH-1	14°55′32.4″	38°25′24.8″	Downstream of the streams confluence
	PBH-2	14°55′41.0″	38°25′25.7″	End of bend section
	PBH-3	14°55′39.1″	38°25′32.0″	End of bend section
	PBH-4	14°55′33.1″	38°25′38.0″	Straight section
	PBH-5	14°55′33.6″	38°25′44.3″	Downstream of the streams confluence
	PBH-6	14°55′25.2″	38°25′43.8″	Confluence of the two streams
Downstream of the confluence	PBH-7	14°55′31.0″	38°26′16.0″	
	PBH-8	14°55′29.2″	38°26′27.3″	Close to Hand dug well
	PBH-9	14°54′47.0″	38°27′03.0″	
	PBH-10	14°54′36.2″	38°27′06.9″	At the point of straight stream
	PBH-11	14°54′20.9″	38°27′17.9″	Downstream of the confluence
Between the existing well (PW2) and the confluence	PBH-12	14°54′13.9″	38°27′49.3″	Rocks appear
	PBH-13	14°54′18.0″	38°28′02.0″	
	PBH-14	14°54′23.0″	38°28′11.0″	

Out of the three test drilling sites, the borehole upstream of PW2 was the observation well and the other two boreholes upstream of PW1 were fault wells. A river basin of PW2, however, has a larger aquifer than PW1 River and a large amount of groundwater is anticipated. Two boreholes were drilled at the downstream of the confluence of the two rivers. One of these boreholes resulted in the observation well. Consequently, there are two sites selected for deep-wells along the river course of PW2 and five sites downstream of the confluence.

The river width narrows five kilometers downstream of the confluence. Large rocks appear a further two kilometers downstream and the rocks interrupt the water flow. It is assumed that groundwater is stored in this area. Therefore, potential sites of six deep-wells are identified.

(3) Adi Keyih

Seven test drillings were conducted in the two valleys around Hawatsu Village and six production wells and one observation well were obtained. The area has an abundance of groundwater and the following nine sites are selected to become deep-well sites in the construction stage. The average well depth of the existing wells in Meharda and Hawatsu villages is 49.3 m so the design well depth is set at 50 m. The well depths in Ugune and Hawatsu villages is 30 m, 37 m, and 38.5 m. Proposed deep-wells are located in the downstream area and the design well depth is set at 40 m.

Table 2.13 Proposed New Well Drilling Sites in Adi Keyih Town

Possible deep-well sites	No.	North Latitude	East Longitude	Description
Meharda village – Hawatsu village	PBH-1	14°54′34.4″	39°19′07.4″	Narrowed section
	PBH-2	14°54′11.2″	39°19′13.5″	Narrowed section
	PBH-3	14°53′39.5″	39°19′58.6″	Narrowed section, along the road
	PBH-4	14°53′40.6″	39°20′11.3″	Narrowed section, along the road
	PBH-5	14°53′40.3″	39°20′15.0″	Narrowed section, along the road
	PBH-6	14°53′40.4″	39°20′41.9″	Narrowed section, along the road
	PBH-7	14°53′46.5″	39°20′52.4″	Upstream of Hawatsu dam
Ugune village – Hawatsu village	PBH-8	14°54′33.2″	39°21′13.7″	Narrowed section
	PBH-9	14°54′27.6″	39°21′00.1″	Narrowed section, upstream of bush

2-2-2-6 Water Supply Facilities Plan

(1) Design Principles

1) Applied Design Standards

The following criteria are applied to design the water supply facilities and the Project follows ECDF design principles.

a) Maximum daily factor is 1.2 times of the average daily water demand,
b) Peak hour water demand is 1.5 times of the maximum daily water demand/24,
c) Head loss in a pipeline is less than 20 m per 1 km,
d) Velocity in a transmission pipe is less than 2.0 m/sec,
e) Velocity in a distribution pipe ranges from 0.3 to 1.5 m/sec, and
f) Reservoir volume is 8 hours of the maximum daily water demand.

2) Considerations for designing the facilities

The water supply facilities shall be designed in consideration of the following criteria:

a) Facilities shall be designed in accordance with the water demand in 2015.
b) Water intake facilities shall be designed, taking into account ease of maintenance during the operations stage.
c) Pump operating systems shall be designed, taking into account convenience during the operations stage such as ease of operation, operations and maintenance costs and availability of spare parts.
d) In principle, pipeline routes shall be set in public spaces such as roads, and installation of pipelinewithin private land shall be minimized.
e) In principle, uPVC pipe shall be applied and buried into the underground. Ductile iron pipe shall be applied in hard rock sections, where pipe is pleased without laying underground, and high water pressure sections.
f) Reservoirs shall be reinforced of concrete type with square shape, and above-ground type.
g) Distribution pipelines shall be based on the distribution plan for 2015, as designed in the 1998 JICA master plan.

(2) Water supply facilities plan

1) Debarwa

Ten deep-wells need to be constructed as part of the Project. Borehole NBH No.6, developed by the test drilling, is located far from the other existing and test boreholes. This borehole also is located near Adi Gheda and Halhale villages. Therefore, NHB No.6 supplies water for both of these villages.

The transmission pipeline consists of two lines; one starts from Shikety Village located on the north side of Debarwa, and the other one starts from Watot Village located on the south side of Debarwa. In principle, these pipeline routes shall be installed along the existing roads.

The proposed reservoir is to be located on the mountain summit near the existing reservoir constructed by the ECDF project. The proposed reservoir is to be located at a higher elevation than the ECDF reservoir to have the necessary water pressure.

The distribution pipeline network has been constructed through the ECDF project and is equivalent to the distribution network plan proposed in the 1998 JICA master plan. However, the current pipeline network is approximately 90% of the final figures due to insufficient funds of ECDF. Installation of the remaining distribution pipeline network shall be undertaken by the Project to enable completion of the pipeline network. A distribution pipeline is installed from the new reservoir for Adi Logo Village. The proposed water supply facilities are summarized in Table 2.14 and illustrated in BD-001 to BD-003.

Table 2.14 Water Supply Facilities Plan for Debarwa Town

No.	Construction item	Specifications	Q'ty	Unit	Remarks
1	Intake pump				
1.1	New pump facilities	Q=0.09m3/min., H=60m	2	nos.	New developed boreholeNo.7,8
		Q=0.09m3/min., H=70m	1	nos.	New developed boreholeNo.11
		Q=0.09m3/min., H=80m	2	nos.	New developed boreholeNo.1,3
		Q=0.09m3/min., H=90m	1	nos.	New developed boreholeNo.6
		Q=0.09m3/min., H=100m	1	nos.	Test drilling boreholeNo.6
		Q=0.09m3/min., H=140m	1	nos.	New developed boreholeNo.14
		Q=0.09m3/min., H=170m	1	nos.	New developed boreholeNo.20
		Q=0.09m3/min., H=180m	1	nos.	New developed boreholeNo.23
		Q=0.09m3/min., H=200m	1	nos.	New developed boreholeNo.26
		Q=0.11m3/min., H=110m	1	nos.	Test drilling borehole No. 11-1
		Q=0.13m3/min., H=150m	1	nos.	Test drilling borehole No. 6, 10
		Q=0.15m3/min., H=150m	1	nos.	Test drilling borehole No. 11-2
2	Pipeline				
2.1	Transmission pipeline	Dia. 50-200mm/uPVC pipe (PN16)	21.6	km	
		Dia. 80-200mm/Ductile iron pipe	3.1	km	
2.2	Distribution pipeline	Dia. 50-125mm/uPVC pipe (PN16)	8.6	km	
		Dia. 65,250mm/Ductile iron pipe	0.3	km	
3	Reservoir	Rainforced concrete	2	nos.	V=500m3/50m3, Each 1 place
4	Public fountain	6 water tap type	9	nos.	

2) Dekemhare

The four deep wellsdeveloped by the test drilling and existing twelve deep wells are able to provide sufficient water supply volumes to meet the water demand in 2015. Four of the existing twelve pump facilities have already deteriorated and are to be replaced by the Project.

Two transmission pipelines are to be designed as the wells are located along the two streams. A new urban development area is located between the wells and the reservoir. Consequently, the western side transmission pipeline is to be installed along the Amhur village road to avoid the new urban development area. The eastern transmission pipeline is to be installed along the existing road and pass within the Dekemhare Town area.

The proposed reservoir is located on the mountain behind the town. As a cemetery is situated on the mountain social environmental issues shall be considered during construction.

The distribution network inside Dekemhare Town was constructed in Italian administration days and has significantly deteriorated since that time. Several pipelines have already been replaced, however the majority still remain. The deteriorated distribution pipelines will be replaced through the Project in order to reduce the unaccounted for water. Distribution pipelines extend to Amhur, Hadamu, Maiwerki, and Metsalu villages. The proposed water supply facilities s summarized in Table 2.15 and illustrated in BD-004 and BD-005.

Table 2.15 Water Supply Facilities Plan for Dekemhare Town

No.	Construction item	Specifications	Q'ty	Unit	Remarks
1	Intake pump				
1.1	Replacement of existing pumps	Q=0.10m3/min., H=190m	1	nos.	Existing deep-wellBH 19
		Q=0.16m3/min., H=180m	1	nos.	Existing deep-wellDEK-1
		Q=0.19m3/min., H=210m	1	nos.	Existing deep-wellBH 14
		Q=0.27m3/min., H=210m	1	nos.	Existing deep-wellDEK-2
1.2	New pump Installation	Q=0.11m3/min., H=190m	1	nos.	Test drilling boreholeNBH-1
		Q=0.14m3/min., H=210m	1	nos.	Test drilling boreholeNBH-3
		Q=0.27m3/min., H=220m	1	nos.	Test drilling boreholeNBH-4
		Q=0.43m3/min., H=210m	1	nos.	Test drilling boreholeNBH-5
2	Pipeline				
2.1	Transmission pipeline	Dia. 50-200mm/uPVC pipe（PN16）	21.9	Km	
		Dia. 125-200mm/Ductile iron pipe	2.2	km	
2.2	Distribution pipeline	Dia. 50-250mm/uPVC pipe（PN16）	13.3	Km	
		Dia. 250mm/Ductile iron pipe	0.3	km	
3	Reservoir	Reinforced concrete	1	nos.	V=1,100m3
4	Public fountain	6 water tap type	8	nos.	
		10 water tap type	8	nos.	

3) May-dima

Thirteen new deep wells are proposed to be constructed by the Project. The water supply plan is based on the proposed and the existing deep-wells (PW-1).

These dug wells are located along the river course, but the transmission pipeline is to be constructed along the existing road taking into consideration ease of operation and maintenance during the rainy season.

The reservoir is planned to be constructed next to the abandoned existing concrete reservoir.

The distribution pipeline is proposed to be installed along the center road of the town and public fountains are arranged at suitable intervals. A public fountain is arranged for Milad-manta Village. The water supply facilities plan is summarized in Table 2.16 and illustrated in BD-006 and BD-007.

Table 2.16 Water Supply Facilities Plan for May-dima Town

No.	Construction item	Specifications	Q'ty	Unit	Remarks
1	Intake pump				
1.1	New pump installation	Q=0.03m3/min., H=230m	3	nos.	New developed borehole No.PBH1-3
		Q=0.03m3/min., H=220m	1	nos.	New developed borehole No.PBH4
		Q=0.03m3/min., H=210m	1	nos.	New developed borehole No.PBH5
		Q=0.03m3/min., H=190m	1	nos.	New developed borehole No.PBH6
		Q=0.03m3/min., H=180m	1	nos.	New developed borehole No.PBH7
		Q=0.03m3/min., H=140m	1	nos.	New developed borehole No.PBH8
		Q=0.03m3/min., H=130m	1	nos.	New developed borehole No.PBH9
		Q=0.03m3/min., H=110m	1	nos.	New developed borehole No.PBH10
		Q=0.03m3/min., H=100m	1	nos.	New developed borehole No.PBH12
		Q=0.03m3/min., H=90m	1	nos.	New developed borehole No.PBH13
		Q=0.03m3/min., H=80m	1	nos.	New developed borehole No.PBH11
		Q=0.06m3/min., H=90m	1	nos.	Test drilling borehole No.1
1.2	Replacement of existing pump	Q=0.06m3/min., H=60m	1	nos.	Existing deep-wellPW-1
2	Pipeline				
2.1	Transmission pipeline	Dia. 50-125mm/uPVC pipe (PN16)	12.1	Km	
		Dia. 50-125mm/Ductile iron pipe	1.8	km	

No.	Construction item	Specifications	Q'ty	Unit	Remarks
2.2	Distribution pipeline	Dia. 65-200mm/uPVC pipe (PN16) Dia. 200mm/Ductile iron pipe	3.8 0.1	Km km	
3	Reservoir	Reinforced concrete type	1	nos.	V=300m3
4	Public fountain	8 water tap type	9	nos.	

4) Adi Keyih

Four deep-wells are to be constructed in Adi Keyih. The new well-field is located in two valleys in Hawatu Village so two transmission pipelines are required. These pipelines will be connected at the downstream of Hawatu Village. Following this, the transmission pipeline will be laid along the national road. One booster pump station is required. As the water pressure between the booster pump station and the reservoir exceeds the design pressure of uPVC pipe standards, ductile iron pipes are applied for this section.

The reservoir is designed to be located next to the ECDF project reservoir. In the ECDF project, the distribution pipeline network was being constructed based on full level of the JICA master plan level. Therefore, the distribution network does not need to be further developed by the Project as the reservoir water proposed by the Study can be connected into the ECDF project's distribution pipe.

The transmission pipeline is to be installed between test drilling well No.6 and Tekondae Village and water will be supplied by the public fountain. The water supply facilities plan is summarized in Table 2.17 and illustrated in BD-008.

Table 2.17 Water Supply Facilities Plan for Adi Keyih Town

No.	Construction item	Specifications	Q'ty	Unit	Remarks
1	Intake pump				
1.1	New pump installation	Q=0.09m3/min., H=40m	1	nos.	New developed boreholeNo.PBH-2
		Q=0.09m3/min., H=60m	1	nos.	New developed boreholeNo.PBH-1
		Q=0.09m3/min., H=80m	1	nos.	New developed boreholeNo.PBH-3
		Q=0.09m3/min., H=130m	1	nos.	New developed boreholeNo.PBH-7
		Q=0.09m3/min., H=110m	1	nos.	Test drilling boreholeNo.6
		Q=0.13m3/min., H=50m	1	nos.	Test drilling boreholeNo.14
		Q=0.24m3/min., H=120m	1	nos.	Test drilling boreholeNo.19
		Q=0.29m3/min., H=60m	1	nos.	Test drilling boreholeNo.17
		Q=0.34m3/min., H=40m	1	nos.	Test drilling boreholeNo.16
		Q=0.38m3/min., H=100m	1	nos.	Test drilling boreholeNo.18
		Q=0.42m3/min., H=130m	1	nos.	Test drilling boreholeNo.20
		Q=2.15m3/min., H=160m	1	nos.	Booster pump
2	Pipeline				
2.1	Transmission pipeline	Dia. 50-200mm/uPVC pipe (PN16)	11.3	km	
		Dia. 50-250mm/Ductile iron pipe	8.4	km	Applied between the booster pump to the reservoir
3	Reservoir	Reinforced concrete type	2	nos.	V=700m3, 50m3
4	Public fountain	6 water tap type	2	nos.	
		8 water tap type	3	nos.	
		10 water tap type	5	nos.	

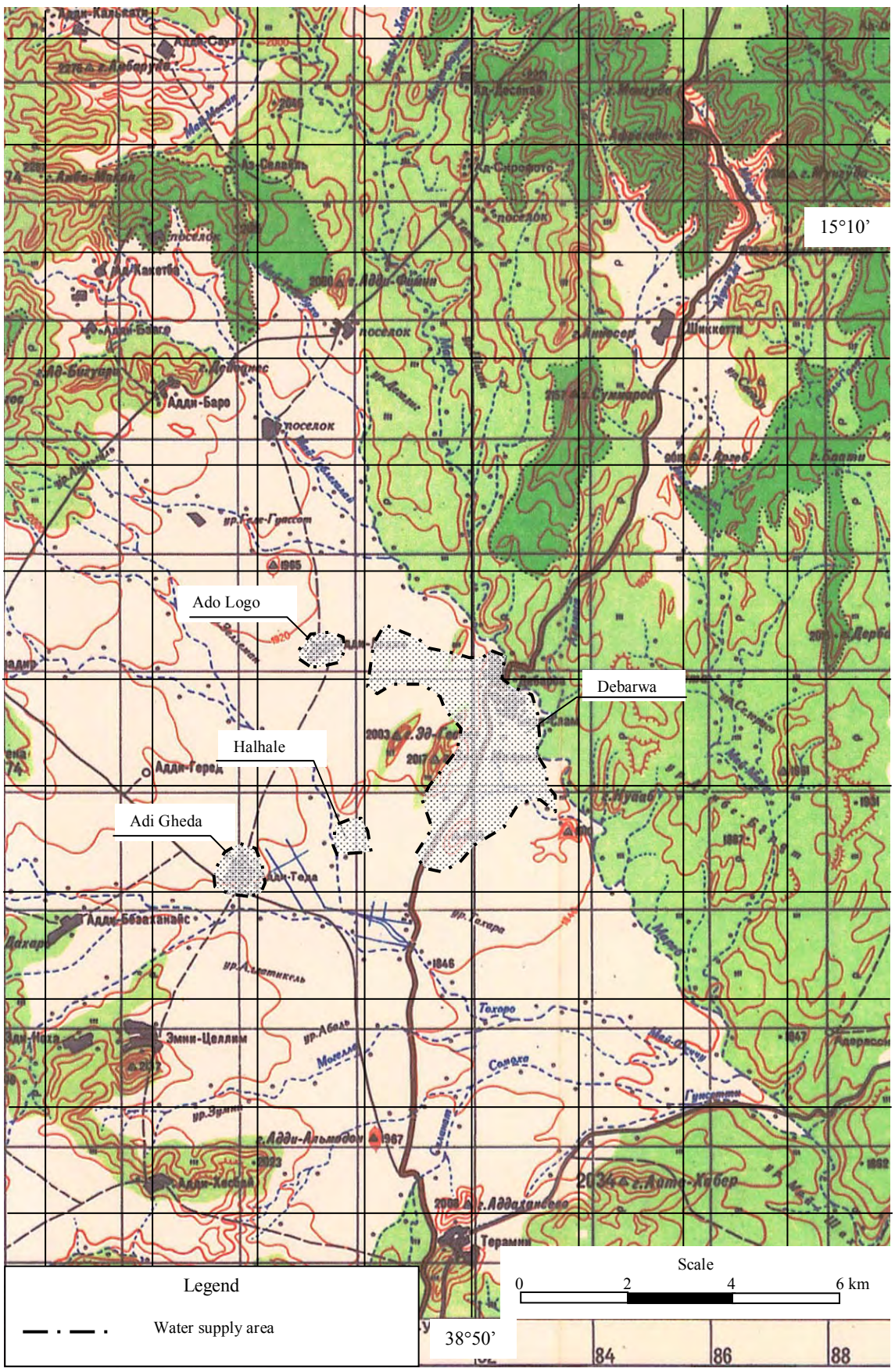


Figure 2.2 Water Supply Area in Debarwa Town

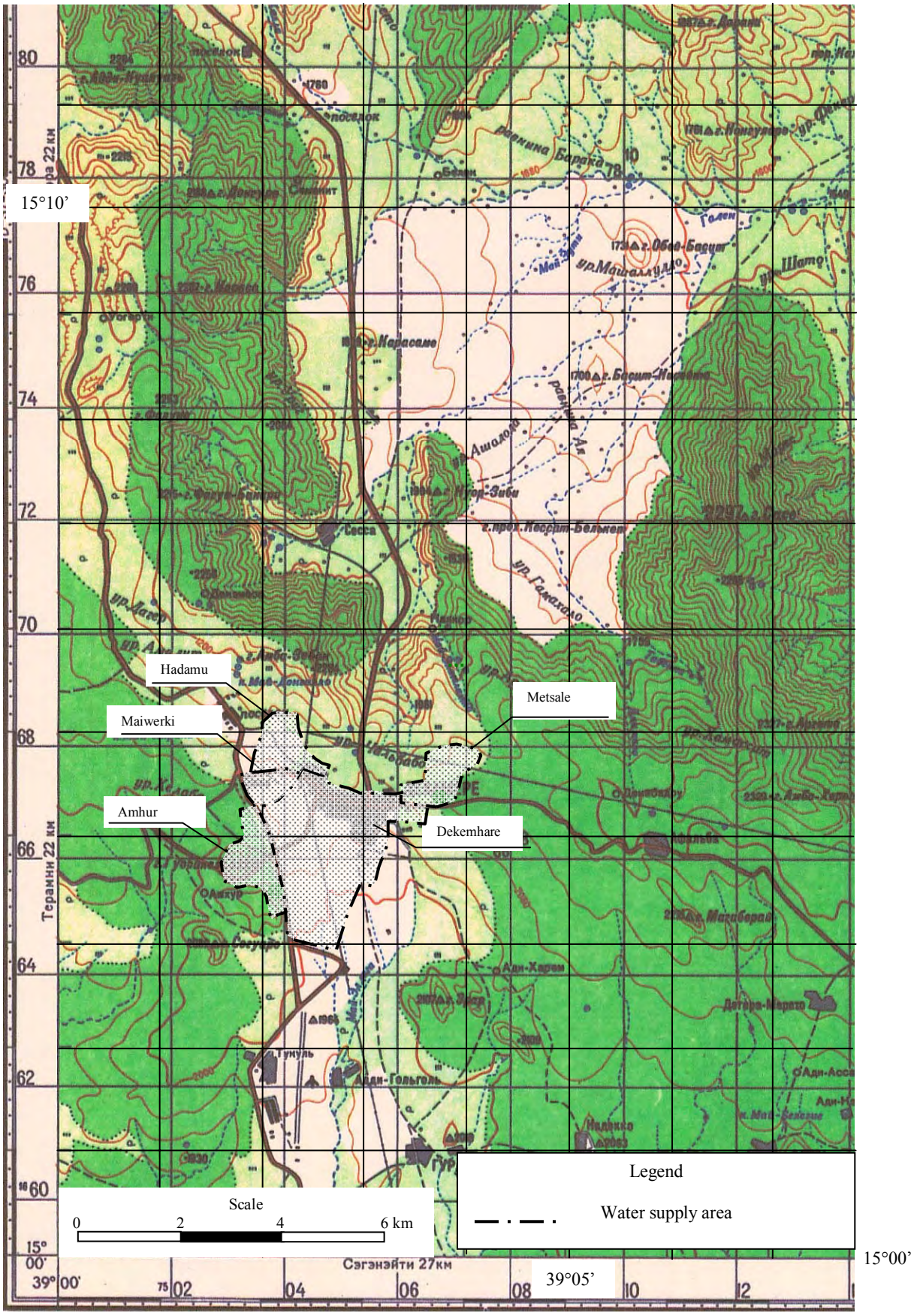


Figure 2.3 Water Supply Area in Dekemhare Town

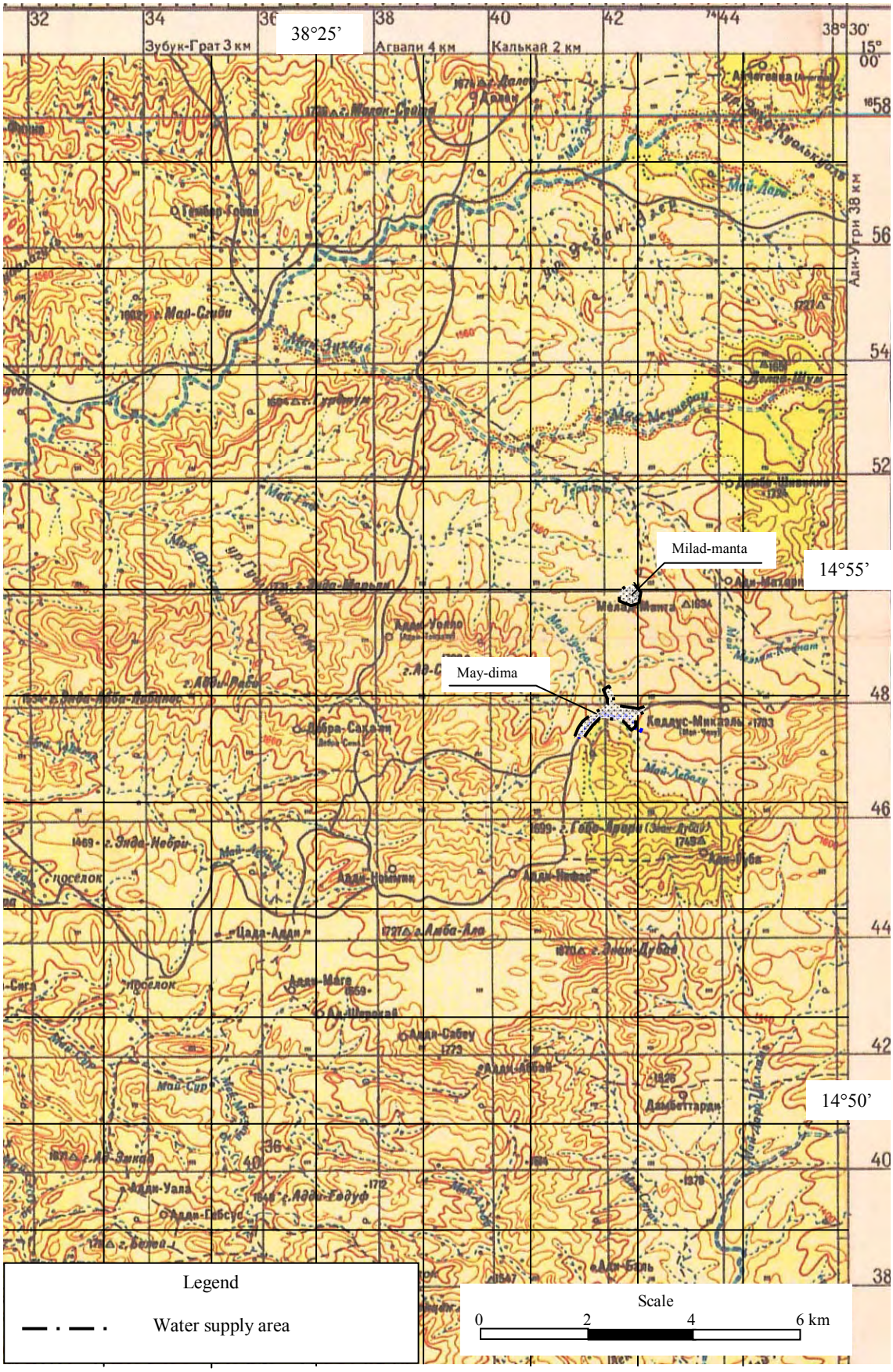


Figure 2.4 Water Supply Area in May-dima Town

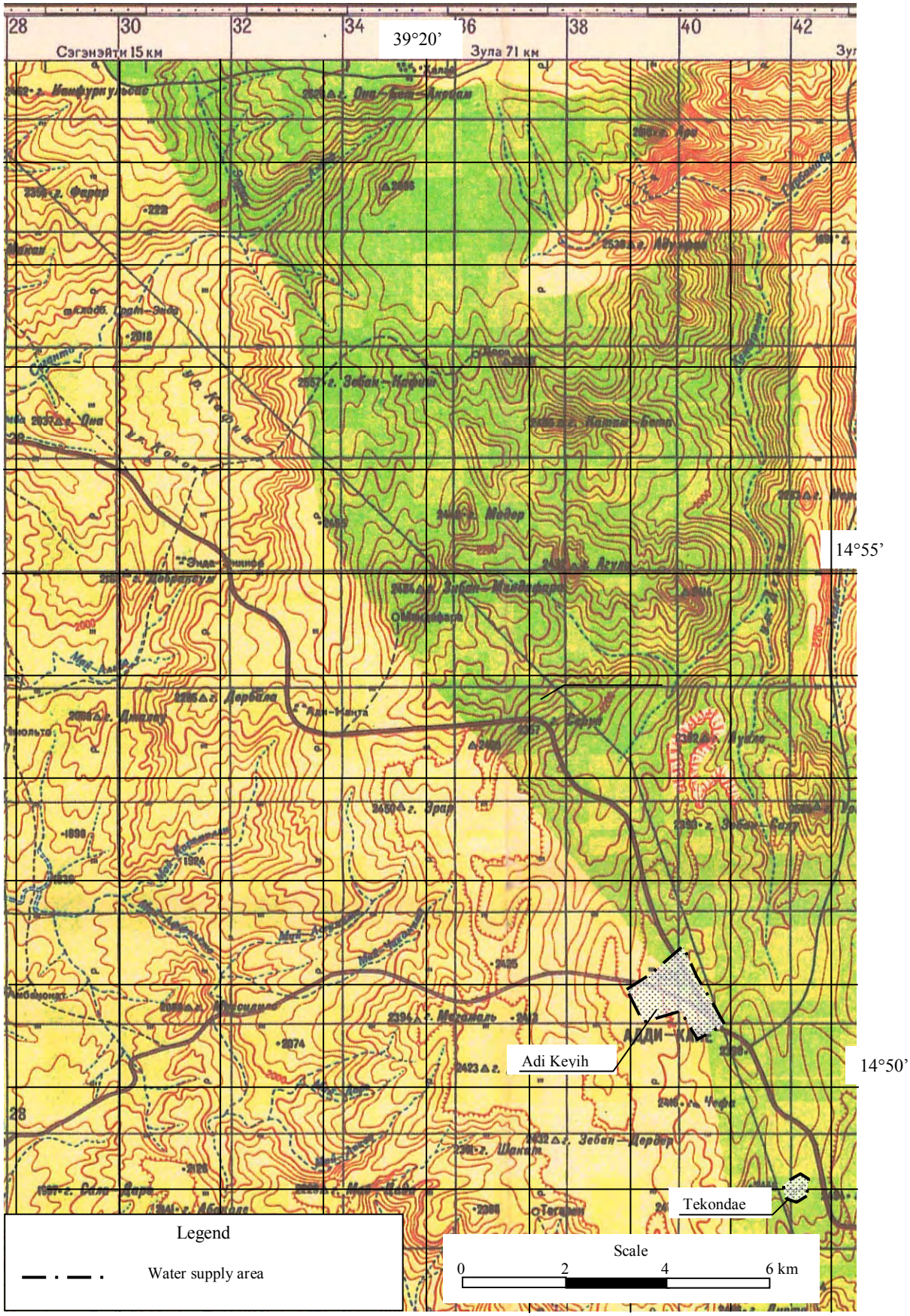


Figure 2.5 Water Supply Area in Adi Keyih Town

2-2-3 Basic Design Drawings

The following drawings have been developed by the Study. The drawings are attached into this report.

Drawing No.	Title
BD-001	Water Supply Facility Plan in Debarwa Town (1) Transmission Pipeline
BD-002	Water Supply Facility Plan in Debarwa Town (2) Distribution Pipeline
BD-003	Water Supply Facility Plan in Debarwa Town (3) Distribution Pipeline
BD-004	Water Supply Facility Plan in Dekemhare Town (1) Transmission Pipeline
BD-005	Water Supply Facility Plan in Dekemhare Town (2) Distribution Pipeline
BD-006	Water Supply Facility Plan in May-dima Town (1) Transmission Pipeline
BD-007	Water Supply Facility Plan in May-dima Town (2) Distribution Pipeline
BD-008	Water Supply Facility Plan in Adi keyih Town (1) Transmission Pipeline
BD-009	Pump House Layout Plan
BD-010	Borehole and Intake Facilities
BD-011	Pump House
BD-012	Reservoir Area Layout Plan
BD-013	Reservoir Plan
BD-014	Disinfection Facility Plan
BD-015	Booster Pump Station Area Layout Plan
BD-016	Reservoir Tank
BD-017	Booster Pump House
BD-018	Fence and Gate
BD-019	Public Fountain
BD-020	Pipe Installation Works
BD-021	Manhole and Valve

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

The Project is implemented under the grant-aid scheme of Japan and the following principles.

1) The implementing agency is the Ministry of Land, Water, and Environment (MoLWE).

2) The MoLWE commences the preparatory works which are entrusted to the WRD and other related organizations. At this time the Exchange of Notes (E/N) for the Project is signed between the Government of Japan and the Government of Eritrea.

3) After the E/N is signed the Japanese Consultants are contracted to the MoLWE and conduct the detailed design, prepare the bidding documents, and commence bidding procedures for the construction work.

4) The Japanese contractor signs the contract with the MoLWE and commences construction. The consultant carries out the supervision work.

5) The MoLWE is responsible for the operation and maintenance of the water supply facilities after completion.

6) The Government of Eritrea provides the necessary land for the Project.

7) Major construction materials such as reinforcing bars, cement, timber, fuel, oil, and paint

are procured in Eritrea and other materials such as submersible motor pumps, ductile iron pipes, galvanized steel pipes, and uPVC pipes are procured in Japan or in third countries.

2-2-4-2 Implementation Conditions

(1) Tax exemption procedures

The MoLWE and many other governmental agencies participate in the necessary tax exemption procedures. It is anticipated that this will be a complicated process and there will be a long period before the tax exemption. The MoLWE takes the initiative for the tax exemption procedures and the Consultant and the Contractor shall fully understand the related laws and regulations, and conduct rapid document preparation and requests.

(2) Environment Impact Assessment during the consruction stage

In general, 1) noise, 2) dust, 3) vibration by heavy equipment, and 4) traffic accidents are considered as adverse effects during construction. Traffic accidents are considered for the case of material transportation because the towns are located around 50 km apart. Both Eritrean and Japanese parties request that the drivers follow traffic regulations and speed limitations and traffic control inspectors are arranged.

2-2-4-3 Scope of Works

(1) Responsibilities of the Japanese side

1) Execution of detailed design
2) Preparation of the bidding documents, support for tendering including tender evaluation and for the contract signing
3) Construction of the water supply facilities

(2) Responsibilities of the Eritrean side

1) Providing the land for the water supply facilities
2) Budget arrangements for the import tax incurred on the procured materials and equipment, internal duties, other charges, and their payment
3) Arrangement for permissions relating with the construction works
4) Providing the counterpart staff
5) House connection/yard connection construction works

2-2-4-4 Construction Supervision

(1) Detailed design and bidding

1) Detailed design

The detailed design and bidding documents are prepared based on the results of the basic design study report.

- Site surveys (electrical prospecting, profile survey)
- Detailed design of the water supply facilities
- Preparation of the design report and design drawings
- Quantity survey calculation and cost estimate
- Preparation of the construction plan and bidding documents

2) Bidding

Pre-qualification is conducted prior to contractor selection. The notice is published in the major Japanese construction and economic newspapers under the name of MoLWE, the State of Eritrea. The Consultant prepares and delivers the pre-qualification documents. The Consultant delivers the bidding documents to the Japanese Contractors that have passed the pre-qualification requirements. The Consultant accepts the bidding documents from the Contractors and the bidding documents are opened under the supervision of the Eritrean representatives. The Consultant evaluates the bidding documents together with the Eritrean representatives, prepares the draft contract agreement, and negotiates with the successful bidder. The Consultant supports MoLWE concerning the following works.

- Bidding notice
- Preparation, delivery, and evaluation of the pre-qualification documents
- Delivery and evaluation of the bidding documents, and contract negotiation

(2) Construction supervision

The Consultant orders the Contactor to commence construction after receiving the contract certificate from the Government of Japan, and commences the construction supervision work. The resident engineer remains at the site after commencement of the construction work, and reports the construction progress to the embassy of Japan in Kenya, JICA Kenya office, and the MoLWE. The resident engineer coordinates between the stakeholders for smooth communication.

The major construction and supervision works are as follows:

1) Evaluation and approval of the construction drawings

Evaluation and approval of the construction drawings, construction permissions, material samples, and equipment specifications.

2) Supervision of the construction work

Review and supervision of the development of the construction plan and program, monitoring and supervision of construction progress, necessary inspections during construction, investigation and direction on countermeasures for any problems encountered.

3) Final inspection

Confirmation of the constructed structures with reference to the as-built drawings under the supervision of the client.

4) Payment approval

Certification of the construction payments and confirmation of the quantities necessary for issuing the completion certificate.

5) Defect inspection

Confirmation of defects after completion of the defect liability period.

2-2-4-5 Procurement Plan

(1) Construction materials

1) Civil work materials

The Project utilizes reinforcing bars, cement, aggregate, sand, stone, timber, formwork, scaffold, asphalt, fuel (gasoline and diesel oil), concrete blocks and bricks. Civil work materials can be obtained in Eritrea.

Cement is produced by a state company in Eritrea. Most of the products are supplied to state companies and the national housing projects. Ninety percent of the domestic demand is fulfilled by imported cement from neighboring counties such as Egypt. Timber, reinforcement bars and fuel are also imported. Therefore, civil work materials are more expensive than in other African countries.

2) Pipe materials

Pipe materials such as uPVC pipes, ductile iron pipes, and galvanized steel pipes, are not produced in Eritrea and are planned to procure from third counties or Japan. uPVC pipe with design pressure of PN 16 is not procured in Japan and therefore these pipes are imported from third countries.

3) Pump equipment

Submersible pumps for domestic water supply and centrifugal pumps are not produced in Eritrea and therefore these pumps will be procured from third counties or Japan.

4) Procurement Source of Main Construction Material and Equipment

Pipes and pumps are not produced in Eritrea and therefore they will be procured from third counties or Japan. Countries, from which these materials and equipment may be procured, are listed as follows:

Table 2.18 Procurement Source of Major Construction Material

Materials	Eritrea	Japan	Third counties	Note
Steel	○			
Cement Aggregate	○			
Timber	○			
Fuel and oil	○			
Temporary works (Scaffold, formwork)	○			
Other civil materials	○			
uPVC pipe (straight pipe)			○	Egypt
uPVC pipe (bend pipe)			○	UAE
Ductile iron pipe (Straight pipe)			○	Germany
Ductile iron pipe (Bend pipe)			○	France
Galvanized steep pipe			○	India
Valve		○		
Pump: control panel, plumbing, etc		○		

Materials	Eritrea	Japan	Third counties	Note
Generator		○		
Chlorination equipment			○	France

(2) Inland transportation

Cargos are loads at Massawa port. After the custom clearance, they are transported to the stock yard in each town by trailer truck and are stored at there. Materials and equipment are transported by 4ton clane truck from the yard to each site to follow the work progress.

(3) Local contractors and construction machines

1) Local contractors

The State of Eritrea implements similar types of regional urban water supply projects of the ECDF. There are several contractors with relevant experience through these projects. These contractors can provide sufficient engineers and labors for the Project. Therefore, engineering staff will be procured through the local contactors and they will construct the works under the instruction and supervision of the Japanese engineers. It is noted that Eritrea only has three drilling companies as shown below:

Table 2.19 List of Local Drilling Contractors

Company name	Number of drilling rigs
Eritrean Core Well Drilling Company	11
Techno Drilling Services PLC	1
Complant Eritrea Co., Ltd.	1

The Project will require the drilling of more than 27 boreholes over approximately four months. The Eritrean Core Well Drilling Company (ECDC) could be the only contractor able to implement such a construction schedule taking into account number of drilling rigs. Therefore, it is assumed that the main contractor procures the materials and equipment from the ECDC.

2) Construction machines

There are no companies that lease the necessary construction machines in Eritrea. The local contractors have the necessary construction machines, though the number of contractors is limited in Eritrea. The construction plan is formulated based on using the existing construction machines, which are owned by the local contractors. The management vehicles will be purchased from local dealers as this is cost effective compared to leasing these vehicles from local companies.

2-2-4-6 Quality Control Plan

The Project will conduct the quality control test shown as below. Water quality test, aggregate material test, concrete mix proportion test and concrete compressive strength test are conducted in Asmara and other tests are conducted in each site.

Table 2.20 Quality Control Tests

Work type	Quality control tests	Q'ty	Remarks
1) Well development	Pumping test	27 places	Cotinuous test and stepwise test
	Water quality test	27 places	WHO water quality standard applied
2) Pipe works	Water pressure・leakage test	11km	
	Operation test	11km	Confirmation of water supply volume by pump test operation
3) Concrete works	Cement, reinforcing bar, aggregate material test	4 nos.	
	Concrete mix proportion test	4 nos.	
	Concrete test (Slump, air, compressive strength)	138 nos.	The test is conducted 1000m interval.
4) Reservoir works	Leakage test	6 places	

2-2-4-7 Implementation Schedule

The project implementation schedule consists of detailed designs, bidding, and construction. The draft implementation schedule is shown below:

Table 2.21 Implementation Schedule

Item	Duration (months)
Detailed design/ Bidding preparation	10.0
Construction/handing over	22.5
Soft-component	22.5

The implementation program mentioned above is illustrated as follows:

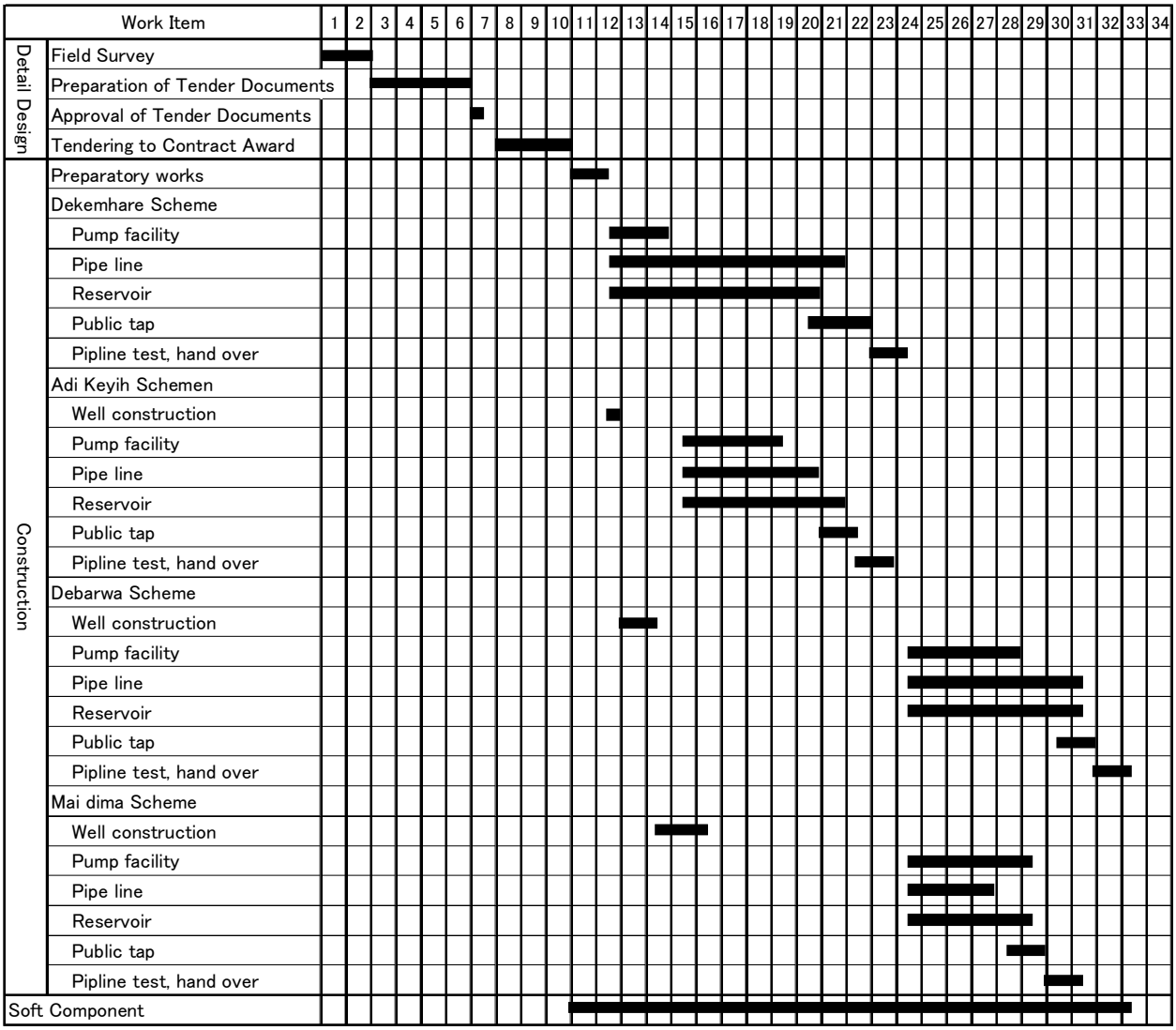


Figure 2.6 Implementation Program

2-3 Obligations of Recipient Country

Undertakings of the Government of Eritrea are drafted as follows:

1) To secure the sites for the proposed water supply facilities.

2) To clear, level and reclaim the sites prior to commencement of construction.

3) To provide data and information necessary for the Project.

4) To provide land for access roads, a temporary site office, warehouse and stock yard during implementation of the Project.

5) To provide a warehouse for storing necessary spare parts and other equipment procured by the Project.

6) To construct the access road to the site prior to commencement of construction.

7) To open a bank account in Japan and bear the commissions of the Japanese bank for the banking services based upon the Banking Arrangement.

8) To ensure the prompt unloading and customs clearance at the port of disembarkation in Eritrea and facilitate transportation within Eritrea of the products purchased under the Grant.

9) To provide a tax exemption and to take necessary measures for customs clearance of materials and equipment procured by the Project at the port of disembarkation.

10) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Eritrea with respect to the supply of the products and services under the Verified Contracts.

11) To accord Japanese nationals, whose services may be required in connection with supply of the products and services under the verified contracts, such facilities as may be necessary for their entry into Eritrea and their stay therein during the performance of their work.

12) To assign the necessary staff and secure the necessary budget for operation and maintenance of the equipment purchased under the Grant Aid.

13) To properly and effectively maintain and use the equipment procured under the Grant Aid.

14) To bear all the expenses, other than those to be borne by the Grant Aid, necessary for construction of the facilities as well as for the transportation and installation of the equipment.

15) To maintain the control of tools and spare parts purchased under the Grant Aid.

16) To establish and manage the Project Management Unit, and to cooperate with relevant Ministries.

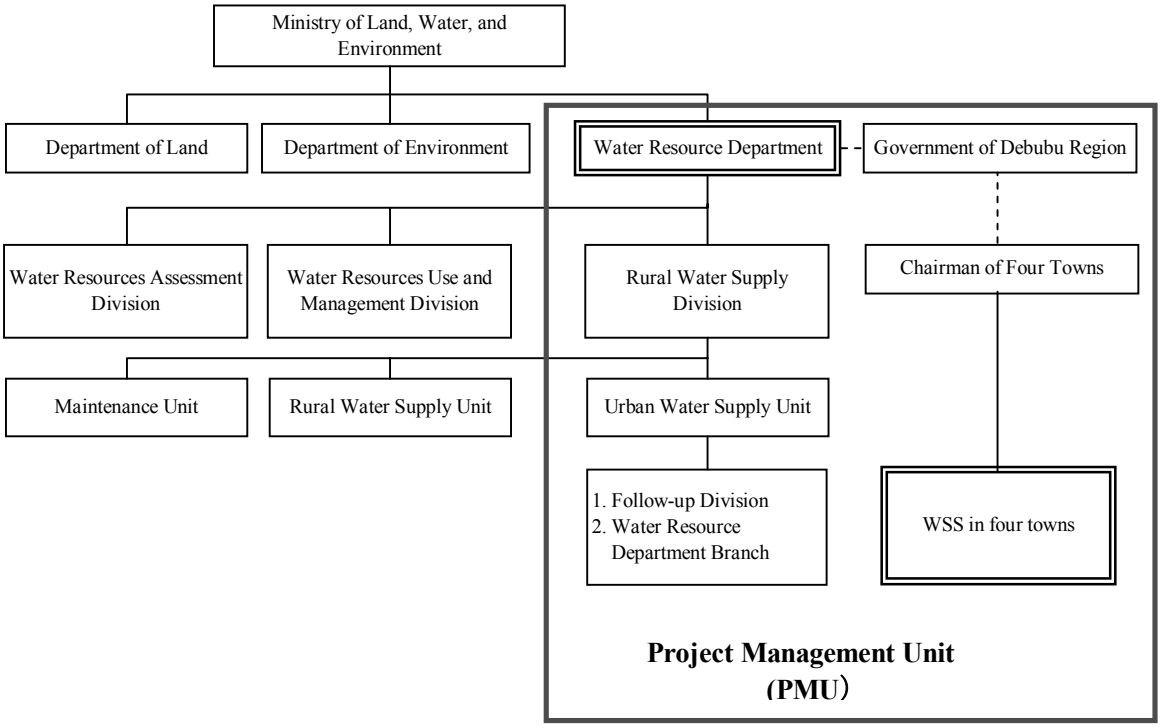
17) To construct house connection/yard connection after the construction by Japanese side.

The Ministry of Land, Water and Environment implements the water supply project under the fund provided by the ECDF and other donors and performs their responsibilities adequately. It can be expected that they will perform the Project properly.

2-4 Project Operation Plan

2-4-1 Operations and Maintenance System

The WSS conducts the operations and maintenance works under the supervision of the MoLWE and the government of the Debub Region, as follows:



2-4-2 Operations and Maintenance Plan

WWS of each town conducts operation and maintenance of the existing water supply facilities as the daily routine work, they already have had the knowledges about operation and maintenance works.

Based on the survey on the operation and maintenance of the existing water supply facilities and the baseline survey, the following points are identified as the operation and maintenance issues.

1) Improvement of the maintenance techniques of the WSS staff in each town for reduction of unaccounted for water, and
2) Improvement of capability of WSS staff for budgeting and business planning

The following training will be implemented under the soft-component scheme in order to enhance the WSS staff operation and maintenance capabilities.

1) Operation and maintenance techniques such as pumps, distribution pipes, public fountains, and water quality, and
2) Improvement of the management capacity such as preparation of the annual business plan, customer management, revenue and expenditure control, account management, and customer claim solutions.

As for customer management, the Study team discusses with WRD and WSS about adoption of new

system, which electronizes from hand writing database because computers have already been settled for four towns and management capability will be improved.

2-5 Soft-component Scheme

2-5-1 Background of the soft-component scheme

(1) Background

House connections have already been implemented in three towns. However, the high rate of unaccounted for water is an important issue due to the inexperienced operation and maintenance of the system and the deterioration in the water supply facilities. The water supply service staff of each town performs the routine daily activities and has a basic knowledge of the system. However, they do not have an overall knowledge concerning the water supply business activities and financial management. It is important to develop the capacity of the staff in relation to trouble shooting and management improvement.

(2) Major issues of the soft-component scheme for the four towns

The following issues are anticipated to be the key issues for realizing the effective use of water resources and facilities to be developed by the Project:

1) Reduction of unaccounted for water

The staff of WSS has low capability for identifying problems for water supply facilities and/or eqiuipment due to lack of experience and/or training opportunities. Whilst, piped water supply by house and yard connection is only available in the limited urban area within a town and, therefore, access rate for clean water is still low rate of 15 % to 30% in the four towns.

Water supply facilities with sufficient water source such as deep wells, transmission and distribution pipelines, storage tanks, and so on, are proposed to be developed by the Project. But connection to existing secondary supply pipes and new customers needs to be done by the WSS. Therefore, if these works, especially replacement of deteriorated old pipes, are not executed properly by the WSS, this may cause leakage of water and result in increase of unaccounted for water and loss of produced water.

After commencement of operation and maintenance of the facilities to be constructed by the Project, staff of WSS needs to sufficient knowledge and knowhow for problems and countermeasures such as leakage of water and replacement of pipe material, and so on. Also, customer data and water meter reading, which gives the basic data and information for detecting leakage, is required to be managed well. As well as these knowledge, the staff of WSS needs to know the method of periodical patrol, technics for repair or replacement of pipes, and preparation of records for these works.

2) Capacity building of staff of WSS

The WSS has operated water supply facilities in accordance with the acertain annual budget. However, in order to effectively use the constructed facilities by the Project, it is necessary to increase the annual budget to cope with increase of house/yard connection and users of public fountains, so as to cover incremental cost for these connection and procurement of secondary supply pipes and water meters, salary for public fountain keepers, meter readers, administraters for preparation of invoice.

The staff has no experience in financial management, budget preparation or implementation plans. They

therefore are required to have capability for preparation of an implementation plan and a development plan to manage the future project expansion. It, also, is necessary for them to have a middle or long term action plan and business plan taking into account the increase in customers, replacement of secondary pipes, increase in staff and annual budget preparation. Capacity building is required so that the staff can prepare this plan.

2-5-2 Objective of the soft-component scheme

The water sources required to meet the water demand in 2015 are secured by the project in each town. It is expected that the WSS will construct the house connection service pipes, using the water supply facilities constructed by the Project, and that after completion of implementation of the Project and towards 2015, the WSS manage the water supply business for the population served in each town.

The soft-component scheme sets an objective to improve capability of staff of WSS in the respective towns, in order to cope with the aforesaid major issues; namely, 1) improvement of technics for repair and replacement of service pipes for reduction of unaccounted for water, and 2) preparation of short and mid term business plans till 2015 after completion of the Project.

2-5-3 Outcomes of the soft-component scheme

The following two points are considered to be outcomes of the soft-component scheme.

Output 1 Improvement of technics for repair and replacement of service pipes for reduction of unaccounted for water

Staff will be able to cope with leakage problems from secondary distribution and/or service pipes and learn methods and tecnics for identification of leakage and repair works.

[Contents of Soft-component scheme]

There are no training schemes for the operations and maintenance staff of the water supply business in Eritrea. It is proposed to prepare a manual for for repair and replacement of service pipes for reduction of unaccounted for water and to provide the staff with training workshop, using this manual. It is expected that the staff who take this training will transfer his knowledge to his colleagues.

Output 2 Development to prepare the annual business operation plan

The WSS staff can formulate annual business operation plan after completion of the project by improvement of their capability for business planning including investment and staff plan.

[Soft-component scheme contents]

At present, the WSS does not independently prepare the annual and mid term budget plan. They also do not have training on business operations such as problem analysis and planning. They perform their work based on experience obtained through their work. To achieve the sustainable implementation of the water supply business, the WSS shall prepare the financial management and annual business plan independently. Therefore, training for the financial and management method will be conducted under the soft-component scheme.

As for annual business plan, milestone of each year will be settled such as design water supply volume,

design water distribution mode, design unaccounted for water ratio, and financial status. Besides, action plan will be prepared to fulfill all the conditions mentioned above with consideration of necessary investment, staffs, subsidy and so on. Annual business plan will be prepared to compare and revise with actual status during the project implementation stage. The Consultant supports to prepare the annual business plan.

2-5-4 Confirmation of the achievements

Output 1 Improvement of technics for repair and replacement of service pipes for reduction of unaccounted for water

The unaccounted for water under soft-component scheme is designed to confirm through; 1) operations records (total water supply volume and total production volume), 2) repairing records (date/place, content, used material, water suspension periods), 3) meter reading records (frequency, reading results), 4) estimated loss of water including method for the estimation, as well as inspection records, and method of repairing leakage, or unusual meter readings. The scheme achievements will be confirmed to check these records and unaccounted for water ratio, and so on.

Output 2 Development to prepare the annual business operation plan

This achievement will be judged by progress of the annual business plan including investment, staff recruit and financial plan..

2-5-5 Soft-component activities (Input plan)

(1) Preparation stage

The expert explains the soft-component scheme, and requests cooperation from the WRD and the WSS of the four towns

(2) Implementation stage

1) Training for strengthening the technical capabilities of the staff

In the course of the training, the following issues will be done through the workshop, using a manual to be prepared under the soft-component scheme:

1) Method for identifying leakage points along pipeline including including examples,
2) Reparing method,
3) Required materials and equipment, and their standard,
4) Requirements for customers data base relevant to secondary and services pipe network including pipe diameter, condition of water meter, and so on.,
5) Survey method for condition of pipelines, especially for deterioration of service pipes, and necessity of replacement, and
6) Check of irregal connection in the network.

It is expected that the staff who take this training will transfer his knowledge to his colleagues. Also, at the completion of the construction works at each town, it is required for the WSS to connect the distribution pipelins with the existing secondary and service pipes and/or to connect reservoirs to the existing distribution network. As a result of the work, it is assumed that leakage from the pipes will be

increased due to proper water pressure higher than the current low pressure because of lack of water. In order to cope with this issue, further training will be done at each town based on the prepared manual.

2) Training and support for preparation of business plan after completion of the Project towards 2015

In order to supply the water meeting the water demand, which is estimated at double to five times of the current supply volume after completion of the Project, the expert prepares the plan and instructs the monitoring work in the course of the training and prepares the long term action plan consisting of investment, staff increasing, budget aiming at 2015. The expert will support the WSS staff that they will develop the capability for preparation of the annual business plan by themselves.

The workshop is planned to include; 1) analysis and study for problems about operational and financial aspects, 2) planning measures for improvement and countermeasures, 3) preparation of action plan, and 4) trainings based on the business plan preparation manual prior to the construction works. The expert also monitors the progress of the preparation and analizes problems between planned situation and actual one, especially increase of customers with house and yard connections. If necessary, the expert will recommend a countermeasures for improving situation.

3) Monitoring stage

The soft-component expert and the counterparts collaborate over the confirmation, inspection and suggestions relating to the items detailed above. The detailed activities are shown in Table 2.22 which consists of activities, target populations, population numbers, implementation methods, people in charge, activity periods and outputs.

Table 2.22 Soft-component Activities

Activities	Trainee	No. of Trainee	Procedures of Training	Experts	Duration	Output
1. Preparation Stage						
1.1 Discussion and explanation of soft-component scheme	WRD and WSS		Explanantion and discussion	Japanese/Eritrean Expert	1 day for 4 towns	
2. Implementation Stage						
2.1 Training for strengthening the technical capabilities of the staff						
a. Preparation of Training manual for reduction of unaccounted for water			Investigation and Preparation of Manual	Japanese/Eritrean Expert	15 days for 4 towns	Manual
b. Execution of Workshop	WSS of 4 Towns	30persons	Workshop for staff of WSS	Eritrean Expert	3 days for 4 towns	Training report
b-1) Method for identifying leakage points along pipeline including including examples		30persons	Workshop for staff of WSS	Eritrean Expert		
b-2) Reparing method		30persons	Workshop for staff of WSS	Eritrean Expert		
b-3) Required materials and equipment, and their standard		30persons	Workshop for staff of WSS	Eritrean Expert		
b-4) Requirements for customers data base		30persons	Workshop for staff of WSS	Eritrean Expert		
b-5) Survey method for condition of pipelines		30persons	Workshop for staff of WSS	Eritrean Expert		
b-6) Check of irregal connection in the network		30persons	Workshop for staff of WSS	Eritrean Expert		
c. Training at Sites in four towns						
c-1) Dekemhare	WSS of 4 Towns	13persons	On the Job Training at Site		5 days per a town	Training report
c-2) Adi Keyh	WSS of 4 Towns	6persons	On the Job Training at Site		5 days per a town	Training report
c-3) May-dima	WSS of 4 Towns	4persons	On the Job Training at Site		5 days per a town	Training report
c-4) Debarwa	WSS of 4 Towns	6persons	On the Job Training at Site		5 days per a town	Training report
2.2 Training and support for preparation of business plan after completion of the Project towards 2015						
a. Preparation of manual for establishing business plan			Investigation and Preparation of Manual	Japanese/Eritrean Expert	10 days for 4 towns	Manual
b. Execution of Workshop	WSS of 4 Towns		Workshop for staff of WSS	Eritrean Expert	3 days for 4 towns	Training report
b-1) Analysis and study for problems and subject						
b-2) Planning measures for problems						
b-3) Preparation of action plan						
b-4) Traning based on the manual						
c. Analyses and recommendation for delay between plan and actual progress						
c-1) Dekemhare	WSS of 4 Towns	4persons	On the Job Training at Site	Eritrean Expert	2 days per a town	Training report
c-2) Adi Keyh	WSS of 4 Towns	7persons	On the Job Training at Site	Eritrean Expert	2 days per a town	Training report
c-3) May-dima	WSS of 4 Towns	3persons	On the Job Training at Site	Eritrean Expert	2 days per a town	Training report
c-4) Debarwa	WSS of 4 Towns	5persons	On the Job Training at Site	Eritrean Expert	2 days per a town	Training report
3. Monitoring						
3.1 Confirmention of progress, analyses of problems, and recommendation for measures	WSS of 4 Towns		Monitoring through records	Eritrean Expert	1 day for per a town	Chech-list

2-5-6 Method of procuring the soft-component resources

(1) Japanese expert

The Japanese expert will be responsible for the following items under the soft-component scheme:

Expert and assignment period	Activities
Japanese operations and maintenance expert : 18 man・day	• Progress control of the soft-component scheme for 4 towns • Discussions with WRD and WSS about operations and maintenance and water quality control, preparation and submission of the manual • Preparation of the operations and maintenance training program for 4 towns
Japanese institutional and operations expert : 14 man・day	• Discussions with WRD and WSS about the operations management manual, and preparation and submission of the manual • Preparation of the operations management training program for 4 towns

(2) Counterparts

The WRD and Debub region governmental staff will participate as the counterparts. They are responsible for supervising the activities in collaboration with the Japanese expert. They are in charge of coordinating with the related agencies during the training period.

(3) Eritrean expert

The Eritrean expert is responsible for the following items in the soft-component scheme:

Expert and assignment period	Activities
Eritrean operations and maintenance expert : 38 man・day	• Discussions with WRD and WSS about the manual of reduction of unaccounted for water, preparation and submission of the manual • Preparation and implementation of the training program for 4 towns
Eritrean institutional and operations expert : 26 man・day	• Discussions with WRD and WSS about the annual business plan preparation manual, preparation and submission of the manual • Preparation and implementation of the training program for 4 towns • Supporting the preparation of the annual business plan targeted for 2015

It is assumed that a local consultant is assigned as the above expert considering the scope of works and local NGO activities.

2-5-7 Soft-component implementation schedule

The soft-component implementation schedule is shown in Figure 2.7. The following points are considered in the formulation of the implementation schedule based on the current WSS situation.

1) The soft-component scheme is implemented over 22.5 months during the construction period.

2) Technical training for the operations and maintenance phase are implemented upon completion of construction in order to effectively maintain the facilities.

3) In the course of training and support for preparation of business plan, workshop will be executed at initial stage of construction work for earlier arrangement for budget and increase of required staff in order to bring the earlier result of the Project.

(Unit: Month)

Contents of Soft-component \ Implementation Stage of the Project		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
		Detailed Design												Tendering																						
		Construction Work																																		
		Dekemhare																																		
		Adi Keyh																																		
		Debarwa																																		
		May-dima																																		
		Soft-component																																		
1. Preparation Stage	Required Days																																			
1.1 Discussion and explanation of soft-component scheme	1 day for 4 towns																																			
2. Implementation Stage																																				
2.1 Training for strengthening the technical capabilities of the staff																																				
a. Preparation of Training manual for reduction of unaccounted for water	15 days for 4 towns																																			
b. Execution of Workshop	3 days for 4 towns																																			
b-1) Method for identifying leakage points along pipeline including including examples																																				
b-2) Reparing method																																				
b-3) Required materials and equipment, and their standard																																				
b-4) Requirements for customers data base																																				
b-5) Survey method for condition of pipelines																																				
b-6) Check of irregal connection in the network																																				
c. Training at Sites in four towns																																				
c-1) Dekemhare	5 days per a town																																			
c-2) Adi Keyh	5 days per a town																																			
c-3) May-dima	5 days per a town																																			
c-4) Debarwa	5 days per a town																																			
2.2 Training and support for preparation of business plan after completion of the Project towards 2015																																				
a. Preparation of manual for establishing business plan	10 days for 4 towns																																			
b. Execution of Workshop	3 days for 4 towns																																			
b-1) Analysis and study for problems and subject																																				
b-2) Planning measures for problems																																				
b-3) Preparation of action plan																																				
b-4) Traning based on the manual																																				
c. Analyses and recommendation for delay between plan and actual progress																																				
c-1) Dekemhare	2 days per a town																																			
c-2) Adi Keyh	2 days per a town																																			
c-3) May-dima	2 days per a town																																			
c-4) Debarwa	2 days per a town																																			
3. Monitoring																																				
3.1 Confirmention of progress, analyses of problems, and recommendation for measures	1 day for per a town																																			
Japanese Experts	Reduction of UFW	23days																																		
	Operation and Financing	19days																																		
Eritrean Experts	Reduction of UFW	43days																																		
	Operation and Financing	31days																																		

Figure 2.7 Soft-component Implementation Schedule

2-5-8 Outputs

The soft-component outputs are shown in Table 2.22.

The soft-component experts will submit the completion report, soft-component progress report, O&M manual, pump operation record, inspection monitoring sheet, facility inventory and operation sheets, water quality control manual and accounting manual.

2-5-9 Soft-component cost

The soft-component project cost is shown in Table 2.23.

Table 2.23 Cost for Soft-component

(Unit : JPY1,000)

Item	Labor cost	Direct cost	Indirect cost	Total
Total	1, 018	3, 650	1, 304	5, 972

Conditions for the cost estimate and cost items are shown below:

(1) Conditions

1) Estimate date May, 2006
2) Exchange rate Nkf 1 = ¥ 7.81
3) Implementation period Construction stage (22.5 months)

(2) Cost items

1) Direct cost
   a) Travel cost, per diem, accommodation cost
   b) Vehicle cost (lease fee : Maintenance expert and operation/financial expert 1 each)
   c) Local staff, Eritrean consultants (Operation and maintenance expert and management/financial expert 2 experts (including per diem and accommodation cost)
   d) Manual printing cost (O&M technology, water quality control, operation and financial management)

2) Direct labor cost It is proposed that the O&M expert and the financial expert are equivalent to a grade 3 class as regulated in the JICA. The dispatch period is shown in Figure 2-15, the soft-component implementation schedule.

3) Indirect cost
   a) General costs : 90% of direct labor cost
   b) Engineering cost : 20% of (Direct labor cost + General cost)

2-5-10 Responsibilities of the Eritrean side

It will be necessary for the Eritrean side to conduct continual operations and maintenance of the facilities and financial management in order to attain the soft-component objectives. Identified issues and countermeasures are as follows:

(1) In order to sustain the project benefits it is important that the staffs who undertake the training course continue to work for the water supply business in the future. Also, it is required to improve the organization and water supply system to ensure that on-site training is provided.

(2) It is important that the action plan, which will be formulated through the soft-component scheme, is implemented up until 2015. Investments, such as house connection costs and an increase in the number of operations and maintenance staff, should be made in line with the business plan. In order to attain the objectives, proper budget arrangements are necessary.

2-6 Cost Estimates

2-6-1 Project Cost

The project cost is estimated to be approximately JPY 1,597 million under Japan's Grant Aid Scheme. Japanese side will bear approximately JPY 1,591 million and the Eritrean side will bear JPY 6 million. A breakdown of each cost item is estimated as follows in accordance with the cost estimate regulations. This cost estimate is provisional and would be further examined by the Government of Japan for approval of the Grant.

(1) Japanese side

Estimated Project Cost **Approx. JPY 1,591 million**

Item		Project Cost (JPY Million)		
Debarwa town Water supply facilities	Intake facilities	140	382	1,426
	Transmission pipeline	146		
	Reservoir	33		
	Distribution pipeline	49		
	Water supply equipment	14		
May-dima town Water supply facilities	Intake facilities	118	243	
	Transmission pipeline	76		
	Reservoir	18		
	Distribution pipeline	18		
	Water supply equipment	13		
Dekemhare town Water supply facilities	Intake facilities	67	391	
	Transmission pipeline	192		
	Reservoir	47		
	Distribution pipeline	61		
	Water supply equipment	24		
Adi Keyih town Water supply facilities	Intake facilities	100	410	
	Transmission pipeline	230		
	Booster pump station	25		
	Reservoir	40		
	Water supply equipment	15		
Detailed design・Construction supervision・Soft-component				165

(2) Eritrean side

The Government of Eritrea is responsible for providing the counterpart staff, coordination with other related organizations, and acquirement of land and storage area. Land belongs to the government in principle; it can be secured for the Project. Thus, it seems that the Government of Eritrea can secure the necessary budget and staff for the Project. The items which Eritrean side provides and those costs are tabulated as below:

Item	Description	Eritrean side cost	
		1000 Nakfa	Equivalent to JPY (million)
1. Land acquisition	Land acquisition･compensation (public area) ,drilling point, pipeline, reservoir, and public fountain	-	-
	Rented land : temporary yard, storage yard, site office yard	-	-
	Road use and drilling permission from the local police and related governmental organization	-	-
2. House/Yard connection	Secondary/Tertiary pipeline to house/yard connection (for 2 years)	737	5.8
3. Project manager	Assignment of the project manager and coordinator		
Total		737	5.8

(3) Condition for cost estimation

1) Date March/2006
2) Exchange rate 1 US$ = ¥117.13
1 Nkf = ¥7.81
3) Project period 22.5 months
4) Others The Project implements to follow the grant-aid scheme guideline of the Government of Japan.

2-6-2 Operation and Maintenance Cost

The operation and maintenance cost in 2015 is estimated based on the assumed water supply connection numbers, total water supply volume, and required staffs.

Table 2.24 Operations and Maintenance Costs in 2015 and the Annual Financial Status

Unit : Nkf

Item	Debarwa	Dekemhare	May-dima	Adi Keyih
Annual balance in 2015				
Maintenance cost (spare part)	51,016	1,815,854	46,137	1,315,670
Operation cost (Fuel)	3,312,850	6,201,259	2,854,304	6,245,357
Administration cost	1,420,479	202,747	177,685	222,619
Labor cost	81,200	288,333	54,600	170,075
Other cost	292,126	5,235	10,313	13,855
Annual total cost	5,157,671	8,513,428	3,143,038	7,967,576
Annual water fee collection	3,085,345	6,913,830	2,607,560	5,190,300
Annual balance	-2,072,326	-1,599,598	-535,478	-2,777,276
WSS staff in 2015				
Staff numbers (persons)	18	27	9	10
Water supply volume (m3/day)	1,942	2,743	675	3,029
Number of pipe connection (numbers)	1,892	787	0	1,919
Number of public fountain (places)	9	9	5	13

The fuel cost occupies about 70 % of the total amount of operation cost in each town, based on unit prices of power supply (8.3 Nkf/Kwh) and diesel oil (16.5Nkf/l). Assuming these high rates of fuels even in 2015, water supply service in each town will have the annual deficit. However, it is expected that operation cost will decrease because power line network will expand for whole town area and unit price of electricity will decrease.

Chapter 3
Project Evaluation and Recommendation

Chapter 3 Project Evaluation and Recommendations

3.1 Project Effect

(1) Direct Effect

The Project will have the following effects:

1) The served population is forecast to increase from 20,000 in 2005 to 150,000 in 2015, which is the target year of the Project.

2) The access rate for clean water in the project area is currently 22% which is lower than the national average of 30%. This figure for the project area increases to 100% in 2015 after completion of all the construction works.

The served population in 2005 and 2015 is summarized in Table 3.1.

Table 3.1 Served Population and Access Rate for Clean Water for Each Town in 2005 and 2015

Item	Town	Figures in 2005	Figures in 2015	
			Without project	With project
1. Served population	Debarwa	4,311	4,311	30,497
	Dekemhare	9,319	9,319	47,983
	May-dima	2,537	2,537	25,962
	Adi Keyih	4,236	4,236	46,459
	Total	20,403	20,403	150,901
2. Access rate for clean water	Debarwa	24.9%	14.1%	100.0%
	Dekemhare	32.8%	19.4%	100.0%
	May-dima	14.8%	9.8%	100.0%
	Adi Keyih	14.2%	9.1%	100.0%
	Total	22.1%	13.5%	100.0%

In addition, the operation and maintenance capabilities of the Water Supply Service (WSS) in the four towns will increase after the soft components of the scheme have been implemented.

1) Technical staff of the WSS will learn leakage reduction methods and improve their operation and maintenance techniques.

2) Administration staff of the WSS will improve their capability to prepare an annual business plan and to manage financial matters relating to the development plan and investment.

3) Residents will obtain reasonably priced water instead of expensive water supplied by tanker. The Project can be useful for poverty reduction.

Issues, project components, and project effects of the Water Supply Service in four towns are summarized as follows:

Table 3.2 Project Effects and Degree of Improvement from the Project Implementation

Current issues	Countermeasures in the Project (Grant-aid project contents)	Project effects and degree of improvement
The access rate for clean water in the four towns is 22%, which is lower than the national average (30%). This is because these four towns have not developed groundwater sources and water supply facilities. As a result, residents must purchase water from water tankers whose water is seven times as expensive in comparison with house connection service or use of unhygienic river water.	Deep-well development in 27 places, intake pump installation for 48 locations, transmission pipeline installation for 82.4km, construction of 1 booster pump station, construction of 6 reservoirs, distribution pipeline installation for 26.4km, and construction of 44 public fountains	1) Served population increases to 15,000 in 2015. 2) Access rate for clean water increases to 100% in 2015.
Leakage and unaccounted for water volume would increase if connections from the constructed distribution pipe to the service pipe and renewal of the old pipes are not implemented properly.	Technical support for leakage control works for WSS technical staff through the soft components of the scheme	Technical staff of each WSS can solve problems with leakage from distribution and service pipe promptly and properly.
It is necessary to invest in equipment and increase staff corresponding to the increase of house connections, yard connections, and public fountain users in order to use the constructed water supply facilities effectively.	Technical support with financial management and planning methods for WSS staff through the soft components of the scheme	The WSS staff who prepare the business plans can formulate adequate annual business plans including equipment investment and increase of staff.

(2) Indirect Effect

The following items can be expected as the indirect project effects:

1) Residents will be able to obtain safe water quality and stable water quantity after the Project. There will be improved hygiene conditions and a decrease in water-related diseases.
2) Women and children will be able to reduce their workload of drawing and carrying water. Women will have increased opportunities to participate in social activities and jobs. Children will have increased study opportunities.
3) People don't have to purchase water from the bender at high price and can get water at cheap price. It will contribute to poverty reduction.

3.2 Recommendations

It is necessary to consider the following items in order to operate the water supply facilities smoothly and sustainably after the Project.

(1) Establishment of WSS staff organization

Technical staff from each WSS shall work at the same WSS office continuously after completion of the project and pass on their knowledge to other staff in order to sustain the project effect. It is important for each WSS to establish an office organization and they should also consider each staff member's career.

(2) Increasing WSS technical staff levels

The Japanese side will construct the Project from the intake to the distribution pipelines and the Eritrean side is responsible for the connection from the distribution pipe to the existing or new service pipes. Debarwa and Adi Keyih have more than 1000 points of service connection working, and it will be difficult to achieve the design access rate by 2015 under the current staff numbers. It is therefore imperative that technical staff numbers be increased and that the increase be implemented before commencement of the operation stage in order to reliably achieve the desired increase in the water access rate.

(3) Establishment of chlorine supply system

As each town cannot purchase chlorine locally, it shall be procured in Asmara. The existing water does not have added chlorine so raw water is supplied to the residents. Each town shall build a chlorine supply system from now on. The WSS shall establish the procurement method for chlorine by the commencement of the operation stage.

(4) Establishment of fuel supply system for generator

There is no power supply network in May-dima, so a generator is the power source for the intake pumps. May-dima town does not have a fuel filling station so diesel oil may not be easily obtained. Therefore, it is essential to acquire a reliable supply of diesel oil in order to provide a stable water supply for May-dima town.

(5) Provision of access road for construction work

In principle a pipe will be installed along the existing roads. However, some pipeline routes are at a distance from the existing road because of the proposed deep-well locations. As a result, an access road for pipe installation will be necessary during the construction stage. In order to construct the water supply facilities promptly, the Eritrean side shall construct access roads by the time of completion of the detailed design works.

(6) Guarantee of the Eritrean side project budget

The Government of Eritrea shall take necessary action to secure the Eritrean side project budget before starting the construction work.