PREPARATORY SURVEY REPORT
ON THE PROJECT FOR
ASMALA WATER SUPPLY DEVELOPMENT
IN THE STATE OF ERITREA

July 2015

JAPAN INTERNATIONAL COOPERATION AGENCY

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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 preparatory survey for a Grant Aid Project for the rehabilitation and expansion of the water supply facility in Asmara and entrusted the survey to the Japan International Cooperation Agency (JICA).

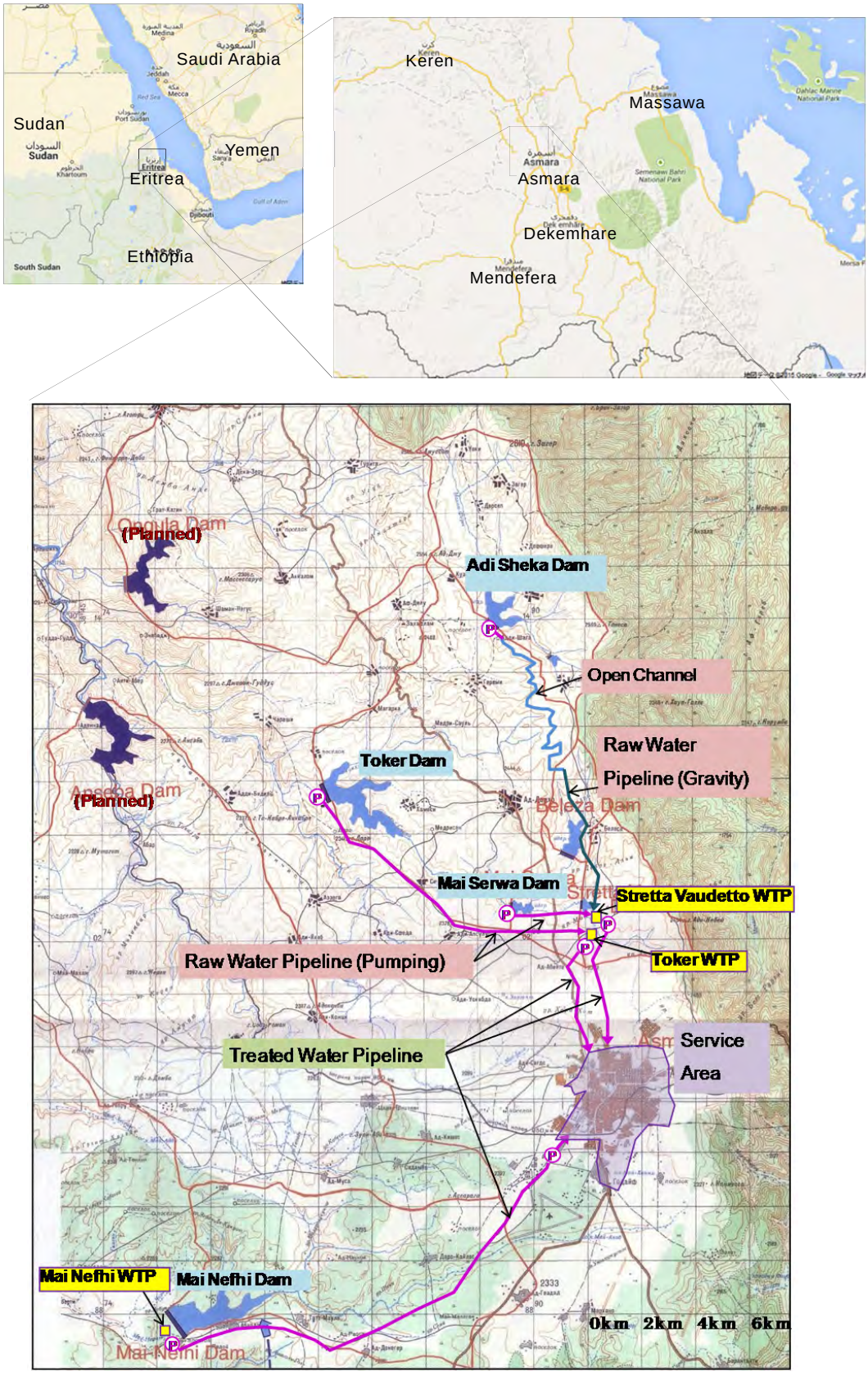
JICA sent to Eritrea a survey team from March 22, 2015 to May 3, 2015 and from May 31, 2015 to June 5, 2015.

I hope that this report will be utilized as a reference by the person concerned.

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 survey team.

July, 2015

Kunihiro Yamauchi
General Manager, Global Environment Dept.
Japan International Cooperation Agency



Location Map

Photos

Stretta Vaudetto System

Adi Sheka dam

Adi Sheka PS

Raw water transmission channel from Adi Sheka dam

Mai Serwa dam

Mai Serwa PS

Stretta Vaudetto WTP

Stretta Vaudetto WTP

Treated water transmission pump in Stretta Vaudetto WTP

Toker System

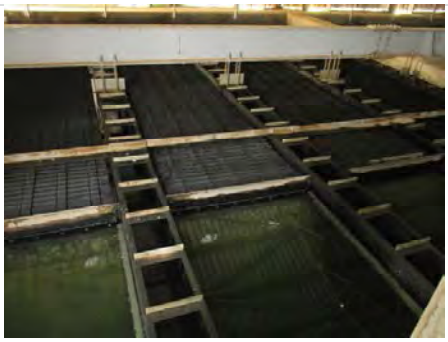
Toker dam

Toker dam

Toker PS　Diesel engine

Toker PS　　Raw water transmission pumpポンプ

Toker WTP　Flocculation facility



Toker WTP　Sedimentation facility

Toker WTP　Rapid sand filter

Treated water transmission pump in Toker WTP

Mai Nefhi System

Mai Nefhi dam

Mai Nefhi WTP

Mai Nefhi WTP　Rapid sand filter

Treated water transmission pump in Mai Nefhi WTP

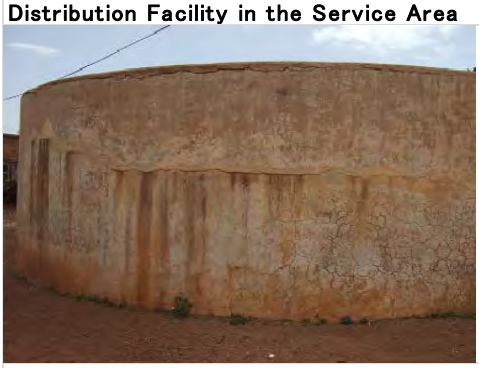
Treated water transmission pipeline
Pipe bridge

Treated water transmission pipeline
Valve pit

Sembel PS

Distribution pump in Sembel PS

Distribution Facility in the Service Area



Hazhaz reservoir

Tsetserat reservoir

Monopolio reservoir

Mai Chehot PS Exterior

Distribution pump in Godaif PS

Distribution pump in Denden PS

Valve pit on the primary distribution pipeline

Gate valve on the primary distribution pipeline

Asmara Water Supply and Sewerage Department

Tariffi collection counter

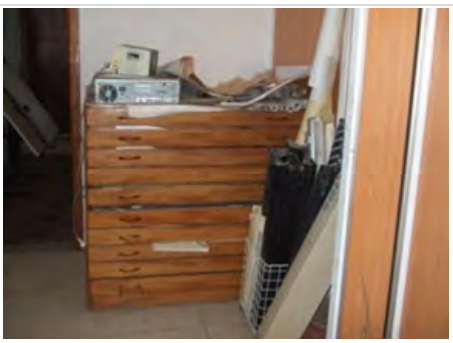
Complaints acceptance counter

Water meter testing equipment

Material store in AWSD

Water meter

Truck with crane owned by AWSD



Drawings storage rack

Signing of Minutes of Discussion

Preparatory Survey on Asmara Water Supply Development

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Abbreviations

AfDB	Africa Development Bank
ALUM	Aluminum sulfate
AWSD	Asmara Water Supply and Sewerage Department
EE	Environmental Evaluation
EEC	Eritrean Electric Corporation
EECF	Environmental Evaluation Clearance Form
EEQ	Environmental Evaluation Questionnnaire
EIA	Environmental Impact Assessment
ESA	Environmental Sensitive Area
ESI	Eritrean Standard Institute
IEE	Initial Environmental Examination
I-PRSP	Interim Poverty Reduction Strategy Paper
MD	Minutes of Discussion
MoA	Ministry of Agriculture
MoEM	Ministry of Energy and Mine
MoH	Ministry of Health
MoLWE	Ministry of Land, Water and Environment
MoND	Ministry of National Development
MoTI	Ministry of Trade and Industry
PS	Pump Station
S.V.	Stretta Vaudetto
WRD	Water Resources Department
WTP	Water Treatment Plant

Chapter 1 Outline of the Survey

1.1 Background and Contents of the Request for Grant Aid Project

Since its independence in 1993, the State of Eritrea has been in a difficult socio-economic condition due to the several armed conflict with its neighboring countries, especially the armed conflict with Ethiopia from 1998 to 2000. Asmara, the capital city of Eritrea, which has a population of approximately 400,000, is facing a serious shortage of water supply (only 30% of the potential demand is being supplied, as of 2009) due to the increasing demand and deterioration of the existing facilities.

In the Interim Poverty Reduction Strategy Paper (I-PRSP) of Eritrea prepared in 2004, improvement of sanitary environment including water supply condition is one of the important components for human resource development in the country. Thus, improvement of water supply system in the urban area such as Asmara City is being set as one of the national development goals. Under these circumstances, the Government of Eritrea submitted an application form for the Japanese Grant Aid in August 2013. The contents of the requested project were for rehabilitation and expansion of the water supply system as shown in Table 1.1.1.

Table 1.1.1 Contents of the Request

Summary of Detailed Contents of the Project

No.	ACTIVITY	SIZE	QUANTITY	COST (USD)	PRIORITY
1.	Construction of New Treated Water Transmission Pipe Line from Mai-Nefhi W.T.P to Sembel Pump Station.	DCI Dia.600mm	25KM	9,212,916	1
2.	Rehabilitation of Stretta Vaudetto Raw Water Transmission line	PVC & DI Dia.300mm	2.6 km	777,370	1
3.	Upgrading of the Stretta Vaudetto system raw water pumping stations				
3a.	Stretta Vaudetto Pumping Stations	Q=180m^3/h H=23m	1 unit	67,710	2
3b.	Mai Serwa Raw Water Pumping Stations	Q=200m^3/h H=61m	2 units	136,620	2
4.	Upgrading of the Stretta Vaudetto clear water pumping station	Q=380m^3/h H=93m	4 units	294,753	1
5.	Upgrading of the distribution system pumping stations				
5a.	Mai Chehot pumping station	Q=200m^3/h H=85m	2 units	160,082	3
5b.	Denden pumping station	Q=170m^3/h H=50m	2 units	53,200	3
6.	Rehabilitation of Stretta Vaudetto W.T.P and Construction of New S.V W.T.P	15,000m^3/day	1 unit	2,798,260	1
7.	Rehabilitation of the Existing Distribution Reservoirs.				
7a.	Monopolio Distribution Reservoir	300m^3	2 units	104,679	2
7b.	Tsetserat Distribution Reservoir	500m^3	2 units	140,623	3
7c.	Haz Haz Distribution Reservoir	500m^3	2 units	121,458	2
8.	Construction of New Distribution Reservoirs.				
8a.	New Arbate Asmara Distribution Reservoir	1,000m^3	1 unit	323,174	1
8b.	Cherkos Distribution Reservoir	1,000m^3	1 unit	339,862	1
9.	Rehabilitation and Extension of Primary Distribution Network.	PVC & DI Dia.150mm Dia.200mm Dia.250mm Dia.300mm	 3.3 km 17.3 km 7.0 km 13.0 km	3,798,982	1
10.	Rehabilitation and Extension of Secondary Distribution Network	PVC Dia.63mm Dia.90mm Dia.110mm Dia.160mm	 7.6 km 9.9 km 8.9 km 3.0 km	2,619,263	2
11.	Soft Component			219,800	
	TOTAL			**21,168,752**	

Source: Application form (2013)

1.2 Objective of the Survey

Before and after submission of this application form, preliminary surveys were conducted: 1) First preliminary survey conducted prior to official submission of this application form by the Government of Eritrea (August 2010) and 2) Second preliminary survey conducted after the adoption of the application form by the Government of Japan. However, the collected information on existing facilities, present water supply condition, and operation and maintenance condition was still insufficient. Thus, it was decided to conduct this preparatory survey in order to collect necessary information for evaluating the necessity of the Grant aid project and the readiness for conducting the preparatory survey (outline design) of the Grant aid project, and considering if the requested Grant aid project is technically effective and sustainable or not.

1.3 Member of the Survey Team

(1) First Field Survey

	Name	Job Title	Organization	Period
1	Yoshiki Omura	Leader	Senior Advisor, JICA	2015/3/21 -2015/3/28
2	Masanori Yamazaki	Program officer	Water Resources Management Team 2, JICA	2015/3/21 -2015/3/28
3	Hidehisa Tamura	Civil Engineer (Water Supply Planning)	Nippon Koei Co., Ltd.	2015/3/21 -2015/5/4
4	Koji Yoshikawa	Civil Engineer (Facility Planning / Operation and Maintenance)	Consultant	2015/3/21 -2015/5/4

(2) Second Field Survey

	Name	Job Title	Organization	Period
1	Akihiro Miyazaki	Leader	Manager, Water Resources Management Team 2, JICA	2015/6/3 -2015/6/7
2	Yoshiki Omura	Senior advisor (Water Supply Planning)	Senior Advisor, JICA	2015/5/30 -2015/6/7
3	Kensuke Ochima	Program officer 1	Africa unit 1 Africa Dept., JICA	2015/5/30 -2015/6/7
4	Keisuke Yamagami	Program officer 2	Water Resources Management Team 2, JICA	2015/5/30 -2015/6/7
5	Hidehisa Tamura	Civil Engineer (Water Supply Planning)	Nippon Koei Co., Ltd.	2015/5/30 -2015/6/7
6	Koji Yoshikawa	Civil Engineer (Facility Planning / Operation and Maintenance)	Consultant	2015/5/30 -2015/6/7

1.4 Survey Schedule

(1) First Field Survey

Date			JICA		Consultant	
			Mr. Omura	Mr. Yamazaki	Mr.Tamura	Mr.Yoshikawa
			Leader	Program Officer	Civil Engineer (Water Supply Planning)	Civil Engineer (Facility Planning / Operation and Maintenance)
1	2015/3/21	sat	NARITA → ISTANBUL ISTANBUL →			
2	2015/3/22	sun	→ASMARA Meeting w/ Mr.Tsurusaki (JICA Expert) Site Visit: Reservoir & Pump Station in Asmara City			
3	2015/3/23	mon	Site Visit:: Dam & Water Treatment Plant (Stretta Vaudetto WTP System) Meeting with Minister of National Development and Minister of Land, Water and Environment @MoND Meeting with Zoba Maekel Administrator and Asmara Water Supply and Sewerage Department, Chaired by Minister of MoLWE @ Zoba Administration.			
4	2015/3/24	tue	Site Visit:: Dam & Water Treatment Plant (Tokar WTP System, Mai Nefhi WTP System)			
5	2015/3/25	wed	Meeting with Ministry of National Development and Zoba Maekel Administration (Confirming Minutes of Discussion) Meetiing with Eritrean Electric Corporation Meeting with Ministry of Land, Water and Environment			
6	2015/3/26	thu	Meeting with Ministry of National Development and Ministry of Land, Water and Environment (Signing of Minutes of Discussion) Site Visit: Laboratory of MoLWE, Training Center of AWSD Internal Meeting, Report to Mr.Tsurusaki			
7	2015/3/27	fri	Analysis of survey results Preparation of report	ASMARA → ISTANBUL →	Meeting with AWSD	Meeting with AWSD
8	2015/3/28	sat	ASMARA → CAIRO	→ NARITA	Data analysis	Data analysis
9	2015/3/29	sun			Data analysis	Data analysis
10	2015/3/30	mon			Data collection (Water supply condition)	Site survey (Stretta Vaudetto System)
11	2015/3/31	tue			Data collection (AWSD business operration)	Site survey (Stretta Vaudetto System)
12	2015/4/1	wed			Site survey (Mai Nefhi System)	Site survey (Mai Nefhi System)
13	2015/4/2	thu			Site survey (Distribution System)	Data collection (WRD)
14	2015/4/3	fri			Data collection (AWSD business operration)	Site survey (Toker System)
15	2015/4/4	sat			Data analysis	Data analysis
16	2015/4/5	sun			Data analysis	Data analysis
17	2015/4/6	mon			Site survey (Mai Nefhi System)	Site survey (Mai Nefhi System)
18	2015/4/7	tue			Data collection (Water supply condition)	Site survey (Toker System)
19	2015/4/8	wed			Data collection (Water supply condition)	Site survey (Distribution System)
20	2015/4/9	thu			Data collection (AWSD business operration)	Site survey (Distribution System)
21	2015/4/10	fri			Site survey (New Development Area)	Site survey (New Development Area)
22	2015/4/11	sat			Data analysis	Data analysis
23	2015/4/12	sun			Asmara → Nairobi	
24	2015/4/13	mon			Interim Reporting @: JICA KENYA Office	
25	2015/4/14	tue			Nairobi → Asmara	
26	2015/4/15	wed			Data collection (AWSD business operration)	Data collection (WRD)
27	2015/4/16	thu			Data collection (WRD)	Data collection (AWSD)
28	2015/4/17	fri			Data analysis	Data analysis
29	2015/4/18	sat			Data analysis	Data analysis
30	2015/4/19	sun			Data analysis	Data analysis
31	2015/4/20	mon			Site survey (Stretta Vaudetto System)	Data collection (WRD)
32	2015/4/21	tue			Site survey (Stretta Vaudetto System)	Data collection (EEC)
33	2015/4/22	wed			Site survey (Toker System)	Data collection (operation and maintenance)
34	2015/4/23	thu			Site survey (Mai Nefhi System)	Site survey (Electric facility)
35	2015/4/24	fri			Site survey (Distribution System)	Data collection (operation and maintenance)
36	2015/4/25	sat			Data analysis	Data analysis
37	2015/4/26	sun			Data analysis	Data analysis
38	2015/4/27	mon			Data collection (Water supply condition)	Supplementary data collection (WRD, AWSD)
39	2015/4/28	tue			Data collection (Water supply condition)	Supplementary data collection (WRD, AWSD)
40	2015/4/29	wed			Data collection (AWSD business operration)	Supplementary data collection (WRD, AWSD)
41	2015/4/30	thu			Data collection (AWSD business operration)	Supplementary data collection (WRD, AWSD)
42	2015/5/1	fri			Data analysis	Data analysis
43	2015/5/2	sat			Data analysis	Data analysis
44	2015/5/3	sun			ASMARA → ISTANBUL →	
45	2015/5/4	mon			NARITA	

(2) Second Field Survey

			JICA				Consultant	
			Mr.Miyazaki	Mr. Omura	Mr. Oshima	Mr. Yamagami	Mr.Yoshikawa	
			Leader	Senior Advisor (Water Supply Planning)	Program Officer1	Program Officer2	Civil Engineer (Facility Planning / Operation and Maintenance)	Civil Engineer (Water Supply Planning)
1	2015/5/30	sat		NARITA → ISTANBUL →				DAKAR → ISTANBUL →
2	2015/5/31	sun		→ASMARA Meeting w/ Mr.Tsurusaki (JICA Expert) and Internal meeting				
3	2015/6/1	mon		Explanation of Result of the Survey (MoND, MoLWE, AWSD, Zoba Maekel, Ministry of Foreign Affairs) Internal meeting				
4	2015/6/2	tue	DAR ES SALAAM → DOHA→	Discussion w/ related organization (WRD, AWSD) Internal meeting				
5	2015/6/3	wed	→ASMARA	—				
			Internal meeting Site Visit: Stretta Vaudetto and and Tokor Purification plan in Asmara City Discussion w/ related organization (MoND, MoLWE, AWSD, Zoba Maekel, Ministry of Foreign Affairs) Discussion w/ related organization (WRD, AWSD)					
6	2015/6/4	thu	Discussion w/ related organization (Confirmation of M/D) (WRD, AWSD) Internal meeting					
7	2015/6/5	fri	Signing of M/D Meeting w/ Mr.Tsurusaki (JICA Expert)					
8	2015/6/6	sat	ASMARA → CAIRO → DOHA	ASMARA → CAIRO → ISTANBUL →				
9	2015/6/7	sun	DOHA → NARITA	→ NARITA				ASMARA → ISTANBUL → DAKAR

1.5 Major Contact Person

(1) Eritrean Side

No	Institution	Name	Position
1	Ministry of National Development	Dr. Giorgis Tekelemikael	Minister
2	Ministry of National Development	Mr. Solomon Tecle	Senior Expert
3	Ministry of Land, Water and Environment	Mr. Tesfai Ghebreselassie	Minister
4	Ministry of Land, Water and Environment / Water Resource Department	Mr. Mebrahtu Iyassu	Director General
5	Ministry of Land, Water and Environment / Water Resource Department	Mr. Tecle Yemane	Unit Leader, Information service unit
6	Asmara Water Supply and Sewerage Department	Mr. Gebrekidan Gabretsiun	Director General
7	Asmara Water Supply and Sewerage Department	Mr. Yohannes Mulu	Unit Leader, Planning and Supervision unit
Others: Refer to the Appendix.			

(2) JICA Eritrea

Tsuneo Tsurusaki JICA Expert

1.6 Outline of Survey Results

1.6.1 Results of First Field Survey

Data collection / analysis and filed investigation were conducted for the following item regarding the present situation and issues of the water supply in Asmara:

1) Organization of the implementing agency of water supply in Asmara
2) Present condition of water supply business operation
3) Present condition of water supply facility

4) Present condition of operation and maintenance and water quality management
5) Water demand projection and water supply balance
6) Prerequisite for operation of the facility
7) Consideration of assistance component of facility construction
8) Consideration of assistance of operation and maintenance

Then, the contents of the requested grant aid project were examined from the three viewpoints as follows:

1) Prerequisite No.1 (Availability of water source)
2) Prerequisite No.2 (Power supply condition)
3) Sustainability of O&M of the constructed facility

As a result of the examination, the proposed grant aid project was evaluated, at this moment, not to be technically appropriate for grant aid for its effectiveness and sustainability.

1.6.2 Results of Discussion with the Eritrean Side

(1) Reporting of the Results of the First Field Survey

The survey team explained to the Eritrean side the present issues of the water supply in Asmara identified through the first field survey. The Eritrean side agreed the contents of it and it was compiled as Annex-1 of the Minutes of Discussion.

(2) Preparatory Survey (Outline Design) of the Project.

The survey team explained to the Eritrean side that the preparatory survey (outline design) of the project will not be commenced, because it is difficult to secure the effectiveness and sustainability, at this moment.

The survey team also explained that the appropriate operation and maintenance of the existing facility should be prioritized over the implementation of the requested grant aid project.

The Eritrean side agreed on the above.

(3) The Possibility of the Japanese Assistance

The survey team explained that, for the proper operation and maintenance, information management on the inventory and operational condition of the facility should be prioritized. The survey team also explained that JICA may consider the implementation of the technical assistance on the information management as the technical cooperation scheme of JICA.

The above discussion results were compiled as Annex-2 of the Minutes of Discussion. It was confirmed that Eritrean side may submit a request for the technical cooperation of JICA on the basis of the Annex-2 of the Minutes of Discussion. It was also confirmed, if the Eritrean side wishes to request the technical cooperation in this fiscal year, the application form needs to be submitted from the Government of Eritrea to the Government of Japan by the end of July, 2015.

Chapter 2 Present Condition Related to the Requested Project

2.1 Outline of the Request for Grant Aid Project

2.1.1 Background of the Request

Since its independence in 1993, the State of Eritrea has been in a difficult socio-economic condition due to the several armed conflict with its neighboring countries. Asmara, the capital city of Eritrea, which has a population of approximately 400,000, is facing a serious shortage of water supply (only 30% of the potential demand is being supplied) due to the increasing demand and deterioration of the existing facilities.

In 2006, under these circumstances, the Government of Eritrea conducted a Feasibility Study on the Development of Asmara Water Supply (hereinafter referred to as FS) with funding assistance by the Asian Development Bank (ADB). Following that, the detailed design of the priority components was prepared in 2007. However, the construction stage has not been commenced.

In 2010, the Japan International Cooperation Agency (JICA) made a discussion with the Government of Eritrea regarding the implementation of the construction works under the Japanese Grant Aid Scheme. As a result, the Government of Eritrea submitted an application form for the Japanese Grant Aid in August 2013.

2.1.2 Contents of the Requested Project

The objectives of the project are i) to improve the water supply condition and ii) to provide a stable and safe water supply in Asmara.

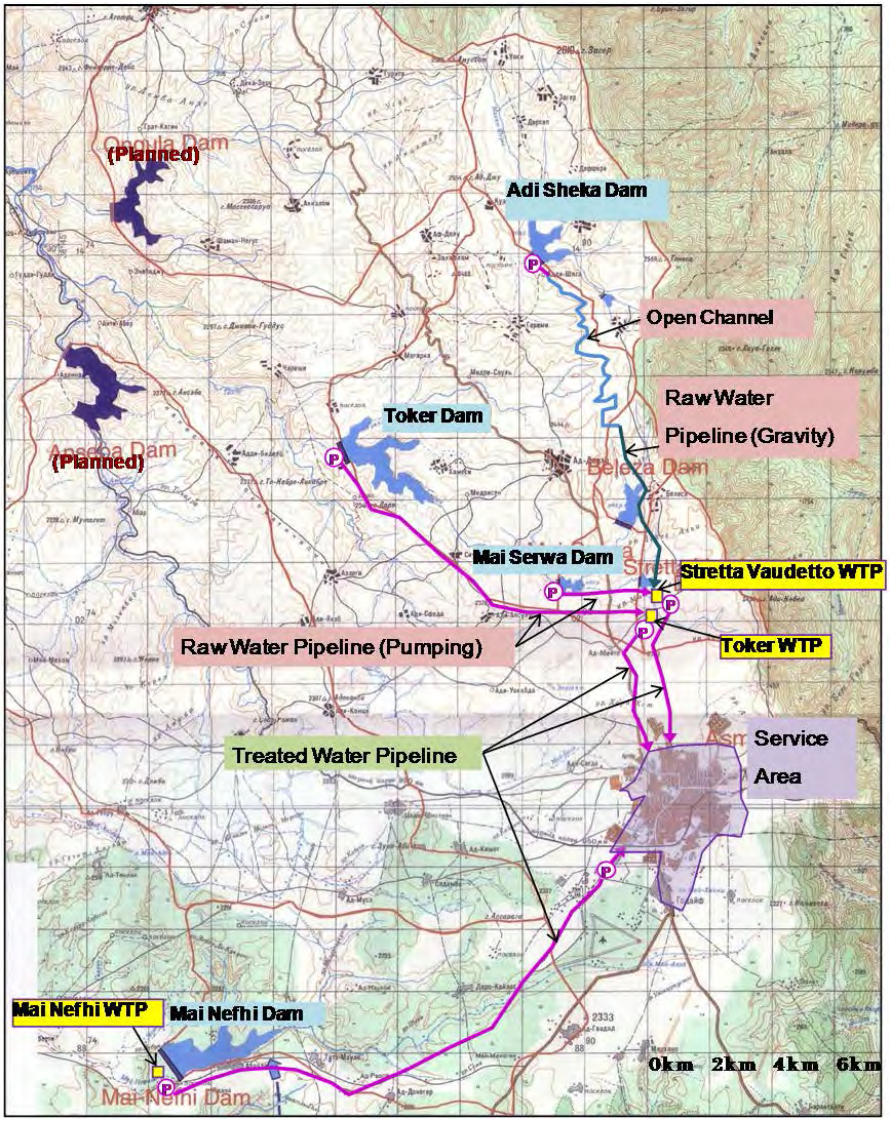
The water source of Asmara Water Supply is the dam lake as shown in Figure 2.1.1. The raw water is treated at the three water treatment plants (WTP) and then transmitted to the supply area in Asmara City. The contents of the requested project are summarized in Table 2.1.1. The colored items are those which were prioritized by the Eritrean government at the inception meeting of the survey held in March 2015.

Table 2.1.1 Contents of the Requested Project

Facility	Requested Contents (August 2013)
Stretta Vaudetto WTP System	
Raw water transmission facility from Mai Serwa Dam	Replacement of intake pump (Q= 200 m^3/h, H=61 m)
	Replacement of existing AC pipe (D300, L=2.7 km) with PVC/DCI pipe (DN300, L= 2.7 km)
Raw water transmission facility from Stretta Vaudetto Dam	Replacement of intake pump, Submersible pump (Q= 180 m^3/h, H= 23 m) x 2 nos.
Stretta Vaudetto WTP	Rehabilitation of existing WTP (8,00 m^3/day) Construction of new WTP (15,000 m^3/day)
Treated water transmission pump from Stretta Vaudetto WTP	Replacement of existing pumps (300 m^3/h x 3 nos.) with new pumps (380 m^3/h, H=93 m x 4 nos.)
Toker WTP System	
Mai Nefhi WTP System	
Treated water transmission pipeline from Mai Nefhi WTP to Sembel PS	Laying of new pipeline (DCI D600) along the existing pipeline (STP D500, L= 16 km), then abolish the existing pipeline.

Distribution Facility in the city	
Pump Station (PS)	Mai Chehot PS: Replacement of pump (Q=200 m^3/h, H=85 m) x 2 nos. Denden PS: Replacement of pump (Q=170 m^3/h, H=50 m) x 2 nos.)
Distribution Reservoir	Monopolio Reservoir (300 m^3 x 2): Rehabilitation Tsetserat Reservoir (500 m^3 x 2): Rehabilitation Hazhaz Reservoir (500 m^3 x 2): Rehabilitation
	New Arbate Asmara Reservoir (500 m^3 x 2): New construction Cherkos Reservoir (500 m^3 x 2): New construction
Distribution pipeline (Primary pipeline)	Pipe laying PVC DN300 L=13 km, PVC DN250 L=7 km, PVC DN200 L =17.3 km, DCI DN150 L=3.3 km
Distribution pipeline (Secondary pipeline)	Supply of pipes and fitting including 10,000 nos. of water meter PVC DN150–DN50

Source: Survey Team



Source: Survey Team

Figure 2.1.1 Outline of the Water Supply Facility of Asmara

2.2 Present Water Supply Condition in Eritrea

2.2.1 Government Organizations Related to Water Supply Sector

The contact authority of the official development assistance (ODA) in Eritrea is the Ministry of National Development. The regulatory agency of water supply business is the Water Resources Department (WRD), Ministry of Land, Water and Environment. The business operation is being undertaken by the regional government (Zoba) or water supply utilities of the town administration under the regional government. The role of each organization is shown in Table 2.2.1.

Table 2.2.1 Role of Organizations Related to Water Supply Sector

Organization	Role
Ministry of National Development	Contact office for ODA
Water Resources Department, Ministry of Land, Water and Environment	Policy-making; Supervision of water supply business; Establishing technical standard; and Technical support to the water utilities.
Water Supply Utilities under the Regional Government or Town Administration	Plan and construction of water supply facility; Operation of water supply business

Source: Survey Team

The water supply business in Asmara is being undertaken by the Asmara Water Supply and Sewerage Department (AWSD) under the Regional Government of Central Region (Zoba Maekel).

2.2.2 Laws and Regulations Related to Water Supply Sector in Eritrea

The laws and regulations related to water supply sector in Eritrea are:

(1) Proclamation No. 162/2010 Eritrean Water Proclamation (2010)

In 2010, "Proclamation No. 162/2010 Eritrean Water Proclamation" entered into force in 2010. The outline of this proclamation is as follows:

1) Objectives

- Conservation and protection from pollution and related risk factors of the country's water resources.
- Systematization of studies and documentation of data on water resources.
- Promotion of integrated water resources management and development as well as judicious prioritization of allocation and use of the same.
- Establishment of pertinent legal framework and institutions with clear mandate in consonance with the principles of Integrated Water Resources Management.
- Promotion of public awareness on participation in water conservation, protection and management, and proper utilization.
- Ensuring equity in the use, management, and development of resources.

2) Main Provisions

- All resources in the country are common property of the people of Eritrea and the state shall regulate them to ensure their management in a balanced and sustainable manner.

- Any person shall have the right to use water resources in compliance with the provisions of this proclamation.
- The use of water for domestic purposes shall have priority over any other water-use rights.
- A permit shall be required for the use and development of water resources.
- A permit shall be required for wastewater disposal.
- No permit shall be issued under this proclamation without prior submission of the environmental impact assessment and its acceptability by the ministry.
- The Ministry of Land, Water and Environment shall be responsible for the effective, efficient, and sustainable development and protection of Eritrea's water resources.
- The ministry shall assess and evaluate the water resources potential of the country.
- The ministry shall formulate the national water policies, development strategies and plans.
- The water resources and related ecosystem of the country shall be protected against pollution and abatement.
- No person may intentionally and/or negligently pollute or contaminate water resources by direct or indirect means.
- The ministry shall set standards and prescribe guidelines for water quality.
- Water charges shall be applied on the use of water resources allowed under this proclamation.
- The state shall exert all effort to ensure that every citizen exercises the right of access to basic supply of clean and safe water.
- Any person wishing to carry out investigations, studies, designs, and supervisions on water works as consultant or supplier shall acquire a permit.

(2) Eritrean Water Resources Policy (Final Draft 2008)

The WRD drafted the Water Resources Policy in Eritrea in June 2008. The objectives of Water Resources Policy are:

- Establish and maximize the available potential of the national water resources.
- Efficient, equitable, and optimum utilization of the available water resources.

The policy presents the basic principle in the following aspects and served as the basis in the establishment of Proclamation No. 162/2010 Eritrean Water Proclamation.

- Assessment, development, protection, allocation and utilization of water resources
- Disaster management
- Institutional frames and mandates
- Financing mechanisms

(3) Eritrean Guidelines for Evaluation of Drinking Water Quality (Draft 2004)

WRD drafted guidelines for the evaluation of drinking water quality in 2004. The guidelines are based primarily on the World Health Organization (WHO) recommendations, and due attention is given to present water quality of the country.

In the guideline, water is to be classified into four groups based on the concentration and values of the following physio-chemical parameters:

Group A: Water with an excellent quality
Group B: Water with good quality
Group C: Water with low health risk
Group D: Water with a higher risk or water unsuitable for human consumption

The group in which the water is classified is decided by a parameter, which falls in the least groups of A, B, C, and D.

Ideally, water for drinking should be Group A or Group B, however, in practice, many of the parameters could be outside the limits for these groups. Based on the practical water quality situation in the country:

- In Zobas Maekel, Debub, Gash-Barka, and Anseba the water quality for consumption should be within groups A or B.
- But, in both Northern and Southern Red Sea Zobas, water for drinking should not exceed Group C.

If the classification of water falls in Group C, attention should be given to this problem, although the situation is not critical yet. If the classification of water falls in Group D, urgent and immediate attention should be given to this problem, and remedial procedures should also be taken.

2.2.3 National Plan Related to Water Supply Sector

(1) The State of Eritrea Five-Year Indicative Development Plan 2014-2018 (Ministry of National Development)

The Government of Eritrea made a five-year national development plan (2014-2018) in July 2014. In the plan, the development plans of the following eight sectors are indicated:

1) Agriculture (Food production)
2) Fisheries
3) Construction
4) Energy
5) Transportation and Communication
6) Land, Water, and Environment
7) Health Care

8) Education

In the water sector development plan as presented in item 6) above, the following ten policies are presented:

1) Develop institutional capacity for assessment of water resource potential.
2) Conservation and sustainable use of surface and ground water.
3) Establishment of flood and drought early warning system.
4) Conduct studies on national water balance.
5) Sustainable water resources development.
6) Protection of water resources from all types of pollution.
7) Optimization of allocation and use of water resource.
8) Enhance appropriate and integrated national water resource information system.
9) Enhance water resources regulatory instrument.
10) Improve working system and practices.

The policy item no."5) Sustainable water resources development" includes:

- Increase domestic water supply system of beneficiaries in urban, semi-urban, and rural areas by 4%.
- Enhance water development works for irrigation, industries, and other economic sectors by 5%.

(2) Action Plan for the Integrated Water Resources Management (IWRM) in Eritrea WRD

WRD made an action plan for the Integrated Water Resources Management (2009-2017) in December 2009. In this action plan, the action plans of the following seven action areas are presented, aiming to strengthen the country's capacity of water resources management.

Action area -1: Water resources assessment, development, and protection
Action area -2: Water resources allocation and use
Action area -3: Disaster management
Action area -4: Implementation and financial mechanism
Action area -5: Research and information exchange
Action area -6: Basin management plan
Action area -7: Enabling environment (gender mainstreaming)

The activities related to water supply development are:

Action area -1: Water resources assessment, development, and protection

- Develop water quality standards for rural, municipal, and irrigation water supplies.
- Provide equipment and facilities that enhance the water quality monitoring and regulating capacity of relevant institutions.

Action area -2: Water resources allocation and use

- Prepare guidelines and procedure for the operation and maintenance of municipal, industrial, commercial, and agricultural water supply facilities including rural water supply facilities.
- Set up standards of water utility equipment and spare parts.
- Capacity development for water-use planning

(3) National Water Supply Action Plan 2013-2017 (WRD)

WRD made the National Water Supply Action Plan (2013-2017) in March 2012. In the action plan, the population with access to safe water, as of 2011, is indicated in Table 2.2.2.

Table 2.2.2 Population with Access to Safe Water in Eritrea

Zoba	Population with access to safe water	Total population	%
Anseba	307,389	434,994	71
Debub	560,380	794,538	71
Gash Barka	506,035	735,977	69
Maekel	611,470	625,667	98
SK Bahri	265,339	374,086	71
DK Bahri	51,703	70,343	74
Total	2,302,316	3,035,605	76

Source: National Water Supply Action Plan 2013-2017 (2012 WRD)

The goal of this 'Action Plan' is to ensure that all people are provided with at least a minimum supply of 20 L (minimal 20 L and 40 L per capita per day in rural areas and towns, respectively) of safe potable water. Under this objective, the following works are to be conducted during the planning period.

Table 2.2.3 Works to be Conducted in the Action Plan (2013-2017)

	New Facility Construction	Rehabilitation of Existing Facility	Total
Beneficially population	674,953	430,837	1,105,790
Construction cost	2,422 million nakfa	743 million nakfa	3,165 million nakfa

Source: National Water Supply Action Plan 2013-2017 (2012 WRD)

By this action plan, the 670,000 people's access to 20 L/day of safe water will be made possible. The requested project does not have a direct relation to the action plan but it will help in attaining this goal.

2.2.4 Activities of the Other Donors

The United Nations Children's Fund (UNICEF) has been working in the water sector in Eritrea for many years. The ongoing project (2013-2016) is the rural water supply project in the six regions in the whole Eritrea. By this project, an approximately 40 water supply systems with solar pump (11 has been completed; 25 under construction) will be constructed. In addition, the construction of shallow well with hand pump and rainwater harvesting facility will be constructed in approximately 40 villages. The main features of the water supply system with solar pump are:

- Planned supply population: Approximately 1,000
- Main facility: Well, solar pump, treated water transmission pipeline, reservoir, distribution pipeline, public hydrant.
- Approximate cost: USD 200,000 – 250,000

2.2.5 Past Project with Assistance of Japan

The water supply project entitled "The Project for Urban Water Supply in Debub Region" with a budget of JPY 1.6 billion was implemented from 2007 to 2010. The project involved the construction of water supply facilities in four towns in Debub Region. The water source of the facility is the groundwater. The project features are shown in Table 2.2.4.

Table 2.2.4 Project Features of the Project for Urban Water Supply in Debub Region

	Debarwa	Mai-dima	Dekemhare	Adi-keyih
Planned Supply Volume	1,370 m^3/day	550 m^3/day	1,800 m^3/day	2,420 m^3/day
Borehole Construction	6 nos.	9 nos.	-	4 nos.
Pump Facility	10 nos.	10 nos.	8 nos.	11 nos.
Transmission Pipeline	14,800 m	12,400 m	23,040 m	19,790 m
Booster Pumping Station	-	-	-	1 no.
Reservoir	500 m^3, 50 m^3	300 m^3	1,100 m^3	700 m^3, 50 m^3
Distribution Pipeline	9,834 m	5,681 m	13,800 m	1,091 m
Service Facility (Public Fountain)	4 nos.	9 nos.	10 nos.	6 nos.

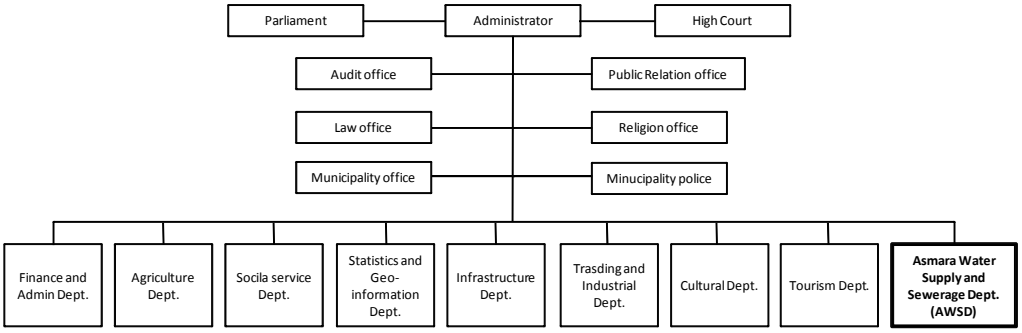
Source: Survey Team

2.3 Present Situation and Issues in the Water Supply in Asmara

2.3.1 Water Supply Utility in Asmara

(1) Asmara Water Supply and Sewerage Department (AWSD)

The executing agency of the water supply project in Asmara is the Asmara Water Supply and Sewerage Department (AWSD), which is one of the nine departments under the Zoba Maekel Administration. Figure 2.3.1 shows the organizational chart of Zoba Maekel Administration.



Source: Zoba Maekel Administration (Job Description)

Figure 2.3.1 Organizational Chart of Zoba Maekel Administration

(2) Organization of AWSD

1) Organization and Staffing

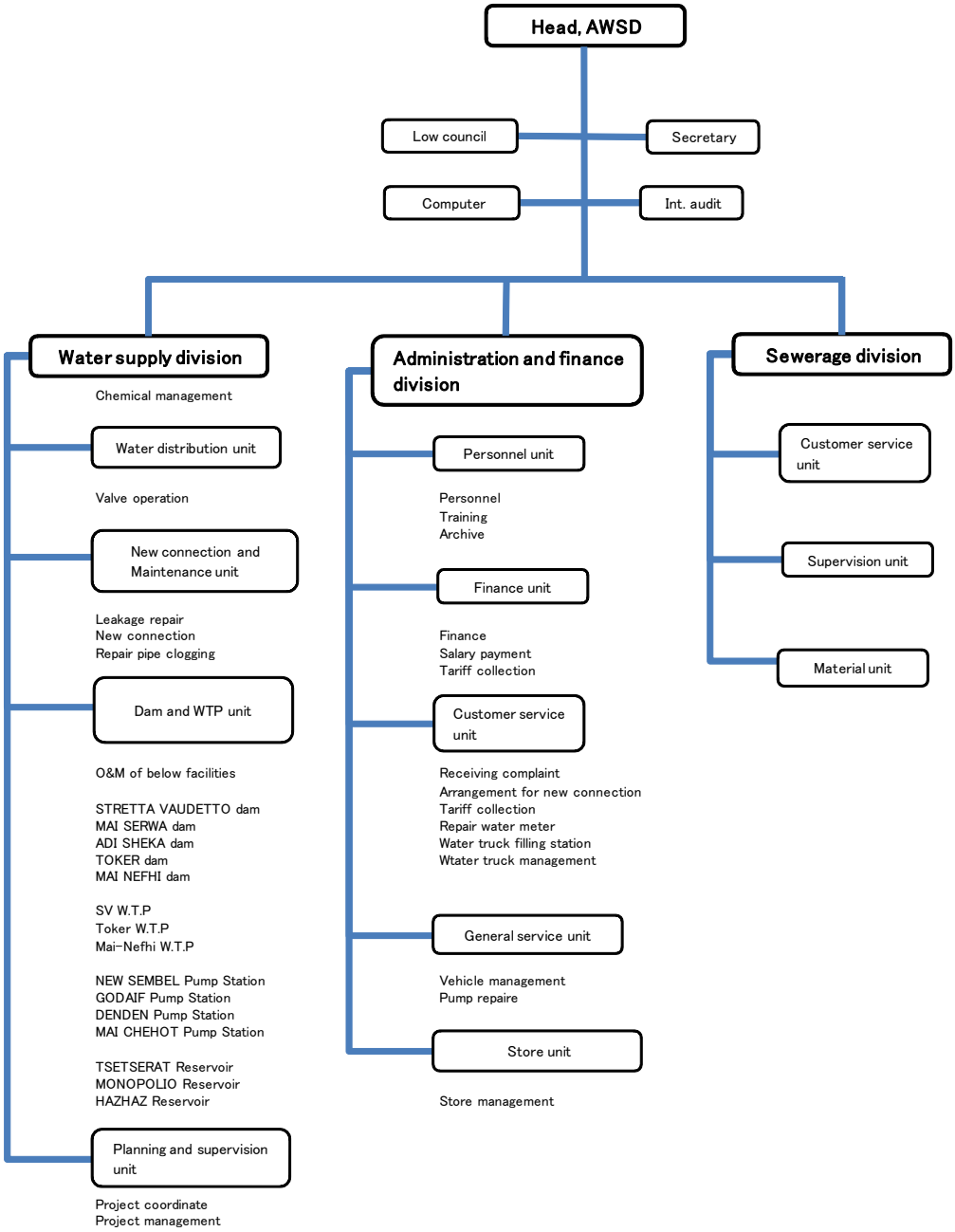
AWSD consists of three divisions, namely: water supply division, administration and finance division, and sewerage division as shown in Table 2.3.1.

Table 2.3.1 Divisions and Roles of AWSD

Division/Unit	Roles
Department Head	Overall management of AWSD activity; and Reporting to the Zoba Administrator
Water Supply Division	Planning and execution of water-supply works; Operation and maintenance of water-supply facility; Installation of new connection; and Reporting to the head of AWSD.
Water Distribution Unit	Planning and execution of distribution control.
New Connection and Maintenance Unit	Monitoring of pipeline condition and water leakage; Repairing of house connection facility; and Installation of new connection.
Dam and Water Treatment Unit	Operation and maintenance of the facility.
Planning and Supervision Unit	Planning and supervision of facility construction works and new connection installation works.
Administration and Finance Division	Planning and execution of business operation of AWSD; Management of material store; Financial management; Customer management; Tariff collection management; and Reporting to AWSD head and Finance Department of Zoba Administration.
Finance Unit	Financial management; Financial reporting; and Tariff collection management.
Personnel Unit	Personnel management; Staff training; and Archive.
General Service Unit	General service in AWSD; Operation of water truck.
Customer Service Unit	Receiving connection request; Receiving customer's complaint; Arrangement for new connection work; Management of water truck; And Water billing.
Store Unit	Material store management
Sewerage Division	Planning and execution of sewerage service; Operation and maintenance of sewerage facility; and Reporting to AWSD head.

Source: Answers from the Questionnaire and Hearing from AWSD Staff

The organizational chart of AWSD is shown in Figure 2.3.2.



Source: Hearing from AWSD staff

Figure 2.3.2 Organizational Chart of AWSD

The staff number of each division is shown in Table 2.3.2.

Table 2.3.2 Staff Number of AWSD

Division	Proper Staff	Contract Staff	National Service	Total
Department Head	1			1
Water Supply	55	129	74	258
Administration and Finance	35	46	63	144
Sewerage	7	9	18	34
Total	98	184	155	437

Source: Answers from the Questionnaire

The number of connection, as of the end of 2014, was 35,483. Thus, the staff number (excluding Sewerage Division) per 1,000 connections is 11.4 persons. The desirable figure of this number is around five. However, in the case of AWSD,

- Most of the national service staff do not come to the office due to a very low salary. If the number of national service staff is excluded from the staff number, the figure becomes 7.7 persons.
- AWSD does not sublet any of the works.

Considering the above, AWSD is understaffed rather than overstaffed.

AWSD reported in the annual report that AWSD is in shortage of staff for operation and maintenance. However, AWSD cannot employ new staff due to low salary scale.

The number of staff who has technical school or higher educational background is shown in Table 2.3.3.

Table 2.3.3 Number of Staff with Technical School or Higher Educational Background

Education/Position	Department Head	Water Supply Division	Administration and Finance Division	Sewerage Division
Civil Engineer		1		
Assistant Engineer (Diploma)		1		
Junior Assistant Engineer (Technical School Diploma)		2		
Public Administration			1	
Accountant			2	

Source: Answers from the Questionnaire

As shown in the table, there are only four staffs with engineering background in the Water Supply Division. This figure is far below the necessary level for the water utilities with served population of 400,000. Moreover, serious personnel loss has been observed such as retirement and external migration of engineers who were in charge of the 2006 FS.

2) Number of O&M Machine/Vehicle

AWSD owns only four machines/vehicles as shown in Table 2.3.4.

Table 2.3.4 Machine/Vehicle Owned by AWSD

Equipment	Type/Specification	Number
Truck with hydraulic lift	Renault (France)	1
Trench excavator	Luilong (China)	1
Dump truck	Fiat 110 (Italy)	1
4WD vehicle	4WD Toyota Hilux	1

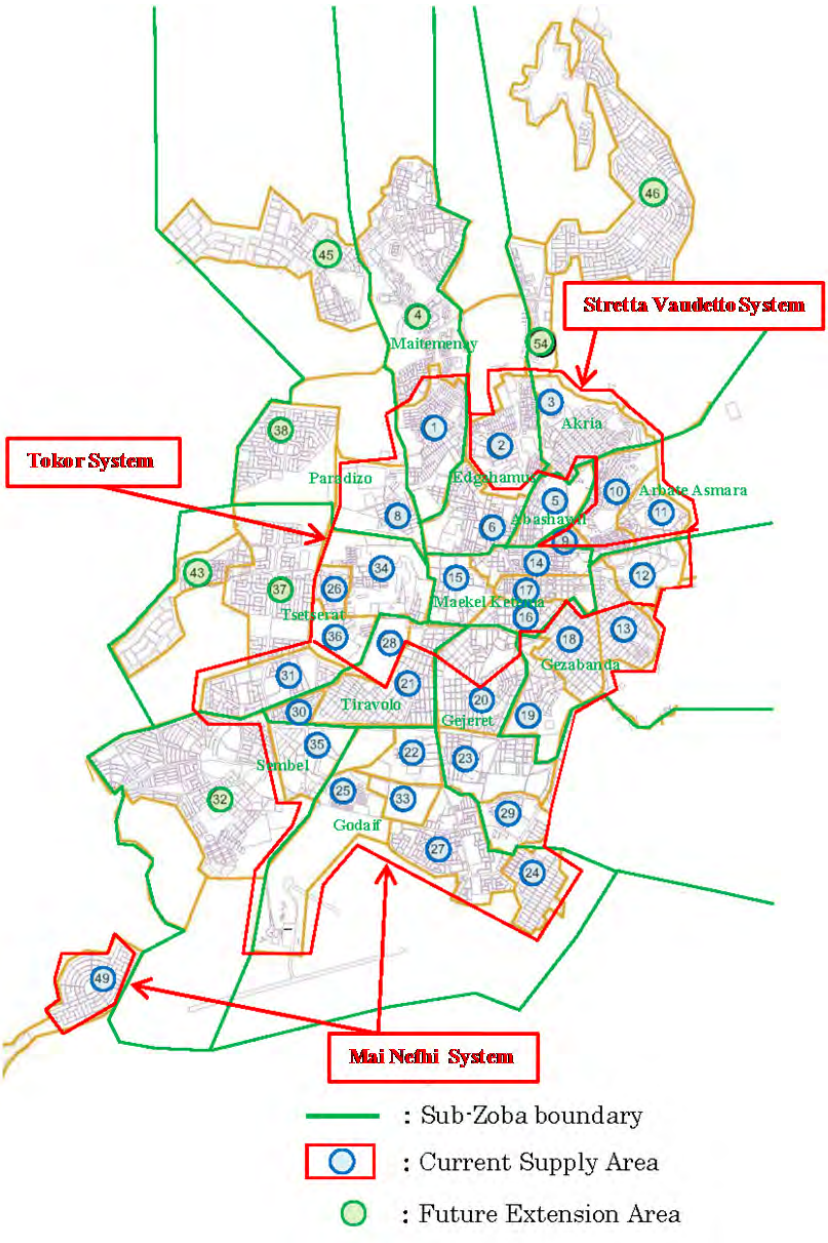
Source: Answers from the Questionnaire

As shown above, AWSD is facing serious shortage of machines/vehicles necessary for the usual maintenance activities. AWSD does not have a welding machine necessary for repairing the leakage of treated water transmission pipeline. AWSD has to rent the welding machine from the national construction company if the need arises. Thus, it is difficult to conduct timely maintenance.

2.3.2 Present Condition of the Water Supply Business

(1) Service Area and its Population

The service area of AWSD is basically the 13 sub-Zobas of Asmara. The treated water from the three WTPs is supplied to the customers in the service area. AWSD also sells water to water trucks. The service area is shown in Figure 2.3.3.



Source: FS in 2006 and Zoba Administration Arranged by the Survey Team

Figure 2.3.3 AWSD Service Area

The population of the 13 sub-Zobas is presented in Table 2.3.5.

Table 2.3.5 Population of 13 sub-Zobas of Asmara

Sub-Zoba	2008 Census	2015 Census	Annual growth rate
1. Paradiso	29,442	32,457	1.0140
2. Maitemenai	24,482	24,257	0.9987
3. Edaga Hamus	32,179	34,016	1.0080
4. Akiria	51,182	55,057	1.0105
5. Abazhawl	40,342	40,957	1.0022
6. Arbate Asmara	35,197	34,484	0.9971
7. Tsetserat	19,851	22,532	1.0183
8. Maekel Ketema	21,312	21,868	1.0037
9. Tiravolo	20,955	21,260	1.0021
10. Geza banda	36,306	36,092	0.9992
11. Sembel	16,861	20,076	1.0252
12. Godaif	43,280	44,645	1.0044
13. Gejeret	39,487	39,728	1.0009
	410,876	**427,429**	**1.0057**

Source: Zoba Maekel Administration

As shown in the above table, the population of Asmara is 427,429. The Asmara area includes the northern and eastern mountainous areas where few people are living. Thus, the above population can be regarded as the population in the AWSD service area. In addition, the people in the Daero Paulos area, although located outside of Asmara, are served with water from AWSD three days a week. The total population in AWSD service area is 427,429 + 6,900 (Daero Paulos) = 4345,329.

In addition, a part of the population in the nine villages located outside the west and south of Asmara (total population: 44,000) are purchasing the water from AWSD through the private water trucks.

At present, the distribution pipelines are laid within the area surrounded by the red line in Figure 2.3.3 (approximately 30 km^2). The pipeline will be extended to the area marked with green circle, in the future.

(2) Water Supply Condition

The water supply condition in 2014 is shown in Table 2.3.6. It should be noted that the billed water volume is the amount of water paid during 2014 and is not the amount consumed in 2014.

Table 2.3.6 Water Supply Condition in 2014

	Unit	2014	Remarks
1. Population in the Service Area	**No.**	**434,329**	427,429 + 6,900
2. Served Population in the Service Area		**409,329**	434,329 - 25,000 (assumed)
By Piped Supply	None	339,472	409,329 - 69,857
By Water Truck	None	69,857	339,971 x (3/4) x 1000/365/10
3. Population Outside of Asmara Served by Water Truck	None	23,286	339,971 x (1/4) x 1000/ 365/10
4. Number of Connection	None	**35,483**	
Domestic	None	29,722	Answer from the questionnaire
Non-domestic	None	5,761	Ditto
5. Billed Water	m^3/year	**2,611,509**	7,155 m^3/day
Piped supply (Domestic)	m^3/year	1,552,317	Answer from the questionnaire
Piped supply (Non-domestic)	m^3/year	519,144	Ditto
Sold to water truck (Domestic)	m^3/year	339,971	2014 Annual Report
Sold to truck (Non-domestic)	m^3/year	200,077	Ditto
6. Water Production (sent from WTP)	m^3/year	**6,659,541**	18,245 m^3/day
Stretta Vaudetto WTP	m^3/year	756,575	2014 Annual Report
Toker WTP	m^3/year	2,740,396	Ditto
Mai Nefhi WTP	m^3/year	3,162,570	Ditto
7. Ratio of Non-revenue Water ((6 -5)/6) x 100	%	**61**	

Source: Zoba Administration (population), Answers from the Questionnaire, Annual Report of AWSD, Arranged by the Survey Team

The explanation on the table is described below.

1) Population

a) Population in the Service Area

As described above, the population in the service area is 427,429 in the 13 sub-Zobas of Asmara and 6,900 in the Daero Paulos area, totaling to 434,329.

b) Served Population in the Service Area

WRD presumes that the number of population who uses the groundwater is increasing due to the decrease in AWSD water supply. According to the well inventory survey conducted by WRD in 2014, there are more than 550 wells (most of them are dug well before the water supply service commenced) in Asmara. Among them, 20 wells had a sufficient yield for selling water by barrel (200 L). The maximum daily yield in such well is approximately 20 m^3, although most of them are not suitable for drinking purposes.

Therefore, the possible amount of domestic water supplied from wells in Asmara is estimated to be 20 x 20 m^3 = 400 m^3/day at maximum. If the per capita consumption is 10 L/day, 40,000 people can be served with water from wells at maximum.

However, according to AWSD, the people in Asmara rely on the AWSD water as much as possible due to the low quality of groundwater. Therefore, it is estimated that 25,000 people are using groundwater only. The AWSD's served population in the service area is estimated to be at: 434,329 – 25,000 = 409,329 (94%).

c) Population Served by Water Truck

The population inside and outside of Asmara served by water truck was estimated by the following:

- Among the water volume of 339,971 m^3/year sold to water truck (domestic), 3/4 is for the inside of Asmara (AWSD service area) and 1/4 is for the outside villages (outside of the AWSD service area). [Information from AWSD]
- The per capita consumption of water from the water truck is assumed to be 10 l/c/d.

Therefore,

- Population inside the service area who is served by water truck:
  339,972 x (3/4) x 1000/365/10 (l/c/d) = 69,857
- Population outside the service area who is served by water truck:
  339,972 x (1/4) x 1000/365/10 (l/c/d) = 23,286

d) Population Served by Piped Water Supply

The population served by piped water supply in 2014 is estimated to be at 409,329 (served population in the service area) – 69,857 (population inside the service area who is served by water truck) = 339,472 (approx. 340,000).

Moreover, among the 69,875 of population inside the service area who are served by water truck, around 10,000 are supplied water from water truck due to the poor supply condition of piped water, even though they have house connection. The potential population with piped water supply service is around 350,000 (= 340,000 + 10,000). By dividing this population of 350,000 with the number of connections (domestic) of 29,722, the population of one service connection comes to 11.8 (2–3 households). This figure is consistent with the information from AWSD and the people in Asmara.

2) Water Supply Amount

a) Average Daily Water Supply and Maximum Daily Water Supply

The average daily water supply in 2014 was 7,155 m^3/day.

Regarding the fluctuation in supply amount, the water transmission amount in May was 1.36 times of the annual average in 2013. However, this fluctuation is due to the factor of supply side (water resource availability and electricity) and is not due to the fluctuation of demand under the current severe water rationing.

b) Per Capita Consumption

By dividing the billed water by piped water (domestic) of 1,552,317 m^3/year with the population served by piped water of 339,472, the per capita consumption comes to 12.5 l/c/d. This figure seems very low for the capital city.

The billed water is likely to be measured lower than the actual amount due to the deterioration of water meter.

3) Non-Revenue Water Ratio

The non-revenue water ratio calculated by the billed water and the water production (transmitted from WTP) is 61%. However, it is presumed that the water leakage ratio is not so high under the current condition where the water is not filled in the pipeline all the time.

The transmitted water volume from Stretta Vaudetto WTP and Mai Nefhi WTP are estimated by the pump running hours. So the transmitted water volume is likely to be overestimated.

(3) Water Rationing Condition

For the purpose of equitable supply of the current limited water, water rationing is implemented dividing the service area into 25 distribution zones in Table 2.3.7. Each zone is supplied with water for 4-10 days a month. The supply time is around half-day per day (16 hours a day from Sembel PS).

Table 2.3.7 Distribution Zone for Water Rationing

Zone No.	Name	Supply Days
Toker WTP Supply Area		
1	Maitemenai, Edaga Hamus, Vilaggio, Adi segdo, Paradizo, Embagaliano	5 days
2	Abashawl + shuk, around Saint Mary Church	3 days
3	Center Town (Marcato)	3 days
4	Taba (Cinema Roma + muagna)	3 days
5	Monopolio + Mufti	3 days
6	Denden Camp (Algien + Tsetserat)	3 days
7	Alformaio	3 days
8	Around San Francesco Church	3 days
1 cycle = 26 days		
Stretta Vaudetto WTP Supply Area		
9	Haz HAz, Mihram Chira, Viya Jida	3 days
10	Akria (Left, Right)	3 days
11	Akria (Saint Gebriel Church), Edaga Arbi	3 days
12	Around 2nd Police Station (Hadish Adi), Geza Brhanu (Geza Banda Habesha)	3 days
13	Arbaete Asmara, Debozito	3 days
1 cycle = 15days		
Mai Nefhi WTP Supply Area		
Distribution from Transmission between Mai Nefhi WTP – Sembel PS		

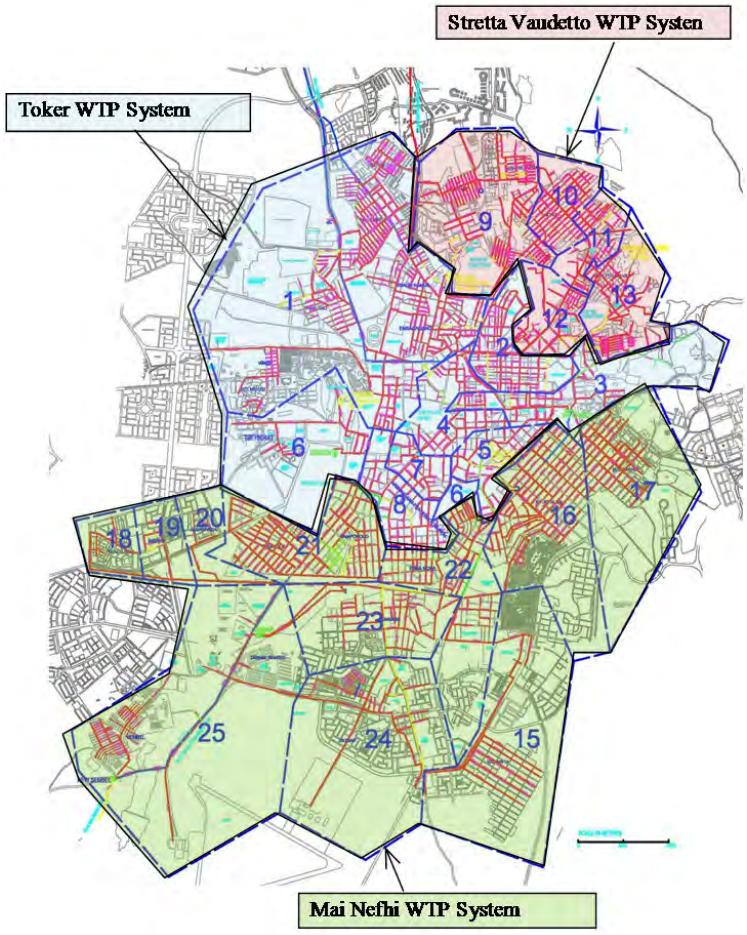
14	Daero Paulos	3 days a week
From Sembel PS via Godaif PS		
15	Kehawta	6 days
16	Geza Banda (Adis Alem)	6 days
17	Mai Chihot	6 days
1 cycle = 18days		
From Sembel PS		
18	Space, Enda Germen	3 days
19	Enda Shewit, Michael Tedros	2 days
20	Jekaranda, Space 1	4 days
21	Tiravolo, Campopolo	3 days
22	Around Asmara Brewery, Around Enda Kisha	3 days
23	Barjima, Gejeret, Around Enda Nora (Lime Factory)	4 days
24	Godaif	3 days
25	Sembel + Dembe Sembel	Every day
1 cycle = 22 days		

Source: AWSD

For example, the valves to zones 10-13 are closed when the water is distributed to zone 9. After supplying water to zone 9 for three days, the distribution zone is shifted to zone 10. The next distribution to zone 9 is after 12 days. According to the people in zone 9, when the water comes, every tap is opened at the same time. Thus, the water reaches only to the lower area for the first and second days. The people in the high area can receive the water only on the third day. Every house has a water storage tank.

Under the above circumstances, the existing distribution reservoirs (Hazhaz, Tsetserat, Monopolio) in zones 1, 5, and 6 are not functioning in their original designated way. The small amount of water flows into the reservoir at the last day of each distribution period. The reservoir is functioning just as the storage tank for the neighboring people.

The water distribution zone is as shown in Figure 2.3.4.



Source: AWSD

Figure 2.3.4 Water Distribution Zone

(4) Business Operation Condition

1) AWSD Annual Report

AWSD submits an annual report to the Administration of Zoba Maekel. The contents of the annual report are shown in Table 2.3.8.

Table 2.3.8 Contents of AWSD Annual Report

Item	Contents	Remarks
A. Executed construction work	New connection; Replacement of water meter; Repair of distribution/service pipe	Only the number of work section is written.
B. Water production volume and amount of chemicals used	Monthly water volume sent from each WTP.	Only the annual total amount is written for 2014.
	Monthly chemical amount (aluminum sulfate and gaseous chlorine) for each WTP.	Only the annual total amount is written for 2014.

C. Toker raw water transmission PS	Monthly water volume transmitted from Toker Dam Monthly amount of diesel consumed.	Not written in the 2014 report
D. Number of staff	Number of staff by division	
E. Water volume sold to water truck	Sold volume and received amount of money by category (AWSD, Government, Private, Military)	The selling price to private water truck is ERN 1.5/m^3. The selling price by the private water truck to the people is prescribed to be less than ERN 45/m^3.
F. Number of connection	Number of connection at the beginning and at the end of the period.	Not written in the 2014 report.
G. Materials used (amount of money)	The materials taken from AWSD store and used for maintenance work are described in terms of amount of money by category use (O&M of transmission and distribution facility, installation of new connection; maintenance of water truck; O&M of WTP).	
H. Annual revenue and expenditure	For 2013, the data up to November 2013 is written. For 2014, the data up to June 2014 is written.	

Source: Survey Team based on the AWSD Annual Report

The contents of the 2013 and 2014 annual reports are described hereunder.

a) Executed Construction Work

AWSD executed the works in 2013 and 2014 as shown in Table 2.3.9.

Table 2.3.9 Executed Construction Work by AWSD

Item	2013	2014
Installation of new connection	93 nos.	16 nos.
Replacement of water meter	99 nos.	91 nos.
Replacement of existing GI pipe with PVC pipe	207 nos.	108 nos.
Repair of water leakage	782 nos.	422 nos.

Source: AWSD Annual Report

The above works are executed by the AWSD staffs. The works of the sewerage pipeline are entrusted to the contractors. The cost of the sewerage works is being shouldered by the beneficiary residents.

b) Water Production Volume and Amount of Chemicals Used

The water production volume and amount of chemicals used in 2013 and 2014 are shown in Table 2.3.10 and Table 2.3.11, respectively.

Table 2.3.10 Water Production Volume and Amount of Chemicals Used (2013)

WTP	Water Production (Transmitted from WTP) (m^3)	Aluminum Sulfate (kg)	Gaseous Chlorine (kg)
Stretta Vaudetto WTP	1,126,855	30,900	2,373
Toker WTP	3,929,120	91,072	6,869
Mai Nefhi WTP	3,654,972	51,000	19,470

Source: AWSD Annual Report

Table 2.3.11 Water Production Volume and Amount of Chemicals Used (2014)

WTP	Water Production (Transmitted from WTP) (m^3)	Aluminum Sulfate (kg)	Gaseous Chlorine (kg)
Stretta Vaudetto WTP	756,575	15,100	1,413
Toker WTP	2,740,396	80,500	5,450
Mai Nefhi WTP	3,162,570	51,600	15,760

Source: AWSD Annual Report

c) Toker Raw Water Transmission PS

The water volume transmitted from Toker Dam and amount of diesel consumed in 2013 are shown in Table 2.3.12. The data of 2014 is not written in the 2014 Annual Report.

Table 2.3.12 Water Volume Transmitted from Toker Dam and Amount of Diesel Consumed in 2013

Water Volume Transmitted from Toker Dam (m^3)	Diesel Consumed (liter)
4,178,520	949,900

Source: AWSD Annual Report

d) Number of Staff

Number of staff by division is presented in the annual report. The contents are as shown in Table 2.3.13.

e) Sold Volume to Water Truck

The water volume sold and the amount of money by the water truck category are shown in Table 2.3.13.

Table 2.3.13 Water Sold to Water Truck and Amount of Money

Category of Water Truck	2013		2014	
	Water Volume (m^3)	Sales (Nakfa)	Water Volume (m^3)	Sales (Nakfa)
AWSD	54,126	1,539,015	42,528	1,698,203
Government	121,882	2,316,480	106,356	1,359,232
Military	46,684	562,374	51,443	617,304
Private	640,584	960,449	339,971	509,581
Total	863,276	5,378,319	540,048	4,184,132

Source: AWSD Annual Report

The customers of each water truck category are:

AWSD water truck : Hospital, embassy, important government facilities
Government truck : Government facility
Military truck : Military facility
Private truck : The people who are not served through piped water and cannot receive sufficient water through pipe connection.

The selling price to private water truck is ERN 1.5/m^3. The selling price by the private water truck to the people is prescribed to be less than ERN 45/m^3.

f) Number of Connection

According to the 2013 Annual Report, the number of connection at the beginning of 2013 (January 2013) and at the end of 2013 (to be exact, November 2013) was 33,609 and 33,923, respectively.

g) Materials Used (amount of money)

The materials taken from the store in terms of amount of money are as shown in Table 2.3.14.

Table 2.3.14 Materials Taken from AWSD Store

Category	2013		2014	
	Amount (Nakfa)	%	Amount (Nakfa)	%
O&M of transmission and distribution facility	724,384	5.0	596,404	2.8
Installation of new connection	516,632	3.5	7,780,779	36.3
Maintenance of water truck	213,871	1.5	680,341	3.2
O&M of WTP	12,020,205	83.0	12,061,006	56.2
Others	995,680	6.9	324,625	1.5
Total	14,470,775	100.0	21,443,157	100.0

Source: AWSD Annual Report

In 2014, a lot of materials for the installation of new connection were taken from the store. This is in addition to the 16 new connection works in the existing distribution pipeline. There were 960 new connection works conducted in the Daero Paulo area where distribution pipeline was newly installed.

h) Annual Revenue and Expenditure

In the annual reports of 2013 and 2014, the data up to November 2013 and up to June 2014 were presented.

The data of the whole year was obtained through the questionnaire.

2) Annual Revenue and Expenditure

The annual revenue and expenditure of AWSD for 2012, 2013, and 2014 are in Table 2.3.15.

Table 2.3.15 Annual Revenue and Expenditure of AWSD

	2012		2013		2014	
Revenue	(Thousand Nakfa)	%	(Thousand Nakfa)	%	(Thousand Nakfa)	%
Water charge (Domestic)	17,971	35	23,154	31	20,693	24
Water charge (Commercial)	21,175	41	12,678	17	11,665	14
Water charge (Water Truck)	5,017	10	5,377	7	4,183	5
Other (Connection works, penalty, etc.)	7,388	14	33,608	45	44,744	52
Subsidy	0	0	37	0	4,449	5
Total	51,551	100	74,854	100	85,734	100
Expenditure	(Thousand Nakfa)	%	(Thousand Nakfa)	%	(Thousand Nakfa)	%
Personnel	6,726	12	6,891	16	6,113	11
Electricity	15,387	29	8,069	19	7,286	14
Fuel for Toker raw water transmission PS	24,941	46	17,287	40	16,977	32
Fuel for AWSD water truck	861	2	1,158	3	1,039	2
Chemicals	266	0.5	1,244	3	1,252	2
Connection works	1,119	2	3,585	8	13,265	25
Maintenance, repair	4,054	8	2,462	6	3,888	7
Other	579	0.5	2,304	5	3,835	7
Total	53,963	100	43,000	100	53,655	100

Source: Answers from the Questionnaire
For data of 2012, Preliminary Survey Report in 2014

In the revenues of 2013 and 2014, the revenue from the new connection work and penalty formed a large part. The annual report states that this is the reason why the revenue far exceeded the expenditure in 2013 and 2014. In 2014, 960 new connections were installed. Accordingly, both the revenue and expenditure for new connection work were increased.

As shown above, the fuel for Toker raw water transmission PS formed a large part of the annual expenditure. It is desirable that the existing diesel engine pump be replaced with the electric motor driven pump.

The Survey Team requested AWSD to provide the budget for 2015. However, AWSD replied that it cannot be provided until it is approved by Zoba.

3) Tariff Collection

The tariff of AWSD is shown in Table 2.3.16. This tariff has not been changed since November 2003.

Table 2.3.16 Tariff of AWSD

Tariff	Zone 1	Zone 2	Zone 3	Commerce
Meter rent	50	40	30	50
Unit price by m^3				
1-10 m^3	5	4	3	15
10-20 m^3	7.5	5	4	20
20-30 m^3	10	7.5	5	20
30-50 m^3	15	10	7.5	20
> 50	20	15	10	20

Source: AWSD

According to AWSD, the water meter is installed on all the house connections.

The customer will pay the water charge every three months based on his own meter reading. If the customer does not pay for more than four months, a penalty will be charged. If it exceeds seven months, the water supply will be stopped.

The tariff should be revised because the current price is more than five times of that in 2003 (IMF World Economic Outlook Database).

4) Long-term Objective/Strategy of AWSD

AWSD prepares a paper which describes its long-term objective/strategy every year. The contents related to water supply as of 2014 are in Table 2.3.17.

Table 2.3.17 Long-term Objectives of AWSD

Objective	Strategy
1. Increase of supply amount; Improvement in water quality 1.1 Daily supply is increased to 61,000 m^3/day 1.2 Water quality is improved from Group B to Group A	- Conduct survey - Construction of new dam and WTP - Rehabilitation and expansion of the existing facility - Increase in number of staff
2. Capacity development of staff 2.1 Age of 25% of the staff is under 40 years old. 2.2 The number of skilled labor is increased by 15%.	- Raise the salary level - New employment - Training of staff - Purchasing of new tools
3. Strengthening of business transaction capacity 3.1 Tariff collection office is increased to four 3.2 Introduction of information system	- Establishment of new tariff collection offices - Tariff collection unit is established - Building the information system - Replacement of water meter - Introduction of GIS

Source: AWSD

Although the AWSD sets the above objectives, it does not have a practical plan for realization. AWSD is in short of staff in terms of its number and capacity. The staffs are busy handling the complaint regarding the shortage of water supply and they seem not to have a capacity to make a long-term plan.

According to AWSD's staff, AWSD recognizes the following matters as important issues for its business operation:

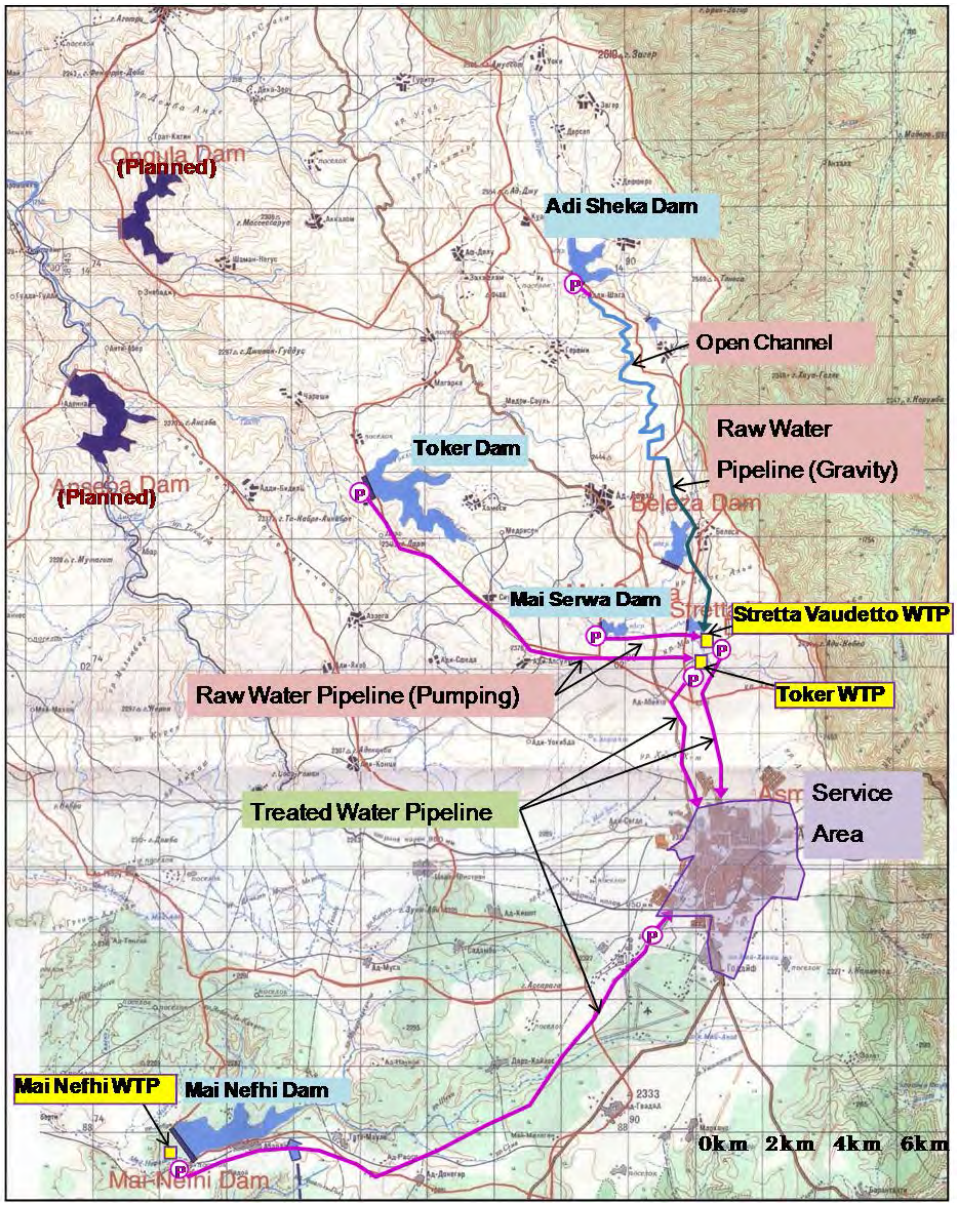
- Increasing the number of staff, especially the young staff (raising the salary level).
- Timely procurement of materials for house connection and spare parts of the equipment.
- Increasing the number of construction machine and vehicle.
- Reducing the fuel cost of Toker PS by electrification.

The current problems/issues of AWSD are described in the following sections.

2.3.3 Present Condition of the Existing Water Supply Facility

(1) Outline

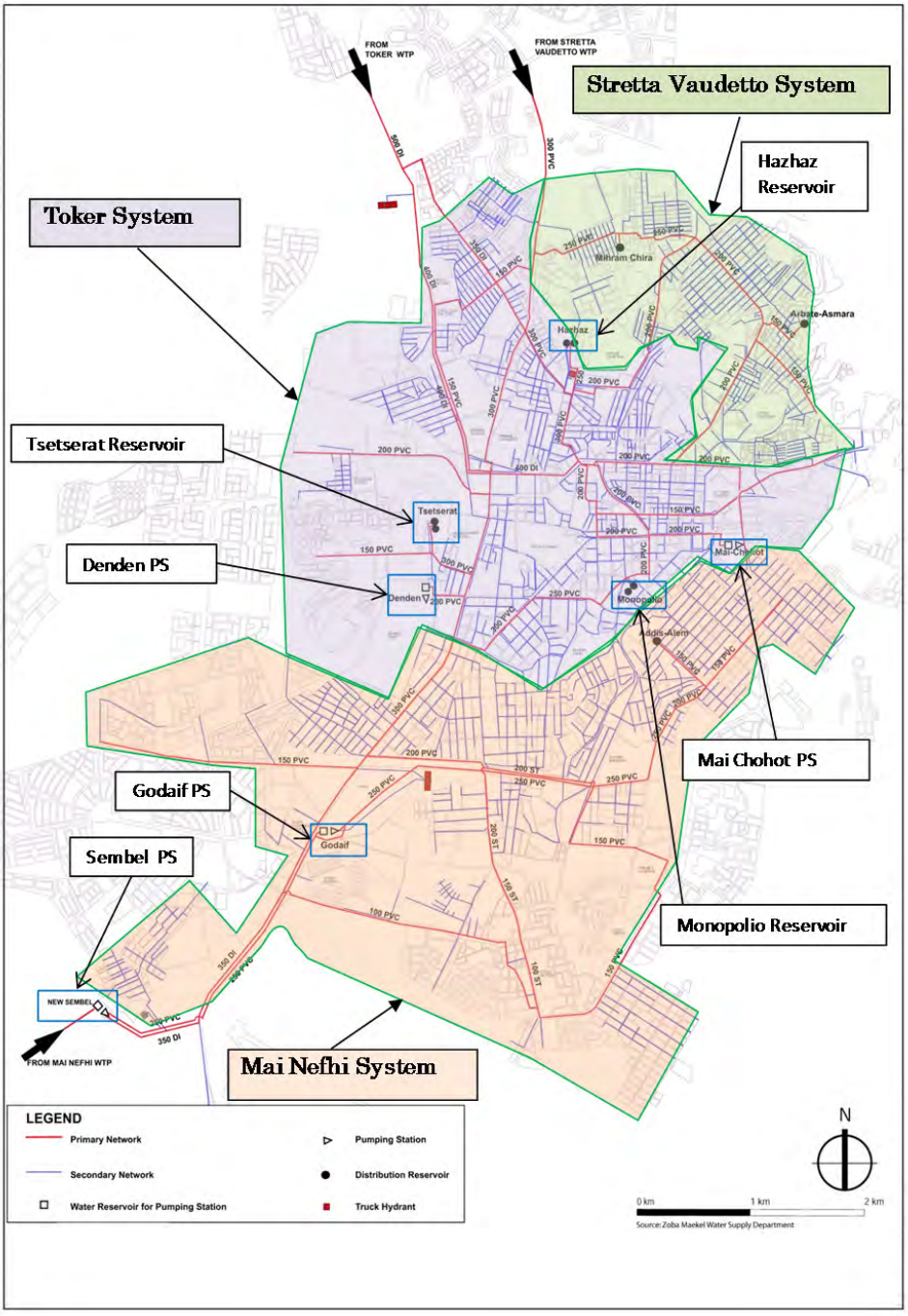
The source of Asmara Water Supply is the dam lake as shown in Figure 2.3.5. The raw water is treated at the three water treatment plants and then transmitted to the supply area in Asmara City.



Source: Survey Team

Figure 2.3.5 Outline of Water Supply Facility of Asmara

The location of the water distribution facility in the city is shown in Figure 2.3.6. The north east area, northwest area, and south area of the city are being supplied by Stretta Vaudetto WTP System, Toker WTP System, and Mai Nefhi WTP System.



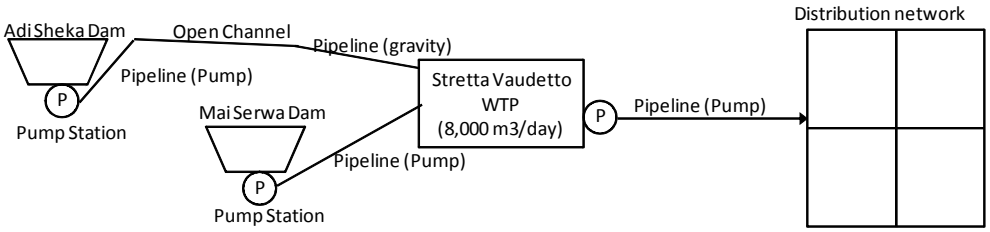
Source: Survey Team added the information on the figure in the FS Report

Figure 2.3.6 Location of the Distribution Facility in the Service Area

The current condition and problems of each facility are described by the three WTP systems in the following order: 1) Water resource facility (dam), 2) WTP, and 3) Intake, transmission and distribution facility.

(2) Stretta Vaudetto WTP System

The water source of Stretta Vaudetto WTP System is Adi Sheka Dam and Mai Serwa Dam, as shown in Figure 2.3.7. The intake facility of Stretta Vaudetto Dam was abandoned. The temporary intake pump is being installed on the crest of Stretta Vaudetto Dam and is operated if need arises.



Source: Survey Team

Figure 2.3.7 Configuration of Stretta Vaudetto WTP System

1) Dam

The various factors or elements of each dam on the S.V W.T.P system are indicated in Table 2.3.18.

Currently, AWSD is taking the raw water from Adi Sheka, Mai Serwa, and S.V dams. AWSD is not able to take the raw water from Valle Gnecchi and Ela Nahib dams because mud is clogged into the water intake pipes, the raw water is not too much for the water-intake, and the raw water is used in agriculture and for daily life. The water right of Beleza dam was transferred to AWSD from EEC, but EEC is using the water as cooling water of thermal power generation.

The penetration water is confirmed from the bottom of the dam at the downstream side of 3 earth-fill dams (Valle Gnecchi, Ela Nahib and Adi Sheka). However, it cannot be said that there is much penetration water. There are no problems because it isn't thought that there is a clear streamline of penetration water.

Among the concrete gravity dams, there is leakage of approximately 0.1ℓ / sec from the joint between the lower left in the S.V dam and the bedrock. It's necessary to monitor this in the future.

There is much sedimentary soil in each dam lake, and the sludge discharge pipes of each dam are clogged up. However, AWSD never has removed the sedimentary soil in the past. Particularly, the S.V dam is remarkable, and the sedimentary soil into the dam lake is estimated to be 61% of gross storage capacity of the S.V dam. (Refer to Appendices 4.3)

Furthermore, the construction is old, and the drawings lost, and nobody can judge whether the gross storage capacity of each dam is exact. In the future, it is necessary to make the

exact drawings by carrying out surveying of each dam lake in order to grasp the size of the dam body and the gross storage capacity exactly.

Table 2.3.18 Various factors or elements of each dam in S.V W.T.P system

Items		Mai Serwa Contents	Adi Sheka Contents	S.V Contents	Valle Gnecchi Contents	Ela Nahib Contents	Beleza Contents
Current situation of utilization		Utilization	Utilization	Utilization	Not using	Not using	EEC is using the water now
Future plan of utilization		Plan to use	Plan to use	Plan to use	Plan to use	Plan to use	Plan to use
Design documents		nil	nil	Schematic plan	nil	nil	Plan only
River name		Anseba river system	Anseba river system Tokar river	Anseba river system	Anseba river system	Anseba river system	Anseba river system
Intended use		Drinking water	Drinking water	Drinking water	The water used as drinking water once, but the water is using as a domestic animal, agriculture and daily life now.	The water used as drinking water once, but the water is using as a domestic animal, agriculture and daily life now.	Cooling water for the thermal power generation(The water right of Beleza dam was transferred to AWSD from EEC, but EEC is using the water as a cooling water of the thermal power generation.)
Structure Type		Concrete gravity dam (non-overflow dam)	Earthfill dam(The surface of upstream slope is lock, the downstream slope is soil)	Concrete gravity dam (overflow dam)	Earthfill dam(The surface of upstream slope is lock, the downstream slope is soil)	Earthfill dam(The surface of upstream slope is lock, the downstream slope is soil)	Concrete gravity dam (non-overflow dam)
Construction year		1960	1938	1941	1940	1941	1953
Design or Constraction company		Unconfirmed(Italy rule age)	Unconfirmed(Italy rule age)	Unconfirmed(Italy rule age)	Unconfirmed(Italy rule age)	Unconfirmed(Italy rule age)	Italy (SEDAO)
Source of funds		Unconfirmed	Unconfirmed(Italy rule age) The water was used for old hydraulic power generation.	Unconfirmed(Italy rule age)	Unconfirmed(Italy rule age) The water was used for old hydraulic power generation.	Unconfirmed(Italy rule age) The water was used for old hydraulic power generation.	Unconfirmed
Dam body	Length	Approx. 125m	Approx. 390m	Approx. 55m	Approx. 200m	Approx. 170m	Approx. 138m
	Height(Max)	Approx. 20m	Approx. 25m	Approx. 25m	Approx. 15m	Approx. 15m	Approx. 25m
	Upper Wide(Max)	Approx. 3.5m	Approx. 3.2m	3.5m	3m	.3m	Approx. 4.5m
	Bottom Wide(Max)	Approx. 18m (inference)	Approx. 153m (inference)	Approx. 18m (inference)	Approx. 48m (inference)	Approx. 33m (inference)	Approx. 44m (inference)
	Dam volume	Approx. 7,500㎥ (inference)	Approx. 250,000㎥ (inference)	Approx. 4,300㎥ (inference)	Approx. 25,000㎥ (inference)	Approx. 15,000㎥ (inference)	Approx. 28,000㎥ (inference)
Attached structure of dam	Intake pipe	Water intake from sludge discharge pipe φ150mm. 2 valves of intake pipe φ200mm (from 2 nos vertical intake pipe in dam lake) are out of order.	Underground pipe into dam body:φ 400mm	Temporary pump was installed in the dam top. Original intake tower is out of order. Old intake pump at dam downstream is out of order.Old.	Underground pipe into dam body:φ 150mm	Underground pipe into dam body:φ 200mm	Multistage-type gate (?stages) (Permission of the inspection is not granted by ECC)
	Spillway (flood way)	New spillway: Depth 3m, Wide 10m It has been placed in emergency because the old spillway at the downstream side collapsed in 2009. New spillway is a possibility of damage to Asmara Flower at the time of severe flood.	Spillway: Depth 2m, Wide 50m Open channel: Depth 3m, Wide 3m	Wide 16.5m, Depth 3m in dam body	Wide 2m, Depth 1m	Wide 5m, Depth 1.5m (Combined use with open channel to Valle Gnecchi dam)	Wide 12m, Depth 1.3m
	Sludge discharge pipe	4 nos φ150mm Unusable for mud clogging 1 no φ150mm Use as a intake pipe	1no φ300㎜ Not used	5 nos φ150mm Uusable for mud clogging	Unconfirmed	Unconfirmed	Unconfirmed
	Discharge pipe	Substitute sludge discharge pipe	Substitute sludge discharge pipe	Substitute sludge discharge pipe	Unconfirmed	Unconfirmed	Unconfirmed
	Water level gauge	nil	nil	nil	nil	nil	nil
Catchment area		Approx. 8.8㎢	Approx. 37.3㎢	Approx. 8.6㎢	Approx. 3.0㎢	Approx. 4.3㎢	Approx. 6.1㎢
Water surface area		Approx. 0.18㎢ (inference)	Approx. 0.36㎢ (inference)	Approx. 0.13㎢ (inference)	Approx. 0.08㎢ (inference)	Approx. 0.15㎢ (inference)	Approx. 0.18㎢ (inference)
Gross storage capacity		Approx. 2.1mill ㎥	Approx. 6.0 mill ㎥	Approx. 0.32 mill ㎥	Approx. 0.6 mill ㎥	Approx. 0.6 mill ㎥	Approx. 1.2 mill ㎥
Effective storage capacity		Approx. 1.785 mill ㎥ (inference)	Approx. 4.05 mill ㎥ (inference)	Approx. 0.125 mill ㎥ (inference)	Approx. 0.496 mill ㎥ (inference)	Approx. 0.45 mill ㎥ (inference)	Approx. 1.022mill ㎥ (inference)
Sedimentary soil into the dam's lake		Approx. 0.315 mill ㎥ (inference)	Approx. 1.35 mill ㎥ (inference)	Approx. o.195 mill ㎥ (inference)	Approx. 0.104 mill ㎥ (inference)	Approx. 0.15 mill ㎥ (inference)	Approx. 0.178 mill ㎥ (inference)
Source of power for Raw-water pump		Commercial power (EEC) 1 no Pump, Pump discharge:200㎥/h, Pump head:75m	Commercial power (EEC) 2 nos Pump, Pump discharge:450㎥/h, Pump head:40.5m	Commercial power (EEC) 1 no Pump, Pump discharge:180㎥/h, Pump head:20m, 132kw	Unnecessary(Gravity)	Unnecessary(Gravity)	Unconfirmed EEC is using the water now.
Generator for backup		nil	265KVA Maide in Italy Out of order	nil	Unnecessary	Unnecessary	Unconfirmed EEC is using the water now.
Operation time for Raw-water pump		Approx. 12hours(No record)	Approx. 12hours(No record)	Approx. 10hours(No record)	Unnecessary	Unnecessary	Unconfirmed EEC is using the water now.
Water quality		No record of water analysis Light green(as of Mar, 2015)	WRD enforces it once a year. The water is satisfied with Eritrea water quality standard. Light green(as of Mar, 2015)	WRD enforces it once a year. The water is satisfied with Eritrea water quality standard. Light green(as of Mar, 2015)	No record of water analysis Light green(as of Mar, 2015)	No record of water analysis Light green(as of Mar, 2015)	No record of water analysis Light green(as of Mar, 2015)
Landownership		Government	Government	Government	Government	Government	Government
Ownership of structure		AWSD	AWSD	AWSD	AWSD	AWSD	AWSD
Water rights		AWSD	AWSD	AWSD	AWSD	AWSD	AWSD(EEC is using the water now)
Conservation-Management for		MoA & Zoba Maekel	MoA & Zoba Maekel	MoA & Zoba Maekel	MoA & Zoba Maekel	MoA & Zoba Maekel	MoA & Zoba Maekel
Management for Structure		AWSD	AWSD	AWSD	MoA	AWSD	AWSD

Source: Survey Team

2) WTP

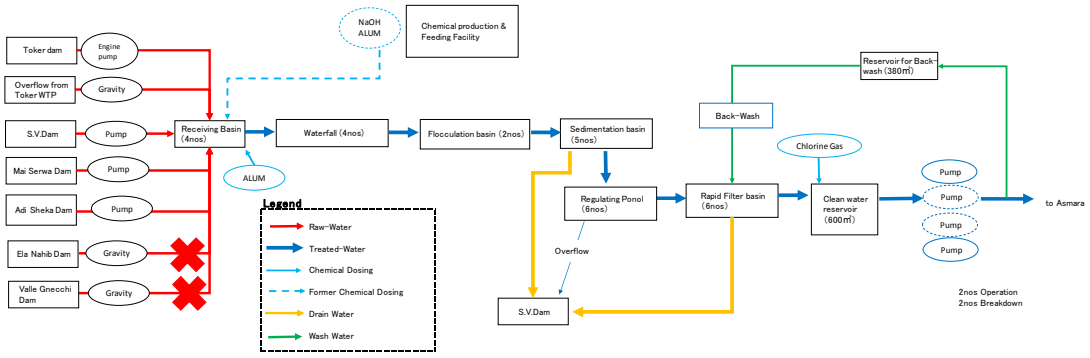
The various factors or elements of S.V W.T.P are indicated in Table 2.3.19.

Table 2.3.19 Various factors or elements of S.V W.T.P

Items	Contents
Design documents	Plans of Flocculation and sedimentation basins.
Water source	Main: Adi Sheka, Mai Serwa, S.V dams and overflow of Toker W.T.P Emergency: Toker dam Unused: Valle Gnecchi and Ela Nahib dams
Construction year	1941
Design or Constraction company	Unconfirmed(Italy rule age)
Source of funds	Unconfirmed(Italy rule age)
Treatment method	Rapid filtration system
Design treatment capacity	8,000㎥/day
Source of power	Commercial power (EEC) 4 nos treated water pump, Pump discharge: 500㎥/h (2nos pumps are out of order)
Generator for backup	230KW It is not operating the treated water pump because generator capacity is small.
Operation time	10 hours (1 no treated water pump)
Operation mathod	Manual operation
Flocculants(Coagulation)	ALUM (Aluminum Sulfate) is dosed into the receiving well directly. The chemical mixing and injection equipment are out of order for a long time.
pH control chemicals	Currently unused The chemical mixing and injection equipment are out of order for a long time.
Chlorination	Chlorine gas Chlorine gas is injected directly into the receiving well by the rubber tube. Sodium hypochlorite had been using in the past.
Other chemicals	nil
Inlet and Outlet flow	No record (Outlet flow understand by the pump operating time.) (Inference 5,000㎥/day)
Water quality (Outlet)	WRD enforces it once a year. E. coli and fecal coliform bacteria have been detected.
Sludge disposal	Sludge has discharged into SV dam directly.
Water quality laboratory	nil
Landownership	AWSD
Ownership of structure	AWSD
Management for W.T.P.	AWSD

Source: Study Team

The flow chart of S.V. W.T.P is indicated in Figure 2.3.8.



Source: Survey Team

Figure 2.3.8 Flow chart of S.V W.T.P

S.V W.T.P was built in 1941 when the area was ruled by Italy, and the deterioration of the facilities is remarkable.

The present situations are indicated as follows.

- There are no inlet and outlet water meters.
- The chemical mixers and injection equipment has been out of order for a long time. Therefore, it can be said appropriate water treatment is not done. The solid alum is sporadically dosed into the receiving well directly without adjusting its concentration.
- The chlorinator has not been out of order for a long time. And chlorine gas is injected directly into the clear water reservoir by rubber tube.
- Several deflectors in the flocculation basin are corroded.
- The sludge in the sedimentation basin is not discharged because the sludge discharge pipes are corroded, and several sludge valves are inoperable.
- Back-wash isn't done effectively so that there is thick sludge on the filter beds. Therefore, the filter beds have break through cracks and holes
- Water is leaking approximately 1 m^3/ hours at the clear water reservoir.
- The land subsidence of approximately 5 cm is confirmed at the building of the filtration basin and the clear water reservoir.
- The deterioration of the building of the filtration basin and the clear water reservoir is remarkable.
- Most of the valves are deteriorated due to old age.
- The raw water transmission pump in Adi Sheka is stopped for 2 months in the rainy season because the muddy soil flows into the open channel.
- Two clear water transmission pumps are deteriorated due to old age. (Refer to transmission facilities)
- The clear water transmission pump (500m^3/h) is operated only about 10 hours/day due to the blackout. (Refer to transmission facilities)
- Total coliform bacteria and fecal coliform bacteria are detected.

3) Intake, Transmission, and Distribution Facility

The present condition and problems of each facility are as shown in Table 2.3.20.

Table 2.3.20 Present Condition and Problems of the Intake, Transmission, and Distribution Facility of Stretta Vaudetto WTP System

Facility	Feature/Present Condition	Problems
Adi Sheka - Stretta Vaudetto WTP Raw Water Transmission Facility		
Adi Sheka PS		
Receiving tank	- There is no receiving tank. Raw water intake pipe is directly connected to the pump via D700 strainer.	
Pump facility features	Dam: HWL = 2,395, LWL = 2,362 P1: (Q = 450 m^3/h, H = 40 m) 85 kW P2: (Q = 450 m^3/h, H = 40 m) 85 kW - The gear of the P2 pump is damaged frequently. The setting seems to be inappropriate. - All the pressure gauges are out of order.	- One pump including the control panel must be replaced. - All the instrumentation facility must be replaced.

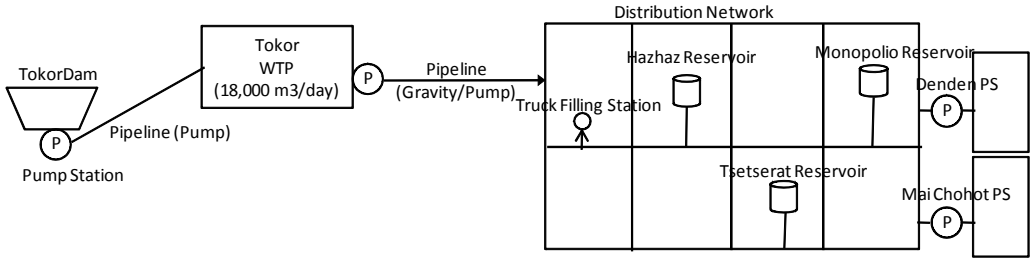
Installation year Operating/ functioning condition	- The magnetic flow meter is not damaged but the data recording system is out of order. - Leakage is observed from the air valve in the D700 strainer. - The power receiving facility is deteriorated and in a dangerous condition. - The pump was replaced in 2000 with the French assistance. The pump station itself was constructed 27 years ago. - Only P1 pump is operated when the electricity is available. (12 h/day) - The emergency generator installed 27 years ago is out of order. - No operation record was kept.	
Raw Water Transmission Pipeline from Adi-Sheka Dam		
Pipeline	D300 Cast iron pipe L = 400 m	No particular problem
Open Channel from Adi Sheka to Beleza		
Concrete open channel	Width: 1.5 m – 1.6 m, Depth: 20 cm, L = 8 km i = 0.002, n = 0.032 EL 2426 – EL 2410 - The 8 km length of concrete open channel was constructed on the hillside. The channel was clogged by the surrounding soil in the flood season. - The soil is removed by manpower (30 persons x 120 days) every year. - There are six tunnels. (L = 150 m – 400 m) - Falling of the upper part of lining concrete is observed. - It is necessary to check the necessity of repair work of the tunnel but it is dangerous.	- Due to soil clogging during the rainy season, the transmission must be stopped around two months every year. - The six tunnels are deteriorated. - To solve these problems, it is necessary to change from open channel to pipeline. - 2 km of AC pipeline should be replaced to PVC/DCI pipe.
Raw Water Transmission Pipeline from Beleza to Stretta Vaudetto WTP		
Pipeline	Starting point – Beleza Lake: D300, Cast iron L = 8 km Beleza Lake – S.V. WTP: D300, AC L = 3 km (1 km was replaced by DCI)	
Raw Water Transmission Facility from Mai Serwa Dam to Stretta Vaudetto WTP		
Mai Serwa PS		
Receiving tank	- The raw water is taken via the sand discharge pipe of the dam. - Receiving tank (V = 50 m^3), HWL = 2,305, LWL = 2,302	- All the facilities of PS are heavily deteriorated and needed to be thoroughly replaced. - The AC pipe (L = 2,600 m) needs to be replaced with PVC/DCI pipe.
Pump facility feature	- Leakage from the valves and wall of the tank P1: (Q = 200 m^3/h, H = 75 m) - Large amount of leakage from the bearings - Pump is seriously deteriorated. - There is no instrumentation.	
Installation year	- Electric facility is in a dangerous condition. - Unknown	
Operating/ functioning condition	- All facilities are heavily deteriorated. - One pump is operated when the electricity is available. - No operation record was kept.	

Raw Water Transmission Pipeline from Mai Serwa PS to S.V. WTP		
Pipeline	D300 Cast iron L = 100 m - In the downstream of the spillway of the dam, the pipe is exposed. D300 AC pipe L = 2,600 m	
Treated Water Transmission Facility from Stretta Vaidetto WTP		
Treated Water Transmission Pump at SV WTP		
Clear water reservoir	- The clear water reservoir is located under the rapid sand filter. V = 600 m^3, HWL = 2,353, L = 2,350 - Leakage from the valves and reservoir wall is observed.	The pump facility is seriously deteriorated as a whole.
Pump facility feature	P1: Q = 510 m^3/h, H = 85 m, 200 kW - Pressure gauge is out of order. P2: Q = 500 m^3/h, H = 80 m 200 kW - Leakage from the bearings and pipe connection. - Pressure gauge is out of order. - There is no instrumentation.	
Installation year	One pump is recently replaced. The other is heavily deteriorated.	
Operating/ functioning condition	Two pumps are operated by rotation when the electricity is available.	
Treated Water Transmission Pipeline from S.V. WTP to the Service Area		
Pipeline	D300 PVC L = 5,000 m Air valve: 3 nos., Drain: 1 no. - The pipeline was thoroughly replaced from AC pipe to PVC pipe after 1997.	- Original AC pipe was replaced to PVC after 1997. Therefore, there is no particular problem. - Pipeline must be extended to the planned New Arbate Asmara Reservoir.
Distribution Facility in the Service Area		
Distribution Reservoir	- Existing two steel-made reservoirs are deteriorated and no more used. They cannot be used due to heavy rust.	- There is no functioning reservoir.
Distribution pipeline (Primary pipeline)	PVC DN150 – DN250 - The valve facility is deteriorated.	- The pipe was replaced to PVC pipe after 1997 but the exact locations of the valves are not recorded.
Distribution pipeline (Secondary pipeline)	PVC DN50 – DN150, GI DN20 – DN50 - The valve facility is deteriorated.	- There remains an approximately 900 m of deteriorated GI pipe. - Exact locations of the valves are not recorded.

Source: Survey Team

(3) Toker WTP System

The water source of Toker WTP System is Toker Dam as shown in Figure 2.3.9.



Source: Survey Team

Figure 2.3.9 Configuration of Toker WTP System

1) Dam

The various factors or elements of Toker dam is indicated in Table 2.3.21.

Table 2.3.21 Various factors or elements of Toker dam

Items		Contents	Items	Contents
Current situation of utilization		Utilization	Catchment area	Approx. 69.6㎢
Future plan of utilization		Plan to use	Water surface area	Approx. 0.18㎢ (inference)
Design documents		CAD drawing Document is only Technical Memorandum.	Gross storage capacity	Approx. 13.6 mill ㎥
River name		Anseba river system	Effective storage capacity	Approx. 0.425 mill ㎥ (inference)
Intended use		Drinking water	Sedimentary soil into the dam's lake	Approx. 12.576 mill ㎥ (inference)
Structure Type		Concrete gravity dam (overflow dam)	Source of power for Raw-water pump	Diesel engine pump(CAT) 990㎥/h×10hours=9900㎥/day
Construction year		2002	Generator for backup	Transmission line of 15KV has been completed up to near the dam. Available at the receiving device and the pump motor replacement.
Design or Constraction company		National budget and soft loans	Operation time for Raw-	Day average of 10 hours (20:00-6:00)
Source of funds		Korean construction company accepted the order.	Water quality	WRD enforces it once a year. The water is satisfied with Eritrea water quality standard. Light green(as of Apr. 2015)
Dam body	Length	Approx. 240m	Landownership	Government
	Height(Max)	Approx. 74m	Ownership of structure	AWSD
	Upper Wide(Max)	Approx. 8.2m	Water rights	AWSD
	Bottom Wide(Max)	Approx. 57m	Conservation-Management	MoA & Zoba Maekel
	Dam volume	Approx. 174,000㎥ (inference)	Management for Structure	AWSD
Attached structure of dam	Intake pipe	Multistage-type gate (6 stages) No.1-5 stage: □1,050mm intake gate		
	Spillway (flood way)	Wide 34m, Depth 10m in dam body		
	Sludge discharge pipe	No.6 stage: □1,050mm sludge gate		
	Discharge pipe	Substitute sludge discharge pipe and intake pipe		
	Water level gauge	Lower scale of gauge is disappeared.		

Source: Survey Team

Toker dam is a new concrete gravity dam, which was built in 2002. The sedimentary soil was discharged several times in the past. There is no outstanding problem.

2) WTP

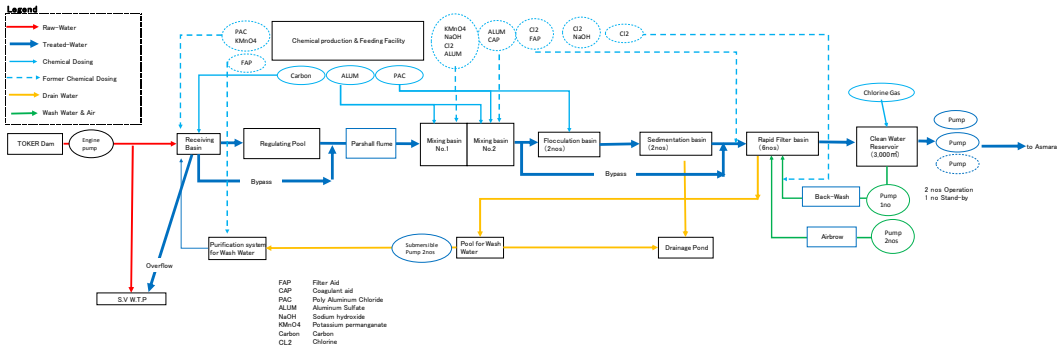
The various factors or elements of Toker W.T.P are indicated in Table 2.3.22.

Table 2.3.22 Various factors or elements of Toker W.T.P

Items	Contents
Design documents	CAD drawing
Water source	Toker dam
Construction year	2002
Design or Constraction company	BIWATER in South Africa
Source of funds	Kuwait fund is 50%, the government funds 50%
Treatment method	Rapid filtration system
Design treatment capacity	18,000㎥/day
Source of power	Commercial power (EEC) 3 nos treated water pump, Pump discharge: 450㎥/h (1 no pump is spare)
Generator for backup	800KVA(600KW)
Operation time	9 hours/day For raw water pump is running only 9 hours.
Operation mathod	Manual operation (Centralized automatic control system is out of order in 2007.)
Flocculants(Coagulation)	ALUM (Aluminum Sulfate) At the time of a blackout, ALUM is dosed directly into the mixing pond.
pH control chemicals	Currently unused Sodium hydroxide was used during the 2002 operation.
Chlorination	Chlorine gas Chlorine gas is injected directly into the clear water reservoir by the rubber tube. Sodium hypochlorite generation apparatus was out of order in 2009.
Other chemicals	Inventories of PAC and carbon at the oparation time in 2002 are using. Potassium permanganate, Filter Aid and Coagulant aid were used at the oparation time in 2002.
Inlet and Outlet flow	No record (Outlet flow understand by the pump operating time.) (Inference 8,000㎥/day)
Water quality (Outlet)	WRD enforces it once a year. E. coli has been detected.
Sludge disposal	Sedimantation basin for sludge
Water quality laboratory	Jar tester, pH meter, turbidimeter and residual chlorine meter are not using.
Landownership	AWSD
Ownership of structure	AWSD
Management for W.T.P.	AWSD

Source: Survey Team

The flow chart of Toker W.T.P is indicated in Figure 2.3.10.



Source: Survey Team

Figure 2.3.10 Flow chart of Toker W.T.P

Toker W.T.P was built in 2002 as the central control management system, but it is under manual operation at the present.

The present situation is indicated as follows.

- The inlet and outlet water meters are out of order.
- W.T.P has been operated manually from 2007 because the central control system was out of order.
- Various chemicals were used at the starting time of the operation in 2002, but ALUM and chlorine gas are used mainly at the present.
- The solid alum is dosed into the mixing basin directly at the time of the blackout.
- The sodium hypochlorite generation apparatus was out of order in 2009, and chlorine gas is injected directly into the clean water reservoir without the chlorinator by rubber tube.
- Only the water of 9,900m^3/day (990m^3/hour ×10 hours) is supplied to the W.T.P from Toker dam in spite of the design treatment capacity of 18,000m^3/ day due to deterioration and the huge fuel consumption of the engine pump. (Refer to transmission facilities)
- Total coliform bacteria are detected.
- The jar test has not been practiced.

3) Intake, Transmission, and Distribution Facility

The present condition and problems of each facility is as shown in Table 2.3.23.

Table 2.3.23 Present Condition and Problems of Intake, Transmission and Distribution Facility of Toker WTP System

Facility	Feature/ Present Condition	Problem
Toker Dam - Toker WTP Raw Water Transmission Facility		
Toker Raw Water PS		
Receiving tank	- There is no receiving tank. Raw water intake pipe is directly connected to the pump. Dam: HWL = 2,210, LWL = 2,172	- The diesel pump can be operated only 10 h/day, because the pump is heated up and the huge fuel consumption. - Thus, the WTP can also be operated only 10 h/day. - AWSD intends to replace the pump with the electric motor driven pump and the power distribution line comes near the PS. - However, the work schedule of replacement is not fixed.
Pump facility feature	P1: (Q = 990 m^3/h, H = 235 m) 2000 rpm Diesel engine P2: (Q = 990 m^3/h, H = 235 m) 2000 rpm Diesel engine - Pressure gauges are out of order. - There is no flow meter	
Installation year	2002	
Operating/ functioning condition	- Only P1 pump is operating 10 h/day during night time. - P2 pump is under maintenance. Only the pump operation hour and consumption of diesel are recorded.	
Remarks	The detailed design and tender document of the electrification work of this pumping station have been prepared by NRCE (the consultant of Toker project)	

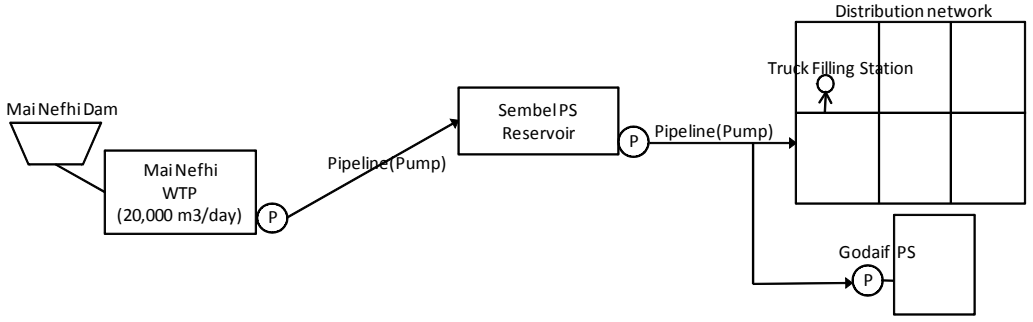
	in 2007. However, because of the trouble with AWSD, the tender document has not been delivered to AWSD. The contract for the construction of access road for this electrification work was concluded with BDHO, the national construction company in 2010. (The contract price was approximately USD 0.5 million). However, the work has not yet commenced because this was not prioritized by the government. The AWSD estimates the cost for this electrification work including the above access road to be approximately USD 10 million.	
Raw Water Transmission Pipeline from Toker Raw Water PS to Toker WTP		
Pipeline	D600 DCI L = 13 km Air valve: 15 nos., Drain: 14 nos. - Leakage occurred in the past.	No particular problem
Treated Water Transmission Facility from Toker WTP		
Treated Water Transmission Pump at Toker WTP		
Clear water reservoir Pump facility feature Installation year Operating/ functioning condition	 V= 3000 m^3, HWL = 2384, LWL = 2379 P1, P2, P3: (Q = 450 m^3/h, H = 65 m) 132 kW Instrumentation and electric facility: Fair condition 2002 - Transmission pump is also operated at 10:00 p.m.-6:00 a.m. - From 6:00 a.m.-1:00 p.m., the water is transmitted by gravity to the water truck filling station located at the entrance of the city area. During this period the pipeline to the service area is closed by the valve.	No particular problem
Treated Water Transmission Pipeline from Toker WTP		
Pipeline	D500 DCI L = 3,600 m Air valve: 6 nos. Drain: 4 nos.	No particular problem
Distribution Facility in the Service Area		
Monopolio Reservoir	V = 300 m^3 x 2 HWL = 2364, LWL = 2360 - Cracks are observed on the wall - Valves and piping are all rusted and should be thoroughly replaced.	- Existing three reservoirs are almost not used. - They are all deteriorated and all the piping must be thoroughly replaced. - It is difficult to continue using the existing reservoir by repairs. - In order to secure the appropriate water distribution in the service area, it is necessary to construct new reservoirs. - It is also necessary to construct the distribution pipeline from the new reservoir.
Hazhaz Reservoir	V = 500 m^3 x 2 HWL = 2366, LWL = 2361 - Cracks are observed on the wall. - Many leakages are observed. - Valves and piping are all rusted and should be thoroughly replaced.	
Tsetserat Reservoir	V = 500 m^3 x 2 HWL = 2366, LWL = 2361 - Cracks are observed on the wall. - Leakages are reported although the tank is covered by the earth. - Valves and piping are all rusted and should be thoroughly replaced.	
Mai Chohot pump station Receiving tank	V = 500 m^3, HWL = 2340, LWL = 2336	- Rehabilitation of the inside coating is necessary.

Pump facility feature Operating/ functioning condition	P1: Q = 150 m^3/h, H = 30 m, 67 kW P2: Q = 200 m^3/h, H = 8 0m, 90 kW - P1 pump is deteriorated and needs to be replaced. - Instrumentation is out of order. Operated only when electricity is available.	- P1 pump needs to be replaced. - Piping and instrumentation need to be replaced.
Denden pump station Receiving tank Pump facility Feature Operating/ functioning condition	V = 3000 m^3, HWL = 2351, LWL = 2347 P1: Feature is unknown. - Instrumentation is out of order. - Control panel and electric facility are heavily deteriorated and in a dangerous condition. Operated only when electricity is available.	- All the facilities are deteriorated. - This pump station is used for a limited area. Thus, the need for priority for rehabilitation is not so high.
Distribution pipeline (Primary pipeline)	PVC DN150 – DN300 - The valve facility is deteriorated.	- The pipe was replaced to PVC pipe after 1997. But the exact locations of the valves are not recorded. - Extension to the newly developed area is needed.
Distribution pipeline (Secondary pipeline)	PVC DN50 – DN150, GI DN20 – DN50 - The valve facility is deteriorated.	- There remains an approximately 1100 m of deteriorated GI pipe. - Exact locations of the valves are not recorded.

Source: Survey Team

(4) Mai Nefhi WTP System

The water source of Mai Nefhi WTP System is the Mai Nefhi Dam. The raw water is treated at Mai Nefhi WTP located just downstream of Mai Nefhi Dam and then transmitted to the reservoir at Sembel PS. Then the treated water is distributed to the service area from Sembel PS, as shown in Figure 2.3.11.



Source: Survey Team

Figure 2.3.11 Configuration of Mai Nefhi WTP System

1) Dam

The various factors or elements of Mai Nefhi dam are indicated in Table 2.3.24.

Table 2.3.24 Various factors or elements of Mai Nefhi dam

Items		Contents	Items	Contents
Current situation of utilization		Utilization	Catchment area	Approx. 94.5㎢
Future plan of utilization		Plan to use	Water surface area	Approx. 0.8㎢ (inference)
Design documents		schematic plan	Gross storage capacity	Approx. 26 mill㎥
River name		Mereb river system Nefhi river	Effective storage capacity	Approx. 23.912 mill ㎥ (inference)
Intended use		Drinking water	Sedimentary soil into the dam's lake	Approx. 2.088 mill ㎥ (inference)
Structure Type		Concrete gravity dam (non-overflow dam)	Source of power for Raw-water pump	Unnecessary(Gravity)
Construction year		1968	Generator for backup	unnecessary
Design or Constraction company		Unconfirmed(Degremont:France)	Operation time for Raw-water pump	unnecessary (Operation time of treated water pump is 18 hours.)
Source of funds		Unconfirmed	Water quality	WRD enforces it once a year. The water is satisfied with Eritrea water quality standard. Light green(as of Mar, 2015)
Dam body	Length	Approx. 220m	Landownership	Government
	Height(Max)	Approx. 35m	Ownership of structure	AWSD
	Upper Wide(Max)	6.5m	Water rights	AWSD
	Bottom Wide(Max)	Approx. 30m	Conservation-Management	MoA & Zoba Maekel
	Dam volume	Approx. 38,000㎥ (inference)	Management for Structure	AWSD
Attached structure of dam	Intake pipe	2 nos Multistage-type gate (5 stages) ϕ 500mm Lower two stages are clogged with mud.		
	Spillway (flood way)	Wide 10m, Depth 3m		
	Sludge discharge pipe	5nos sludge discharge pipes are clogged with mud.		
	Discharge pipe	Substitute sludge discharge pipe		
	Water level gauge	nil		

Source: Survey Team

There is much sedimentary soil in the dam lake, and the sludge discharge pipes are clogged up. However, AWSD has never removed the sedimentary soil in the past.

Furthermore, the construction is old, and the drawings are lost, and nobody can judge whether the gross storage capacity of the dam is exact. In the future, it is necessary to make exact drawings by carrying out surveying of the dam in order to grasp the size of the dam body and the gross storage capacity exactly.

2) WTP

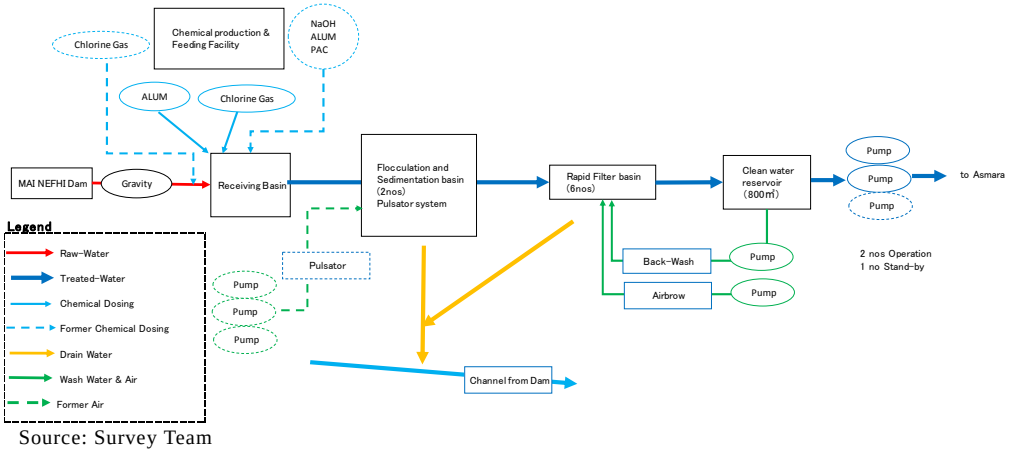
The various factors or elements of Mai Nefhi W.T.P is indicated in Table 2.3.25.

Table 2.3.25 Various factors or elements of Mai Nefhi W.T.P

Items	Contents
Design documents	Drawing in 1967 remains partially.
Water source	Mai Nefhi dam
Construction year	1967
Design or Constraction company	Degremont in France
Source of funds	unconfirmed(France？)
Treatment method	Rapid filtration system(Pulsator type coagulation-sedimentation pond and Akazuru type filtration system)
Design treatment capacity	20,000㎥/day
Source of power	Commercial power (EEC) 3 nos treated water pump, Pump discharge: 500㎥/h (1 no pump is spare)
Generator for backup	nil
Operation time	18 hours (2 nos treated water pumps)
Operation mathod	Manual operation
Flocculants(Coagulation)	ALUM (Aluminum Sulfate) is dosed into the receiving well directly. The chemical mixing and injection equipment were out of order in 1995. And it was rehabilitated in 2000, but it was used one year only.
pH control chemicals	Currently unused The chemical mixing and injection equipment were out of order in 1995. And it was rehabilitated in 2000, but it was used one year only.
Chlorination	Chlorine gas Chlorine gas is injected directly into the receiving well by the rubber tube.
Other chemicals	Currently unused Polymer was used one year only in 2000.
Inlet and Outlet flow	No record (Outlet flow understand by the pump operating time.) (Inference 18,000㎥/day)
Water quality (Outlet)	WRD enforces it once a year. The water is within Eritrea water quality standard.
Sludge disposal	Sludge has discharged into dam's channel directly.
Water quality laboratory	Jar tester is not using. pH meter and turbidimeter are out of order.
Landownership	AWSD
Ownership of structure	AWSD
Management for W.T.P.	AWSD

Source: Survey Team

The flow chart of Mai Nefhi W.T.P is indicated in Figure 2.3.12.



Source: Survey Team

Figure 2.3.12 Flow chart of Mai Nefhi W.T.P

Mai Nefhi W.T.P was built in 1967 composed of the flocculating sedimentation basin of pulsator type and the filtration basin of aquazur type.

The present situation is indicated as follows.

- The inlet and outlet water meters are out of order.
- After the chemical mixers (alum and lime), the chemical dosing pimps and the vacuum pumps were out of order more than 20 years ago, France donated the equipment of the chemical mixers (alum, lime and polymer), the chemical dosing pumps and the vacuum pumps in 2000. But those were out of order 1 year later. The solid alum is sporadically dosed into the receiving well directly without adjusting its concentration.
- The chlorinator has been out of order for a long time. And chlorine gas is injected directly into the receiving well by rubber tube.
- The pulsator system isn't functioning because of the failure of the vacuum pumps.
- Most of equipment of the vacuum tower are out of order due to corrosion.
- Water is leaking at the link channel between the flocculating sedimentation basin and the filtration basin.
- The crack valves, the partialization boxes and the clogging indicators (pressure) in each filtration basin are out of order.
- Most of the valves are deteriorated due to old age.
- There are no spare of the back-wash pump and air-brow pump.
- Water is leaking at the transmission pumps and the valves. (Refer to transmission facilities)
- The water quality satisfies with the national water quality standard.

3) Intake, Transmission and Distribution Facility.

The present condition and problems of each facility are as shown in Table 2.3.26.

Table 2.3.26 Present Condition and Problems of Intake, Transmission and Distribution Facility of Mai Nefhi WTP System

Facility	Feature/ Present Condition	Problems
Treated Water Transmission Facility from Mai Nefhi WTP		
Treated Water Transmission Pump at Mai Nefhi WTP		
Clear water reservoir	V= 800 m^3, HWL = 2154, LWL = 2150	- Checking and maintenance of the pumps are necessary. - Instrumentation and water hammer prevention equipment need to be replaced.
Pump facility Feature	P1, P2, P3: (Q = 500 m^3/h, H = 215 m), 450 kW - The pump capacity has been reduced due to the wearing of the bearings and impellors. - Pressure gauges are out of order. - The Woltman water meter is installed but the AWSD does not adopt the figure of the meter. - Air chamber for water hammer prevention is out of order.	
Installation Year	2001	
Operating/ functioning condition	Two out of three pumps are operated by rotation 16 h/day. The water flow (by two pumps) is 680 m^3/h	

	according to the Woltman flow meter.	
Treated Water Transmission Pipeline from Mai Nefhi WTP to Sembel PS		- The pipeline was laid more than 40 years ago. The leakage due to the deterioration of the pipe occurs. - The leakage firstly occurred at L = 13-14 km in 2001. Formerly, the leakage location was limited. However, after 2013, the leakage also occurs at other locations. - It will be difficult to manage the leakage through supportive repair for the future. The replacement of the pipeline is needed.
Pipeline	D500 Steel pipe L = 17 km Air valve: 8 nos.; Drain: 8 nos. - Leakage occurred at: L = 13-14 km, L = 10 km, L = 8.5 km, L = 6 km, L = 3.5 km - Especially, the leakage occurs every year at L = 13-14 km. - It takes a day to repair the leakage.	
Remarks	- Four distribution reservoirs (total of 1,600 m^3) were constructed at the newly developed area near Semble PS. The transmission pipeline to the new reservoir is to be branched from the existing transmission pipeline. The construction contract was already concluded with the Chinese contractor. - The elevation of the new reservoir is higher than that of Sembel PS but lower than the highest point of the existing transmission pipeline. - The measure for water allocation between the new reservoir and the reservoir at Sembel PS is not yet determined.	
Sembel PS		
Reservoir Pump facility feature Installation year Operating/ functioning condition	V = 300 m^3 x 2, HWL = 2364, LWL = 2360 P1, P2, P3: (Q = 500 m^3/h, H = 90 m), 200 kW - Several pressure gauges are out of order. - Chlorine gas injector is out of order. - Instrumentation and electric facility is in fair condition. - The emergency generator is not equipped. 2002 Operated 16 h/day	- Windows equipped on the wall of the reservoir are broken. It must be repaired to prevent possible contamination of the stored water. - No particular problems in the pump facility
Distribution Facility in the Service Area		
Godaif pump station Receiving tank Pump facility Feature Operating/ functioning condition	 V = 200 m^3, HWL = 2323, LWL = 2320 Heavily deteriorated. P1: Q = 300 m^3/h, H = 88 m - Only one pump is operated. - Instrumentation is out of order. - Control panel and electric facility is in fair condition. Operated only when electricity is available.	 - The facility is heavily deteriorated. - The elevation is almost the same as Sembel PS. Thus, it is proposed to abolish this PS in the FS.
Distribution pipeline (Primary pipeline)	PVC DN150 – DN300 - The valve facility is deteriorated.	- The pipe was replaced to PVC pipe after 1997. But the exact locations of the valves are not recorded. - Extension to the newly developed area is needed.

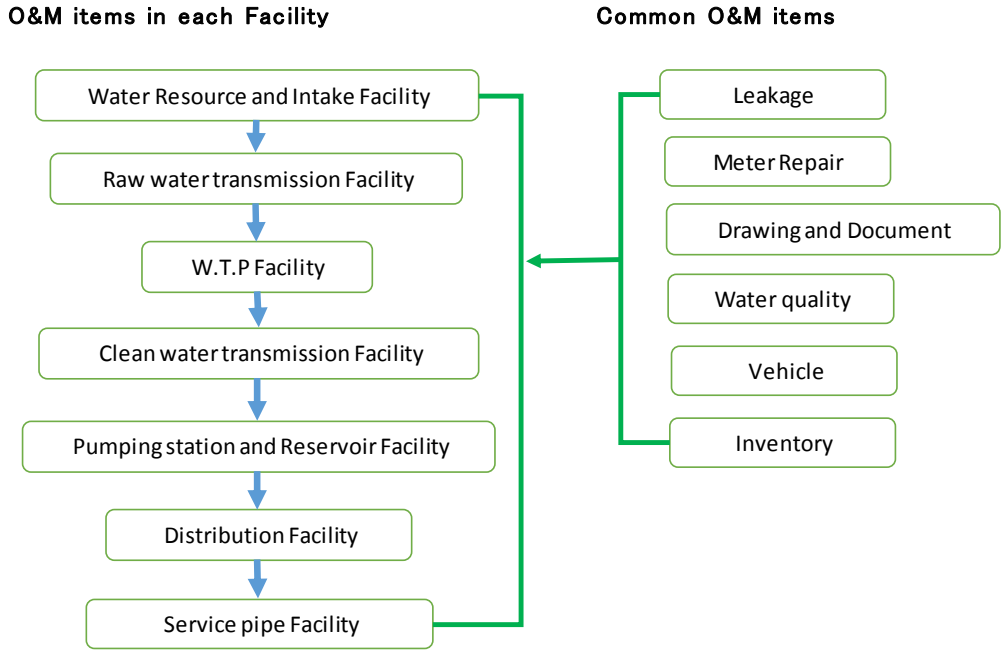
Distribution pipeline (Secondary pipeline)	PVC DN50 – DN150, GI DN20 – DN50 - The valve facility is deteriorated.	- There remains an approximately 1200 m of deteriorated GI pipe. - Exact locations of the valves are not recorded.

Source: Survey Team

2.3.4 Operation and Maintenance (O&M)

(1) Outline

The current state of operation and maintenance is divided as indication Figure 2.3.13.



Source: Survey Team

Figure 2.3.13 Flow chart of operation and maintenance

(2) Current state of O&M in each facility

1) Water source and intake facilities

The water sources and the water intake facilities (dams) are not managed as follows, and the staff is not enough.

- There isn't an engineer for managing the O&M of each water resource and dam.
- There are no vehicles to manage each water source and intake facility.
- Young and middle-aged workers are lacking.
- The preservation of water sources (patrol, cleaning, etc.) isn't practiced.
- There are no water level indicators. However, there is only a water level indicator at Toker dam, but the lower scale of the gauge has disappeared.
- There is no water quality equipment (turbidity, pH, electrical conductivity etc.) at each dam, in other words, AWSD does not enforce the water quality test. However, WRD

enforces the water quality test at the planed facilities (Adi Sheka, S.V, Toker and Mai Nefhi dams) once a year.

- A daily record of checking, repairing and operating isn't kept.
- There is much sedimentary soil in each dam lake. Particularly, S.V dam is remarkable, and it is inferred to be 61% of the gross storage capacity of S.V dam.
- There is no outlet and inlet water meter at each intake facility.

2) Raw water transmission facilities

CAT agency carries out the management of the diesel engine pumps at Toker raw water pumping station, and the maintenance is perfect. AWSD staff has implemented the oil change and the other checks based on the guidance of the CAT agency. But, there aren't enough management records in other raw water pumping stations.

Accepting the report of water leakage in the raw water pipeline from the residents, AWSD makes an investigation and repairs it. The record has been recorded in the PC at the head office.

The O&M situation is as follows.

- Young and middle-aged workers are lacking.
- A daily record (Checking, repairing and operating) of the pumps and the pipelines isn't kept. However, AWSD records only the daily record about the engine pump at Toker raw water pumping station.
- There is no outlet water meter at each raw water pump.
- The mechanic who repairs the pumps doesn't have enough technical know-how.
- The repairing materials aren't purchased in a timely manner. In particular, the purchase of the large size materials is difficult. (due to foreign currency shortage)
- Spare parts aren't purchased in a timely manner. (due to foreign currency shortage)

3) W.T.P facilities

Each W.T.P cannot be said to be managed properly because of the following.

S.V W.T.P

AWSD staff is recording the working hour and the operation time of the pump and the amount of consumption of chlorine gas and ALUM in the diary record every day. (other notices are contained in the remarks .） In addition, the staff carries out to repair of water leakage from valves (abrasion of the packing) , to operate the back-wash and to clean the site regularly. However, AWSD doesn't carry out the water quality test because there is no equipment for the test.

The AWSD chief staff grasps the whole W.T.P facilities and is managing the O&M while materials and equipment aren't timely supplied. But it is difficult for O&M to be carried out continuously because young and middle-aged workers are lacking.

Mai Nefhi W.T.P

AWSD staff is recording the working hours and the operation time of the pump and the amount of consumption of chlorine gas and ALUM in the diary record every day. (other notices are contained in the remarks .） The jar tester is not used. In addition, the turbidimeter and the pH-meter are broken and are left unused.

The AWSD chief staff grasps the situation of all W.T.P facilities and is managing the O&M while materials and equipment aren't timely supplied. The operation system in the W.T.P is organized into 3 shifts and 3 teams. Each team leader grasps the W.T.P facilities and carries out the back-wash and air-blow. But it may be said that it is difficult to decide whether the O&M are carried out continuously because young and middle-aged workers are lacking.

Toker W.T.P

The facilities have been in manual operation since the central control system was broken in 2007. When the computer didn't operate well, the system engineer in South Africa (origin of design) couldn't come immediately. Therefore, the staff attempted to repair it, and it was further worsened. Because it is difficult to manage the central control system in AWSD, we think that AWSD should continue the manual operation in the future.

In addition, only Toker W. T. P has not been keeping the diary record and does not have exact management of records.

The AWSD chief staff grasps the situation of all W.T.P facilities and is managing the O&M while any materials and equipment aren't supplied timely. All W.T.P staff (30 staff at that time) received OJT about the O&M for 6 months at the time of the W.T.P completion in 2002. For that reason, even if the central control system was broken, the manual operation was put into effect with no problem.

Though the staff can operate the water quality tests which are jar tester, pH meter, turbidity meter and residual chlorine meter (without reagent) in the W.T.P, the staff doesn't carry out these tests at the present.

The situation of the O&M at 3 W.T.Ps is as follows.

- There isn't an engineer for managing the O&M of the 3 W.T.Ps.
- There are no vehicles to manage the W.T.Ps
- Young and middle-aged workers are lacking.
- A daily record about checking, repairing and operating has not been arranged.
- There isn't any equipment and staff for the chemical dosing test.
- （But, there is the Jar tester and Staff is assigned at Toker W.T.P. The staff has six months OJT experience of water quality testing.）

- There is no water quality equipment (Turbidity, pH and electrical conductivity meters etc.) at the W.T.Ps. However, WRD enforces it once a year at each W.T.P.
- There are no inlet and outlet water meters at the W.T.Ps.
- The repairing materials aren't purchased timely. In particular, the purchases of the large size materials are difficult.
- Spare parts aren't purchased timely.

4) Clear water transmission facilities

In the same situation as the raw water transmission, it is not managed as properly indicated below. However, the record of water leakage repair has been recorded in the PC at the head office.

- Young and middle-aged workers are lacking.
- A daily record (Checking, repairing and operating) of the pumps and the pipelines isn't being kept. However, AWSD records only the operation time of the clear water transmission pumps at S.V and Mai Nefhi W.T.Ps.
- There are no inlet and outlet water meters at each pumping station and reservoir.
- The mechanic who repairs the pumps doesn't have enough technical know-how.
- The repairing materials aren't purchased timely. In particular, the purchase of large size materials is difficult.
- Spare parts aren't purchased timely.
- The repairing works of water leakage are behind schedule due to the shortage of the construction vehicles, the repairing machines and tools.

5) Reservoirs and pump stations

There is only an old staff, and the record keeping isn't done at all. Each reservoir carries out cleaning periodically. The staff of the pumping station is working only for ON /OFF of the pump. In other words, the staff only guards the facilities.

The O&M situations are as follows.

- Young and middle-aged workers are lacking.
- A daily record (Checking, repairing and operating) of the pumps and the pipelines isn't being kept.
- There are no inlet and outlet water meters at each pumping station and reservoir.
- The mechanic who repairs the pumps doesn't have enough technical know-how.
- The level indicator of each reservoir is out of order.
- The water quality management (Residual chlorine) is not being carried out.
- The repairing materials aren't purchased timely. In particular, the purchases of the large size materials are difficult. (due to foreign currency shortage)
- Spare parts aren't purchased timely. (due to foreign currency shortage)

6) Distribution network

Maintenance is practiced by CAD drawing of “F / S AfDB 2006". Accepting the report of the water leakage in the distribution network from the residents, AWSD makes an investigation and repairs it. The record has been recorded in the PC at the head office. However, it is necessary to specify the repair place on the CAD drawing because the identification of the place is difficult in the management of the tabular format.

The valves of the distribution network are operated to solve the shortage of water flow by 4 staff in the distribution unit.

The O&M situation is as follows.

- Young and middle-aged workers are lacking.
- A daily record (Checking and repairing) of the pipelines isn't being kept. But AWSD has managed water leakage repair records in the PC.
- There are no water meters for block management of the distribution network.
- The repairing materials aren’t purchased timely. In particular, the purchase of the large size materials is difficult. (due to foreign currency shortage)
- Spare parts aren't purchased timely. (due to foreign currency shortage)
- The repairing works of water leakage are behind schedule due to the shortage of the construction vehicles, the repairing machines and the tools. (due to foreign currency shortage)

7) Service pipes

AWSD is repairing the clogged pipes and water leakage from complaints by customers. Then, the record of the water leakage repair has been recorded in the PC at the head office.

There is no management drawing for the service pipe. Therefore, AWSD repairs the clogged pipes by excavating in order from the meter.

The two water filling stations are operated mainly, and three staff is working at each water filling station in the container office.

Each outlet meter at the water filling station is out of order, and the amount of outlet flow is calculated by the capacity of the water truck which was indicated on the sold ticket. The vehicle number and tank capacity are listed on the sold ticket, and the water charge is paid at the collection desk in AWSD head office.

The O&M situation is as follows.

- Young and middle-aged workers are lacking.
- There are no management drawings for the service pipes.
- AWSD carries out repair with the materials in the stockyard (Grant aid in 2000 by France).

- There are no outlet and inlet water meters at each filling station.
- The water quality management (Residual chlorine) is not carried out.

(3) Common O&M items in each facility

1) Water leakage

- AWSD has only worked to handle a lot of current complaints, and can't do other work.
- Young and middle-aged workers are lacking.
- The repairing materials aren't purchased timely. In particular, the purchase of the large size materials is difficult. (due to foreign currency shortage)
- Spare parts aren't purchased timely. (due to foreign currency shortage)
- Most of the repairing works of pipe clogging are left.
- The repairing works of water leakage are behind schedule due to the shortage of the construction vehicles, the repairing machines and the tools. (due to foreign currency shortage)
- There is no leak detection equipment, and there are no staff stationed.

2) Meter repairing

- AWSD has repaired the water meters by using a meter checking machine, only when there were customer complaints.
- There are no water meters in the warehouse. For that reason, there is a lot of work remaining in the new pipe connection and meter repairing.

3) Drawing and documents

- AWSD has not kept any past complete drawings and documents.
- (Most of the past drawings and documents are lost.)
- There are few staff who can operate CAD.
- (There isn't any staff to update and manage the CAD drawings.)
- The pipeline drawings of transmission and distribution pipelines aren't being managed.
- (The pipe diameter, the pipe class and the valve position are not specified in the drawing.)

Confirmed drawing:

- CAD drawing of Toker W.T.P system (dam, raw water transmission, W.T.P, clear water transmission).
- Plan of flocculation and sedimentation at S.VW.T.P.
- Facilities drawing at Mai Nefhi W.T.P. (Lost some)
- Vertical section of clear water transmission between Mai Nefhi W.T.P and New Sembel Pumping Station.
- Facilities drawing at New Sembel Pumping Station.

- CAD drawing of distribution network by “F/S AfDB 2006”

Confirmed documents:

- Technical memorandum report of Toker dam

4) Water quality
   - There isn't a water quality laboratory in AWSD.
   - There are no analyses of water quality test in AWSD.

5) Vehicles and machines
   - There aren’t sufficient construction vehicles.
   - There aren’t sufficient vehicles for management.
   - The mechanic who repairs the vehicles doesn't have enough technical know-how.
   - There aren’t sufficient tools and the repairing machines.

6) Inventories
   - The inventories are managed correctly.
   - Spare parts aren’t purchased timely. (due to foreign currency shortage)

2.3.5 Water Quality Control

The water quality test is not conducted in AWSD. In addition, there is no water quality laboratory. On the other hand, National water quality laboratory in WRD enforces it. WRD is responsible for monitoring the water quality at the rivers, the water supply facilities and the wells in Eritrea. National water quality laboratory is managed by only 1 chief who graduated the chemistry department of a university. The chief is requesting an assistant, but it's uncertain. He is hardly in the laboratory because he is monitoring the nationwide by himself.

Other water quality laboratories are ESI (Eritrean Standards Institute) in MoTI, MoH and MoEM. But National water quality laboratory is the responsibility institution for the water supply.

Currently, 27 possible items are shown in Table 2.3.27.

Table 2.3.27 Possible items of water quality test at National Water Quality Laboratory

	Parameters	Items		Parameters	Items
1	EC	Conductivity	15	Mg	Magnessium
2	PH	pH	16	Na	Sodium
3	Turbidity	Turbidity	17	K	Potassium
4	TDS	Total dissolved solids	18	Fe	Iron
5	Total alkalinity	Total alkalinity	19	Mn	Manganese
6	Total hardness	Total hardness	20	Color	Colour
7	HCO3	Hydrogen Carbonate Ion	21	odor	odor
8	Cl	Chloride	22	Cl2	Residual chlorine
9	NO3	Nitrate	23	Total coliform bacteria	Total coliform bacteria
10	NO2	Nitrite	24	Faecal coliform bacteria	Faecal coliform bacteria
11	NH3	Ammonia	25	Ba	Barium
12	SO4	Sulfate	26	BOD	Biochemical Oxygen Demand
13	F	Fluoride	27	COD	Chemical Oxygen Demand
14	Ca	Calcium			

Source: Survey Team on the basis of WRD hearing

The reagents are replenished by requesting to Unicef.

The water quality standards are in accordance with the "Eritrean water quality standard (Draft) Aug, 2004" based on WHO.

The drinking water is evaluated by dividing into Group A, B, C and D as follows. And Group A, B and C are judged that there are no problem.

Group A: Water with an excellent quality.
Group B: Water with good quality.
Group C: Water with low health risk.
Group D: Water with a higher risk or water unsuitable for human consumption.

The drinking water quality standard and river water quality standard are shown in Appendices 4.8.

The implementation plan for the monitoring of water quality by National water quality laboratory is shown in Table 2.3.28.

Table 2.3.28 Implementation plan for monitoring of water quality by National Water Quality Laboratory

Parameters group	parameters	Sampling points	Sampling frequency
General	Temp, EC, PH, DO, TDS	3 dams	Every 6 month
Nutrients	NH3, NO3, NO2, total P	12 Points	Once every year
Organic matter	BOD, COD	–	–
Major ions	Ca++, Mg++, K+,Na+, HCO3, SO4--, Cl-, F,	12 Points	Once every year
Metals	Fe, Mn,	3 dams	Once every year
Hydrocarbon	BTEX , oil and grease	3 dams	–
Microbiological	Total and faecal coliform bacteria	12 Points	Once every 6-month

3 Dams Mai-Nefhi、Toker、S.V dam
3 Treatment plant Mai-Nefhi、Toker、S.V W.T.P
3 Pumping stations New Sembel、Denden、Mai Chehot
3 Reservoirs Tsetserat、Monopolio、Hazhaz
Source: Survey Team on the basis of WRD document

However, the water quality tests are really carried out once a year only at 4 dams (Mai Nefhi, Toker, S.V, Adi Sheka dam) and 3 W.T.Ps. The results of the lake water quality tests at the 4 dams are shown in Table 2.3.29, and the results of treated water quality tests at 3 W.T.Ps are shown in Table 2.3.30.

Table 2.3.29 Results of lake water quality test at 4 dams

Parameters	July, 2013				May, 2014				Standards for Rivers	Standards for Drinking Water(C)
	Mai-nefhi	TOKER	S.V	Adi-shaka	Mai-nefhi	TOKER	S.V	Adi-shaka		
Turbidity (NTU)	3.5	3.3	3.5	3.32	2.12				–	<10
EC	254	273	280	263	265	296	279	268	–	<3000
PH	6.78	8.31	8.43	8.43	8.3	8.23	8.21	7.78	5.5-9	5.5-9.5
TDS	170	182.9	187	157	159	198	186	179	<2000	<2000
Total hardness	100	160	112	110	130	124	115	108	–	<600
Total alkalinity	63.9	212	72	76	110	80	104	122	–	–
Coliform bacteria	many	many	many	many	many	many	many	many	<20000	Nil

Source: WRD

Table 2.3.30 Results of treated water quality test at 3 W.T.Ps

Parameters	July. 2013			May. 2014			Standards for Drinking Water(C)
	Mai-nefhi	TOKER	S.V	Mai-nefhi	TOKER	S.V	
EC in µs/cm	310	314	310	320		330	<3000
PH	177	177	207.7	214.4		221	5.5-9.5
Turbidity NTU	7.43	8.3	8.3	6.92		7.36	<10
TDS	1.21	2.32	1.33	1.12		10	<2000
Total alkalinity	36.9	101	128	64		112	-
Total hardness n	112	120	148	112		108	<600
HCO3	43.9	123	156	78		136.4	-
Cl	8	8	4	6		8	<600
NO3	3.5	8.8	4.43	6.67		4.8	<50
NO2	0.0012	0.017	0	0		0	<3
NH3	0.01	0.15	0.22	0.13	0.16	0.75	<1.5
SO4	36	36	25	47		41	<500
F	0.31	0.12	0.11	0.28		0.21	<3
Ca	24	35	33.3	32		30.4	-
Mg	6.7	7.6	15.3	7.68		7.6	<80
Na	21	6.9	28	19		21	<400
K	1.2	1.2	1.24	1.29		1.33	<20
Fe	0.04	0.03	0.04	0.06		0.16	<0.3
Mn	0.01	0.01	0.1	0.02		0.15	<0.5
Color	Agreeable	Agreeable	Agreeable	Agreeable		disagreeable	<20
odor	Agreeable	agreeable	Agreeable	agreeable		disagreeable	-
Cl2	<1ppm	<1ppm	0.12	11		low	-
Total coliform bacteria	No	10	5	No		15	Nil
Faecal coliform bacteria	No	no	no	no		2	Nil

Source: WRD

The problem about the lake water quality at the 4 dams hasn't been found from the results.

E.coli was detected in the treated water at Toker and S.V W.T.Ps from the results. Furthermore, fecal coliform bacteria were detected at the S.V W.T.P because the chlorine is not injected properly.

In addition, turbid water is confirmed every year in Asmara city because the raw water cannot be treated sufficiently in W.T.Ps and the muddy water flows into the dam lake in the rainy season of July and August. Therefore, AWSD is necessary to carries out the water quality test and grasp the data at each dam lake and W.T.P at that time.

In addition, as a turbid water measure in the rainy season, the citizens dose a few ALUM into the turbid water in a personal tank and precipitate the floating particles and using the surface of the water.

2.4 Environmental and Social Consideration

The initial investigation of important matters for the environment (Confirmation of current states) was carried out as follows.

(1) Authorization and explanation

1) EIA and environmental authorization

The environment procedures (EIA and environmental authorization) for the contents of the request letter were not performed at the time of the site survey because it was in the middle of confirmation of the validity for the project.

In addition, the general environment authorization procedure in Eritrea is indicated in the following for reference.

- The draft of the environmental law made in 2002 and revised editions in 2012 have not yet been approved. Therefore, the procedure is proceeding in accordance with "National Environmental Assessment procedures and guideline Mar, 1999".
- IEE (Initial Environmental Examination) has not been carried out in WRD and AWSD.
- The enforcement organization makes the project environmental screening form (PSF) by the requested project contents and submits it to the environment department in MoLWE.
- The environment department in MoLWE checks and evaluates category A, B, C.
    - Category A: The project that enforcement of EIA (Environmental Impact Assessment) is necessary
    - Category B: The project that enforcement of EE (Environmental Evaluation) is necessary
    - Category C: The project that environmental assessment isn't necessary any more
- If the project is evaluated as "category B", the enforcement of EE (Environmental Evaluation) is necessary. In that case, the enforcement organization makes ① EEQ (Environmental Evaluation Questionnaire) and ② EECF (Project Environmental Evaluation Clearance Form) with the stakeholder, and submits them to the environment department in MoLWE.
- The environment department judges them and announces the evaluation results.

2) Explanation to local residents

The explanation of the contents in the request letter has not been carried out for stakeholders at the time of this survey.

However, if EE and EIA are carried out before the start of the project, an evaluation of stakeholders is required. In other words, the enforcement organization gives an appropriate explanation to the local residents and is required to get there understanding.

(2) Pollution abatement

1) Air quality

Chlorine gas is injected directly into the clean water reservoir or the receiving well by rubber tube at the present. Therefore, it is necessary to install a chlorinator in 3 W.T.Ps, and it is necessary to carry out safety training and to purchase safety equipment.

In particular, a chloric smell fills the whole Mai Nefhi W.T.P due to the previous chlorine injection, and it is dangerous for human health. It is necessary to inform the appropriate chlorine injection rate due to avoiding excessive chlorine injection by measuring the residual chlorine and inspecting E.coli.

However, the survey as to whether chlorine satisfies Eritrean labor safety standards couldn't be carried out.

2) Water quality

The waste water quality standard has not been legalized in Eritrea. It's unclear about whether the sludge water which discharges from W.T.P satisfies the waste water quality standard (SS, BOD, COD, pH etc.).

However, "Eritrean water quality standard (Draft) Aug, 2004" describes the waste water discharge standards for rivers, the contents are pH: 5.5-9.0, BOD: 30mg / ℓ or less, COD: 70mg / ℓ or less. Because it is not monitoring sludge water which discharges from W.T.P, it's unclear about whether the sludge water satisfies the waste water discharge standards for rivers.

3) Waste

It could not survey the disposal of waste in Eritrea.

However, if a sludge water treatment system is built at each W. T. P, the dry sludge is possible to be used in a field of the neighborhood.

4) Noise and vibration

It could not survey whether there is a noise and vibration standard in Eritrea.

However, noise and vibration problems will not occur because each facility is for away from the neighborhood houses.

5) Ground subsidence

Ground subsidence will not occur because there is no pumping up of groundwater.

(3) Natural environment

1) Protected areas

There is no influence on protected areas because each facility is not in the area.

2) Ecosystem

There is no influence on the ecosystem because each facility is not in the area.

(4) Social environment

1) Resettlement (Targeted for new S.V W.T.P)

Only the requested new construction of S. V W. T. P needs new land. But the government land is approximately 300 m between Toker W.T.P and S.V W.T.P (from the hill top to S.V dam) and only there are only three staff houses (the neighborhood of the top hill at Toker W.T.P). And there are small apple groves belonging to the Ministry of Defense approximately 200m along the river from the existing SV W.T.P. Therefore, there is enough land for new S.V W.T.P and there is no resettlement problem.

2) Living and livelihood

There is no influence on living and livelihood in particular because the water sources of this project and the living water of the residents are different.

3) Heritage

There isn't valuable heritage and ruins around the facilities which this project is intended for.

But, there are a lot of historical structures built before 1940 in the city, and it's necessary to pay attention to these at the time of the rehabilitation of the pipeline.

Italy constructed an open channel of a gravity-type (approximately 7km) from the Adi Sheka dam to the Beleza dam for hydraulic power generation built before 1940. It's even used now as the raw water transmission channel of S.V W.T.P. And it is necessary to confirm the environmental department in MoLWE at the time of the rehabilitation because the open channel is thought to be historically valuable.

4) Landscape

There is no influence on the landscape in particular.

5) Ethnic minorities and indigenous peoples

There is no influence on ethnic minorities and indigenous peoples in particular.

(5) Other

1) Impact during construction

If this project is carried out, it is necessary to consider the pollution (noise, vibration, turbid water, dust, exhaust gas, waste, etc.) during the construction. But the natural environment (ecosystem) and social environment will not have a bad influence from the construction.

In addition, safety training will be required for the workers engaged in the project.

2) Monitoring

A monitoring plan (water quality, Heritage, Pollution under construction, etc.) of the enforcement organization will be necessary.

(6) Important notice

There is an Adinfase gold mining development plan about 5 km from the east side of S.V dam. But, it is necessary to consider the drainage treatment method because the influence of health hazard from the mining drainage is a concern. Currently, the plan of mining drainage is expected to discharge to the sea side, which will not influence the S.V dam. The Eritrean government is not going to authorize the plan, if the plan is to discharge mining drainage in the drinking water area and will not install a waste water treatment facility.

2.5 Water Demand Projection and Water Balance

2.5.1 Condition of Water Demand Projection

(1) Potential Water Demand in 2015

Recently, the amount of treated water sent from the WTPs is only 18,000 m^3/day in average due to: 1) Shortage of available water due to drought; 2) Decline of the WTP capacity; 3) Limited operation hour of the transmission pumps due to malfunction/deterioration and; 4) Limited operation hour of the facilities due to frequent power cut. The potential water demand in 2015 on the assumption that these constraints are taken way and the 24 h of supply is made possible has been estimated on the condition as shown in Table 2.5.1.

Table 2.5.1 Conditions of 2015 Potential Demand

Item	Condition
1) Population in the service area (13 sub-Zobas and Daero Paulos area)	427,429 + 6,900 = 434,329, as shown in Table 2.3.6
2) Population served by piped water supply	As explained in Section 2.3.2, the potential piped water supply population is estimated to be around 350,000 (80% of the population in the service area: 348,699)
3) Per capita consumption (Piped water supply)	It was set at 50 l/c/d on average as a result of the consultation with AWSD. This figure can be considered reasonable compared with that of other African countries.
4) Population served by water truck (inside Asmara)	The service ratio in Asmara has been assumed to be 98% based on AWSD's suggestion. Then, the population ratio served by water truck is estimated to be 18% (98% - 80% of piped supply).
5) Population served by water truck (outside villages)	As shown in Table 2.3.6, 23,000 people (52%) out of 44,000 of villagers are being supplied with the AWSD water by water truck. Thus, the potential demand has been set to be 60%.
6) Per capita consumption (water truck)	There was 15 l/c/d as a result of the consultation with AWSD. This figure seems to be nearly the maximum considering the transportation of the water from the water truck to each house.
7) Non-domestic water	The amount of non-domestic water can be estimated in proportion to the domestic water. Therefore, it was estimated by the non-domestic water demand (2010) projected by the FS multiplied by the ratio of the potential domestic water demand in 2015 estimated by this survey, and the domestic water demand (2010) projected by the FS.
8) Water loss (%)	In the FS, it is assumed to be 33% on the condition that the pipe is filled with water all the time. Accordingly, the same figure was assumed in this survey.

Source: Survey Team

(2) Projection of Water Demand in 2020 and 2025

Based on the estimated potential demand in 2015, the water demand in 2020 and 2025 has been projected on the conditions as shown in Table 2.5.2.

Table 2.5.2 Conditions of Water Demand Projection in 2020 and 2025

Item	Condition
1) Population in the service area	The annual population growth rate of Asmara was 0.57% as shown in Table 2.3.5. The population in 2020 and 2025 were projected applying this growth rate to the population in 2015.
2) Population served by piped water supply	Present ratio of 80% was assumed to be increased to 82% and 84 % in 2020 and 2025, respectively.
3) Per capita consumption (Piped water supply)	50 l/c/d was assumed to be unchanged.
4) Population served by water truck (inside Asmara)	The AWSD service ratio of 98% was assumed to be unchanged. The service ratio by water truck was assumed to decrease in relation to the increase in service ratio by piped water supply.
5) Population served by water truck (outside villages)	60% was assumed to be unchanged.
6) Per capita consumption (water truck)	Assumed to be the same as of 2015 (15 l/c/d)
7) Non-domestic water	The potential demand in 2015 was assumed to be increased in proportion to the increase in domestic demand.
8) Water loss (%)	For the year 2020, it was assumed to be 33%, same as of 2015. For the year 2025, it was assumed to be 32% (reduced by 1%), considering that there will be not so much leakage from the newly installed pipe.

Source: Survey Team

2.5.2 Results of Water Demand Projection

Under the abovementioned conditions, the water demand was estimated/projected as shown in Table 2.5.3.

Table 2.5.3 Projected Water Demand

	Potential Demand in 2015	2020	2025
Conditions			
Population in the service area	434,329	446,744	459,513
Service ratio	98%	98%	98%
By piped water	80%	82%	84%
By water truck	18%	16%	14%
Served population (by piped water)	348,628	364,557	386,285
Served population (by water truck)	77,797	75,026	65,359
Per capita consumption (by piped water)	50 l/c/d	50 l/c/d	50 l/c/d
Per capita consumption (by water truck)	15 l/c/d	15 l/c/d	15 l/c/d
Water Consumption			
Domestic (Piped supply) (m^3/day)	16,506	17,347	18,356
Domestic (Water truck) (m^3/day)	1,566	1,508	1,402
Non-domestic (Piped supply) (m^3/day)	4,511	4,723	4,998
Non-domestic (Water supply) (m^3/day)	411	431	456
Total (m_3/day)	23,054	24,009	25,212
Water loss	33%	33%	32%
Water Demand			
Total water demand (m^3/day)	34,412	35,834	37,076
Stretta Vaudetto WTP System (m^3/day)	5,627	5,816	6,456
Toker WTP System (m^3/day)	15,498	16,189	16,409
Mai Nefhi WTP System (m^3/day)	13,287	13,829	14,211

Source: Survey Team

2.5.3 Water Balance

(1) Potential Water Demand in 2015 and Actual Supply in 2014

The potential water demand estimated in Section 2.5.2 and actual supplied amount in 2014 (the figure was converted to daily amount from the annual amount indicated in Table 2.3.6) are indicated in Table 2.5.4 by each WTP system.

Table 2.5.4 Potential Water Demand in 2015 and Actual Supply in 2014

		Stretta Vaudetto System	Toker System	Mai Nefhi System
Potential demand in 2015 (m^3/day)	(A)	5,627	15,498	13,287
Actual supply in 2014 (m^3/day) (Volume sent from WTPs)	(B)	2,073	7,508	8,665
Balance	(B)/(A)	0.37	0.48	0.65

Source: Survey Team

As shown above, the actual supply amount is below the potential demand in all systems. Especially, the actual supply amount in Strettta Vaudetto System is less than 40% of the potential demand.

(2) Water Demand in 2020 and 2025 and Supply Capacity

The water demand projected in Section 2.5.2 and the supply capacity of each WTP systems are indicated in Table 2.5.5.

Table 2.5.5 Water Demand and Supply Capacity

		Stretta Vaudetto System	Toker System	Mai Nefhi System
Projection of 2020				
Water demand (m^3/day)	(A)	5,816	16,189	13,829
Expected capacity of the facility after rehabilitation (m^3/day)	(B)	8,000	18,000	20,000
Possible intake amount from the dam (Note*) (m^3/day)	(C)	8,770	16,040	17,360
Water Balance	(B)/(A)	1.38		
	(C)/(A)		0.99	1.26
Projection of 2025				
Water demand (m^3/day)	(A)	6,456	16,409	14,211
Expected capacity of the facility after rehabilitation (m^3/day)	(B)	8,000	18,000	20,000
Possible intake amount from the dam (Note*) (m^3/day)	(C)	8,770	16,040	17,360
Water Balance	(B)/(A)	1.24		
	(C)/(A)		0.98	1.22

Note*: Refer to Section 3.1.1
Source: Survey Team

As shown above, the existing supply facility of each system can meet the water demand in 2025 if the capacity is returned to its original by rehabilitation.

However, it was presumed that the possible intake amount from Toker Dam and Mai Nefhi Dam is less than the respective design capacity of the WTPs, as described in Section 3.1.1. Thus, the possible supply capacity of Toker System and Mai Nefhi System is the possible intake amount from the dam at maximum.

Accordingly, the water demand in the Toker System after 2020 is expected to exceed the supply capacity.

Chapter 3 Consideration of the Contents of the Request

3.1 Consideration of Effectiveness and Sustainability of the Grant Aid Project

3.1.1 Examination of the Prerequisites (Water Source and Power Supply)

(1) Available quantity of water intake from each dam

The annual average rainfall is 419mm from the rainfall data for 22 years (1992-2014) of Asmara Airport meteorological station. The potential quantity of water intake from each dam is calculated based on those values. The results are indicated in Table 3.1.1. (Refer to Appendices 4.3. for the detailed calculation.)

Table 3.1.1 Potential and available quantity of water intake from each dam

W.T.P Group	Dam's Name	Potential quantity of water intake (m3/day)	Available quantity of water intake (m3/day)	Notes
Stretta Vaudetto W.T.P	Vall Gnecchi	150	0	The water isn't used as drinking water for a long time. The water is used for agriculture at present.
	Ela Nahib	0	0	The water isn't used as drinking water for a long time. The water is used for agriculture at present.
	Stretta Vaudetto	440	0	There are much sediment into the dam lake. Potential quantity of water intaken is little.
	Beleza	730	0	EEC has used the water as the cooling water of generator.
	Mai Serwa	2,350	**8,770**	Raw water transmission pipe is AC pipe.
	Adi Sheka	6,420		The pump stops for 2 months in the rainy season because muddy water inflow into the open channel.
Toker W.T.P	Toker	16,040	**16,040**	As a result of changing the average annual rainfall to 419mm from 500
Mai Nefhi W.T.P	Mai Nefhi	17,360	**17,360**	

Source: Survey Team

1) Stretta Vaudetto (S.V) W.T.P system

Valle Gnecchi dam hasn't been used for a long time and is used for agricultural water at the present. And Beleza dam is used for the cooling water of diesel power station by the EEC. Furthermore, S.V dam does not have enough water storage capacity because there is much sedimentary soil in the dam lake. Therefore, the water intake from Mai Serwa dam and Adi Sheka dam is regarded as the best plan for the water sources of S.V W.T.P system from this aspect. The available quantity of water intake from the two dams is inferred at 8,770 m^3/ day. Therefore, 8,000m^3/ day is proper for S.V W.T.P (Design treatment capacity 8,000m^3/day).

2) Toker W.T.P system

The available quantity of water intake from the Toker dam is inferred at 16,040 m^3/ day. In addition, the design treatment capacity of Toker W.T.P is 18,000 m^3/ day because the available quantity of water intake was calculated by the annual average rainfall of 500mm/ year at the time of the design.

3) Mai Nefhi W.T.P system

The available quantity of water intake from Mai Nefhi dam is inferred at 17,360 ㎥/ day. In addition, the design treatment capacity of Mai Nefhi W.T.P is 20,000 ㎥ / day because the available quantity of water intake was calculated by the annual average rainfall of 500mm/ year at the time of the design.

(2) Electric power supply

1) Current electric power supply and production, future plans

Currently, electricity is supplied for about 14 hours per day in Asmara city. Electricity is supplied from Beleza diesel power station (5MW X 3=15KW) in Asmara city and Hirgigo diesel power station (22MW X 4=88KW) in Massawa city. Therefore, electric production is possible up to 103MW.

Currently, electricity generates only 44MW at Hirgigo diesel power station because the two generators are being maintained of the four generators. Furthermore, electricity generates only 5MW at Beleza diesel power station because the two generators are maintained of the three generators. The quantity of current electric demand is estimated to be 65-70MW, but only 49MW is produced. Therefore, when the quantity of electricity demanded exceeds the quantity of the electric supply, the electricity stops accidentally or deliberately. However, the future electric state is expected to be better than the current one because the maintenance of all generators is going to be finished in 2 or 3 months.

The two generators (23MW×2=46MW) in the Hirgigo diesel power station are going to be completed by of SFECO construction company (Chinese company) in early 2016 because EEC is thinking there will be more than 80 MW of electricity demand in the future. Therefore, electric production capacity will be 99MW (Total capacity of the facilities is 149MW) beyond 80 MW of future prediction electricity demand.

But, it is questionable whether electricity can be supplied for 24 hours, because the purchase of the spare parts and diesel is difficult in Eritrea where the acquisition of foreign currency is difficult. The supply and demand of electricity is indicated in Table 3.1.2.

Table 3.1.2 Supply and demand of electricity

	Existing facilities	Maximum amount of production	As of Apr, 2015	2016	After 2016
Demand forecast in Asmara city			60-70MW	80MW	80MW
Hirgigo Diesel power station	22MW*4 generators (1 generator is a spare)	66MW	44MW (2 nos generators are under maintenance)	New 2 generators (23MW*2) will be completed. (1 generator is a spare)	89MW
Beleza Diesel power station	5MW*3 generators (1 generator is a spare)	10MW	44MW (2 nos generators are under maintenance)		10MW
Total		76MW	49MW		99MW

Source: Survey Team on the basis of EEC hearing

2) Electricity states in water supply facilities

The Operation time of each raw water transmission pump is not recorded except for the Toker raw water transmission pump. Therefore, the operational states of W.T.Ps are indicated in Table 3.1.3.

Table 3.1.3 Operational states of W.T.Ps

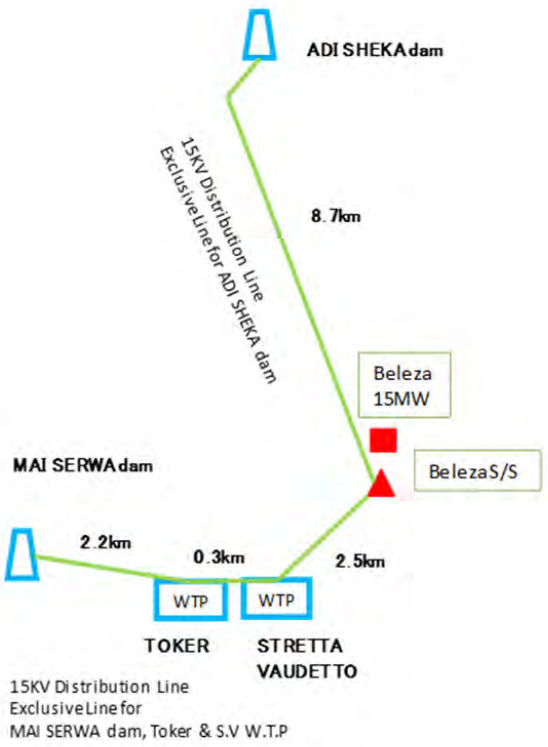
W.T.P	Daily mean operation time of treated water transmission pump (as of Apr, 2015)
S.V	10 hours/day (1 no treated water transmission pump)
Mai Nefhi	18 hours/day (2 nos treated water transmission pump)
Toker	9 hours/day (2 nos treated water transmission pump) A raw water transmission pump (diesel pump) can operate only at night.

Source: Study Team

Electricity is supplied for 24 hours at Mai Nefhi W.T.P because the exclusive distribution line is drawn from a nearby substation. But, the operation time in S.V W.T.P is only ten hours because it is influenced by the operation time of each raw water transmission pump at each dam.

The exclusive distribution lines are drawn to Mai-Nefhi W.T.P and Toker dam. The other water supply facilities are drawing general power distribution lines where electricity is delivered to each family. And the switch of general power distribution line at a substation is turned off in a time of power shortage.

Therefore, if the two exclusive distribution lines from Beleza substation to 3 facilities (Mai Serwa dam, S.V W.T.P and Toker W.T.P) and Adi sheka dam are drawn, the water supply for 24 hours in Asmara city is also possible under the current situation. (Refer to Appendices 4.4. for the details.)



Source: Survey Team

Figure 3.1.1 Exclusive distribution lines required in the future plan

3.1.2 Consideration of the Possibility of Assistance (Facility Construction)

(1) General

The effect of the water supply project is generated only after the treated water is delivered to the people in the service area. Thus, the project component of each system was designed so that all the facilities from raw water intake facility to their distribution facility function appropriately.

It was confirmed that existing WTPs can meet the water demand in 2025 if their capacity are returned to their original by rehabilitation, as described in Section 2.5.

Regarding the transmission/distribution facility, it was confirmed that by pipe network analysis the demand in 2025 can be met by constructing the facility listed in the application form of the project.

The conceivable items for construction/rehabilitation for each WTP system are presented hereunder, together with the expected effects.

(2) Stretta Vaudetto WTP System

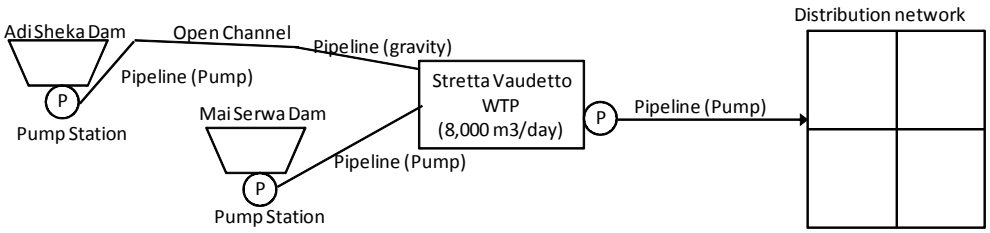
1) Water Treatment Plant

The existing receiving well, the flocculation basin and the sedimentation basin will be rehabilitated, and the structure of the filtration basin and the clear water reservoir will be constructed newly because the deterioration is remarkable.

- Improvement of inlet pipes (pipes and inlet water meters from 7 routes)
- Rehabilitation of chemical dosing equipment(ALUM) by using the existing chemical house
- Construction of turbid water treatment facilities (sedimentation system) for rainy season
- Rehabilitation of deflectors in existing flocculation basin
- Rehabilitation of sludge pipes and valves in sedimentation basin
- Construction of structure of filtration basin and clear water reservoir
- (Inc. filtration basin, clear water reservoir, back-wash pumps, air-blow pumps, clear water transmission pumps, chlorinator etc.)
- Installation of outlet water meter
- Installation of generator and fuel tank
- Construction of sludge treatment facility
- Repairing of water leakage in existing facilities

2) Intake, Transmission and Distribution Facility

The configuration of the Stretta Vaudetto WTP System is shown in Figure 3.1.2.



Source: Survey Team

Figure 3.1.2 Configuration of the Stretta Vaudetto WTP System

The feature, present condition, and problems of each facility are described in Table 2.3.20. The conceivable construction/rehabilitation works as the countermeasure to the problems are shown in Table 3.1.4.

Table 3.1.4 Conceivable Project Components of Stretta Vaudetto System

Facility	Present Condition/Problems	Proposed Construction
Adi Sheka PS	- One pump including the control panel must be replaced. - All the instrumentation facilities must be replaced.	

	- The open channel will be changed to the pipeline. Accordingly, the pump capacity needs to be increased.	- Thorough replacement of pump facility: (Q = 300 m^3/h, H = 60 m) x 2 (1w+1s)
Raw water transmission facility from Adi Sheka Dam	- Due to soil clogging during the rainy season, the transmission must be stopped around two months every year. - The six tunnels are deteriorated. - To solve these problems, it is necessary to change from open channel to pipeline. - 2 km of AC pipeline should be replaced to PVC/DCI pipe.	- Open channel (L = 8 km) to be changed to DCI DN300 pipeline. - AC pipe pipeline (L = 2 km) to be replaced to PVC DN300 pipeline.
Mai Serwa PS	- All the facilities of PS are heavily deteriorated and need to be thoroughly replaced.	- Thorough replacement of pump facility: (Q = 130 m^3/h, H = 61 m) x 2 (1w+1s)
Raw water transmission pipeline from Mai Serwa PS	- The AC pipe (L = 2,600 m) needs to be replaced with PVC/DCI pipe.	- Replacement to DCI DN300 L = 2.7 km
Treated water transmission pump at SV WTP	The pump facility is seriously deteriorated as a whole.	- Thoroughly replacement of pump facility: (Q = 170 m^3/h, H = 93 m) x 3 (2w+1s)
Treated water transmission pipeline from SV WTP to the service area	- Pipeline must be extended to the planned New Arbate Asmara Reservoir.	- Construction of PVC DN 250 pipeline (L = 1,340 m)
Distribution Reservoir	- There is no functioning reservoir. - The capacity should be 4 h not 3 has proposed in the FS considering the fire-fighting capacity.	- Construction of New Arbate Asmara Reservoir (700 m^3 x 2)
Distribution pipeline (Primary pipeline)	- The pipe was replaced to PVC pipe after 1997. But the exact locations of the valves are not recorded.	- Construction of PVC D250 pipeline (L = 250 m) (Outlet from the newly constructed reservoir)
Distribution pipeline (Secondary pipeline)	- There remains an approximately 900 m of deteriorated GI pipe. - Exact locations of the valves are not recorded. It is necessary to supply materials for: - 450 house connections until 2020 - Extension of 9,000 m distribution pipeline - Replacement of 900 m distribution pipeline	Supply of: - PVC pipe: DN 150, DN100, DN75, DN50 L = 2,500 m each - House connection materials and water meter: 450 nos.

Source: Survey Team

3) Project Effect

The expected project effect is shown in Table 3.1.5.

Table 3.1.5 Expected Project Effect (Stretta Vaudetto WTP System)

Present Condition	After the Project (2025)	Project Effect
Piped supply population: 77,736	Piped supply population: 92,873	Increase in piped supply population: 15,537
Total water supply volume (Sent form WTP): 2,073 m^3/day	Total water supply volume (Sent form WTP): 2,073 m^3/day	Increase in total water supply volume: 4,380 m^3/day Per capita consumption: 12 l/c/d => 50 l/c/d Water rationing => 24 h supply

Source: Survey Team

(3) Toker WTP System

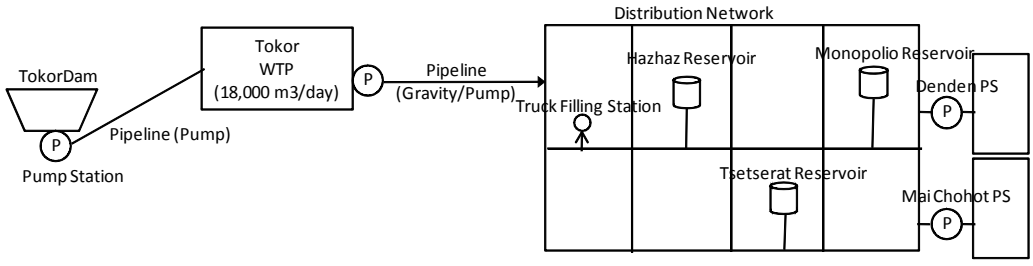
1) Water Treatment Plant

Even if the central control management system is rebuilt, electricity for 24 hours is necessary. Therefore, it cannot be said that this is the best plan in the current electric situation. In addition, it is similar in the rehabilitation of the sodium hypochlorite generation apparatus* which was used before. Therefore, it is considered to install the chlorinator which is used at present as the best plan for now.

Notes : *Sodium hypochlorite generation apparatus
It supplies a purified salt solution (water and refined salt) to an electrolyzer and produces sodium hypochlorite by turning on a direct current.

2) Intake, Transmission and Distribution Facility

The configuration of the Toker WTP System is shown in Figure 3.1.3.



Source: The Survey Team

Figure 3.1.3 Configuration of the Toker WTP System

The feature, present condition, and problems of each facility are described in Table 2.3.23. The conceivable construction/rehabilitation works as the countermeasure to the problems are shown in Table 3.1.6.

Table 3.1.6 Conceivable Project Components of Toker System

Facility	Present Condition/Problems	Proposed Construction
Toker Dam PS	- The diesel pump can be operated only 10 h/day because the pump is heated up and there is huge fuel consumption. - Thus, the WTP can also be operated only for 10 h/day.	- Replacement of the engine pumps with the electric motor driven pumps (Q = 990 m^3/h, H = 235 m) x 2(1W+1S) - Construction of access road
Raw water transmission pipeline from Toker Dam	- No particular problem	-
Treated water transmission pump at Toker WTP	- No particular problem	-
Treated water transmission pipeline from Toker WTP	- No particular problem	-
Distribution reservoir	- Existing three reservoirs are almost not used. - They are all deteriorated and all the piping must be thoroughly replaced. - It is difficult to continue using the existing reservoir by repairs. - In order to secure the appropriate water distribution in the service area, it is necessary to construct new reservoirs. - It is also necessary to construct the distribution pipeline from the new reservoir. - The capacity should be 4 h not 3 has proposed in the FS considering the fire-fighting capacity.	Monopolio Reservoir: - Demolishing the existing facility - New construction (350 m^3 x 2) - Distribution pipe DN200 x 400 m Tsetserat Reservoir: - Demolishing the existing facility - New construction (575 m^3 x 2) - Distribution pipe DN300 x 400 m Hahaz Reservoir: - Demolishing the existing facility - New construction (575 m^3 x 2) - Distribution pipe DN250 x 400 m
Distribution pipeline (Primary pipeline)	- Extension to the newly developed area is needed.	- Construction of PVC D300 pipeline (L = 4,320 m) - Construction of PVC D200 pipeline (L = 7,470 m)
Distribution pipeline (Secondary pipeline)	- There remains an approximately 1,100 m of deteriorated GI pipe. - Exact locations of the valves are not recorded. It is necessary to supply materials for: - 1,100 house connections until 2020 - Extension of 22,000 m distribution pipeline - Replacement of 1,100 m distribution pipeline	Supply of: - PVC pipe: DN 150, DN100, DN75, DN50 L = 5,800 m each - House connection materials and water meter: 1,100 nos.

Source: Survey Team

3) Project Effect

The expected project effect is shown in Table 3.1.7

Table 3.1.7 Expected Project Effect (Toker WTP System)

Present Condition	After the Project (2025)	Project Effect
Piped supply population: 134,303 Total water supply volume (Sent form WTP): 7,508 m^3/day	Piped supply population:150,308 Total water supply volume (Sent form WTP): 14,993 m^3/day	Increase in piped supply population: 16,005 Increase in total water supply volume: 7,485 m^3/day Per capita consumption: 12 l/c/d => 50 l/c/d Water rationing => 24 h supply

Source: Survey Team

(4) Mai Nefhi WTP System

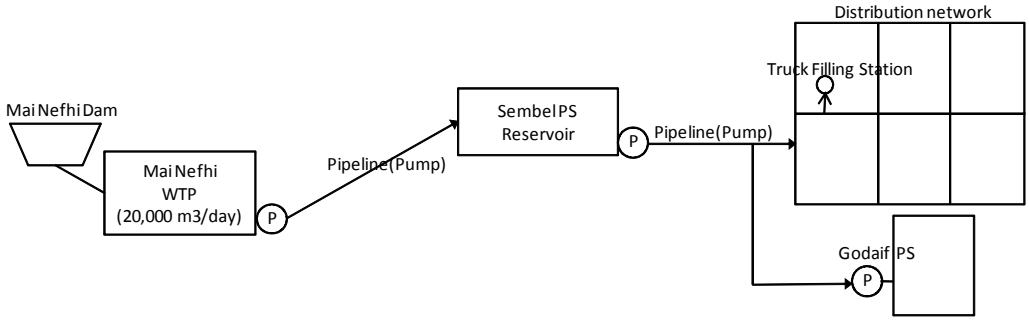
1) Water Treatment Plant

The equipment in the flocculating sedimentation basin of pulsator type was broken, and the process of the flocculating sedimentation isn't performed at the present. Therefore, the rehabilitation of equipment will be mainly carried out.

- Improvement of inlet pipe (φ500mm valves and inlet water meters)
- Rehabilitation of chemical dosing equipment (ALUM, Lime, Polymer) by using existing chemical house
- Installation of chlorinator
- Rehabilitation of vacuum pumps and equipment of vacuum towers
- Rehabilitation of crack valves, partialization boxes, clogging indicators (pressure) and siphons in each filtration basin of aquazur type
- Installation of back-wash pump and air-blow pump for spare
- Rehabilitation of each valve on flocculating sedimentation basin and filtration basin
- Installation of outlet water meter
- Installation of generator and fuel tank
- Constriction of sludge treatment facility
- Repairing of water leakage in existing facilities
  (Link channel between flocculating sedimentation basin, filtration basin etc.)

2) Intake, Transmission, and Distribution Facility

The configuration of the Mai Nefhi WTP System is shown in Figure 3.1.4.



Source: Survey Team

Figure 3.1.4 Configuration of the Mai Nefhi WTP System

The feature, present condition, and problems of each facility are described in Table 2.3.26. The conceivable construction/rehabilitation works as the countermeasures to the problems are shown in Table 3.1.8.

Table 3.1.8 Conceivable Project Components of Mai Nefhi System

Facility	Present Condition/Problems	Proposed Construction
Treated water transmission pump at Mai Nefhi WTP	- Checking and maintenance of the pumps are necessary. - Instrumentation and water hammer prevention equipment need to be replaced.	- Checking and repairing of the pumps: ($Q = 500\ m^3/h$, $H = 215$ m) x 3 nos. - Replacement of instrumentation - Replacement of water hammer prevention equipment
Treated water transmission pipeline from Mai Nefhi WTP to Sembel PS	- The pipeline was laid more than 40 years ago. The leakage due to the deterioration of the pipe occurs. - The leakage firstly occurred at L = 13-14 km in 2001. Formerly, the leakage location was limited. However, after 2013, the leakage occurs also at other locations. - It will be difficult to manage the leakage by the supportive repair for the future. The replacement of the pipeline is needed.	- Thorough replacement of the existing pipeline with D500 DCI pipeline (L = 16.1 km)
Sembel PS	- The chlorine gas injection equipment is out of order.	- Replacement of the chlorine gas injection equipment.
Distribution pipeline (Primary pipeline)	- Extension to the newly developed area is needed.	- Construction of PVC D300 pipeline (L = 2,700 m) - Construction of PVC D200 pipeline (L = 2,530 m)
Distribution pipeline (Secondary pipeline)	- There remains an approximately 1,200 m of deteriorated GI pipe. - Exact locations of the valves are not recorded. It is necessary to supply materials for: - 890 house connections until 2020 - Extension of 18,000 m distribution pipeline - Replacement of 1,200 m distribution pipeline	Supply of: - PVC pipe: DN 150, DN100, DN75, DN50 L = 4,800 m each - House connection materials and water meter: 890 nos.

Source: Survey Team

3) Project Effect

The expected project effect is shown in Table 3.1.9

Table 3.1.9 Expected Project Effect (Mai Nefhi WTP System)

Present Condition	After the Project (2025)	Project Effect
Piped supply population: 128,312 Total water supply volume (Sent form WTP): 8,665 m^3/day	Piped supply population:143,104 Total water supply volume (Sent form WTP): 15,626 m^3/day	Increase in piped supply population: 14,792 Increase in total water supply volume: 6,961 m^3/day Per capita consumption: 12 l/c/d => 50 l/c/d Water rationing => 24 h supply

Source: Survey Team

3.1.3 Consideration of the Possibility of Assistance on O&M

The support possibility for O&M is considered as follows. The necessary support contents in facilities maintenance are considered for AWSD. It should be noted that the prerequisite of technical assistance is to secure young staffs and to make them continue working. If the human resources are not continuously provided, O&M of the facilities is difficult. Securing human resources is a responsibility of AWSD.

Necessary main human resources are indicated as follows.

- Engineers to manage water sources and dams
- Engineers to manage 3 W.TPs
- Engineers to manage raw and clear water transmission and distribution facilities
- Staff of water quality test
- Young and middle-aged workers

(1) Support contents of O&M in each facility

Securing human resources in the following supports is a responsibility of AWSD. In addition, it is necessary to solve the foreign currency shortage in Eritrea for the purchase of repairing material and spare parts.

1) Water source and intake facilities
   - Purchase of vehicle for management
   - Preparation and training of daily record (Patrol, cleaning etc.) for water source preservation
   - Purchase and training of equipment of water qualities. (pH, turbidity, EC meters etc.)
   - Preparation and training of daily record (Checking, repairing etc.) at dam body.

2) Raw and clear water transmission facilities and distribution network
   - Preparation and training of daily record (Checking, repairing, operation etc.) for pipeline

- Installation of outlet and inlet water meters for raw and clear water transmission and blocked distribution network
- Capacity development of pump mechanic
- Purchase of construction vehicle, repairing machine and tools

3) W.T.P facilities
- Purchase of vehicle for management
- Preparation and training of daily record (Checking, repairing, operation etc.)
- Purchase and training of chemical dosing test (Jar tester)
- Purchase and training of equipment of water qualities. (pH, turbidity, EC meters etc.)
- Installation of outlet and inlet water meters

4) Reservoir and pumping station facilities
- Preparation and training of daily record (Checking, repairing, operation etc.)
- Installation of outlet and inlet water meters at reservoirs and pumping stations
- Capacity development of pump mechanic
- Installation of level indicator at reservoirs
- Purchase and training of equipment of water qualities. (Residual chlorine meter etc.)

5) Service pipe facilities
- Installation of outlet water meters at filling stations
- Purchase and training of equipment of water qualities. (Residual chlorine meter etc.)

(2) Cooperation contents of common O&M items in each facility

1) Water leakage
- Training of repairing for clogged pipe
- Purchase of construction vehicles and machines and tools
- Purchase and training of water leakage detectors

2) Meter repairing
- Purchase of water meters for service pipe

3) Drawing and documents
- Arrangement of depository for drawing and documents
- Preparation of past drawing and documents
- Capacity development of CAD operator
- Update and preparation of drawing of raw and clear water transmission and distribution network (Pipe diameter, pipe type, valve position etc.)

4) Water quality
- Arrangement of water quality laboratory in AWSD
- Purchase and training of equipment of water qualities. (pH, turbidity, EC meters etc.)

5) Vehicles and machines
- Purchase of motorbikes for management and water leakage repair
- Purchase of vehicles for management.
- Capacity development of auto-mechanic

(3) Summary of support contents

① Preparation and training of daily record for required facilities (Water source, dam body, raw and clear water transmission, W.T.P, reservoir, pumping station, distribution network etc.)

② Training of water quality test. (Water source, W.T.P, reservoir, service pipe, head office)

③ Training of chemical dosing test (Jar tester)

④ Training of water leakage repairing

⑤ Update and preparation of drawing of raw and clear water transmission and distribution network (Pipe diameter, pipe type, valve position etc.)

⑥ Training of CAD operation

⑦ Training of water leakage detector

⑧ Capacity development of pump mechanic

⑨ Capacity development of auto-mechanic

3.1.4 Consideration of the Possibility of Assistance on Organization Strengthening

(1) Present Condition of the AWSD Operation

The present condition and problems regarding AWSD's operation is described in Table 3.1.10 by the following categories:

1) Personnel Management
2) Customer Service
3) Financial Management
4) Business Plan

Table 3.1.10 Present Condition and Problems on AWSD Operation

Item	Present Condition/Problems
1) Personnel Management	
Recruitment	The government assigns around 30 people to AWSD every year as national service. However, most of them started to go missing shortly. It is difficult to recruit the staff due to low salary scale.
Training	30-day trainings are provided to the newly employed national service staff. The head staff of each unit works as an instructor. There is a training center but the training text book is not prepared. After the training, most of them disappear from the office within one year.
2) Customer Service	
Complaint desk	Two staffs are assigned to the complaint desk. They handle the complaints regarding water charge, water leakage, etc.
New connection	One staff is handling the application. Due to the shortage of water meter,

	it is difficult to meet the increasing demand for new connection.
Operation of water truck filling station	There are two water truck filling stations. Three staffs are assigned for each filling station. The operation is being executed fairly.
Supply by water truck	AWSD's water truck is supplying water to hospitals, embassies, government facilities, etc. The operation is being executed fairly.
Meter reading	35,000 of water meter reading are being conducted by 18 staffs every 3 months. The operation is being executed fairly.
Water charge collection	Four collection counters are handling the collection task. The receipt is being issued by using computer. The collected charge is totaled up every day. Water meter is installed in all houses with connection. The customer will pay the water charge every three months based on his own meter reading. If the customer does not pay for more than four months, the penalty will be imposed. If it exceeds seven months, the water supply will be cut. The tariff should be revised to meet the current condition. However, it needs the approval of Zoba. The tariff has not been revised since 2003.
3) Financial Management	
Financial Statements	The property ledger has not been prepared. Only the revenue and expenditure statements are being prepared monthly and annually.
Budgeting	AWSD is a semi-financially independent organization. Government subsidy is provided only when it is necessary.
4) Business Plan	
Annual reporting	Each unit leader submits the work report to the AWSD head every three months. The AWSD submits the annual report to Zoba.
Business plan	Annual business plan and work plan is submitted to Zoba in January.
Non-revenue water management	Accurate measuring of the water volume sent from the WTP is not conducted. Accordingly, the accurate grasping of non-revenue water is not being conducted.
Procurement of spare parts	The procurement is not being conducted in a planned manner. Zoba's approval is necessary for the procurement of more than USD 2,000. Due to shortage of foreign currency of the government, timely procurement is difficult.
Facility improvement/ construction plan and maintenance plan	AWSD is lacking with competent staff for facility improvement/construction planning, and facility maintenance planning. Thus, AWSD is being operated without appropriate facility planning.

Source: Survey Team

(2) Consideration of the Possibility of Assistance

As shown above, the customer service, financial management, and annual reporting are being fairly conducted by AWSD. The urgent assistance for these areas is not required.

The current problems are mainly on human resources, tariff, and procurement of water meter and spare parts. However, these problems are related to the social and economic policy of the whole country. Thus, these problems cannot be solved by assistance to AWSD.

3.1.5 Consideration Results of the Contents of the Requested Grant Aid Project

The contents of the requested grant aid project were examined from the three viewpoints as follows:

1) Prerequisite No.1 (Availability of water source)
2) Prerequisite No.2 (Power supply condition)

3) Sustainability of O&M of the constructed facility

(1) Prerequisite No.1 (Availability of water source)

As a result of re-calculation of possible intake volume from each dam as described in Section 3.1.1 (1), it was presumed that:

1) The possible intake volume from the water source of Stretta Vaudetto WTP System (Adi Sheka Dam and Mai Serwa Dam) is 8,770 m^3/day and slightly exceeds the design capacity of Stretta Vaudetto WTP (8,000 m^3/day).
2) However, the possible intake volume from the water source of Toker WTP System and Mai Nefhi WTP System is less than the design capacity of the respective WTPs.

That is, even if the WTPs are rehabilitated, the WTP will not be able to thoroughly demonstrate their capacity.

(2) Prerequisite No.2 (Power supply condition)

Recently, power supply condition in Asmara is around 14 h/day by rolling blackout. According to EEC, this is because the power station is under rehabilitation. EEC explained that the power supply condition in Asmara will return to 24 h/day after several months.

However, even if the rehabilitation is completed, considering the present political and economic situation of Eritrea, it is doubtful whether the sufficient foreign currency for importing the fuel and spare parts for operation of the power plant is secured by the government. That is, uncertainty of power supply still remains.

All the water supply systems in Asmara require power supply for running the transmission pumps. Therefore, the water supply facilities do not demonstrate their capacity without continuous power supply.

(3) Sustainability of O&M of the Constructed Facility

As described in Section 2.3.4, the existing water supply facilities are in very poor O&M condition. The facilities are not performing their planned capacities. This is mainly because of the shortage of human resources (resigning of young staff) and the shortage of spare parts (shortage of foreign currency). These are related to the social and economic policy of the whole country. It seems to be difficult to resolve these situations in a short period.

Therefore, if the new facility is constructed, it will be difficult to secure the sustainability of its O&M.

Considering the above, it is difficult to say that the proposed grant aid project is technically appropriate for grant aid for its effectiveness and sustainability.

3.2 Consideration of the Conceivable Assistance

As a result of the discussions held in the second field survey, it was confirmed that at the moment the outline design for the grant aid project is not commenced. However, in order to improve the water supply condition in Asmara, the possibility of implementation of the technical assistance is considered.

3.2.1 Issues and Countermeasures for Improvement of Asmara Water Supply

The present condition and problems of the water supply in Asmara were clarified by the first field survey. The Survey Team prepared the summary of these findings as shown in Table 3.2.1.

Table 3.2.1 describes the issues and countermeasures for improvement of Asmara Water Supply for each facility having common issue on O&M and business operation. The urgency of each issue is indicated by the following category:

Urgency A: Countermeasure can be conducted immediately
Urgency B: To be conducted
Urgency C: Countermeasure needs a long-term approach

The Survey Team explained the contents of Table 3.2.1 to the Eritrean side and it was attached on M/D as Annex-1.

Table 3.2.1 Issues and Countermeasures for Improvement of Asmara Water Supply

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
1. Raw water storage facilities (Dam)	**O&M Conditions**				
	1.1 There is no water level indicator in each dam except for Toker Dam.	- Installation of water level indicators.	- The water availability at the dam is confirmed, and restriction on water intake is implemented.	- Water level indicator × 5 dams (Toker, Adi-Sheka, Mai-Serwa, Stretta Vaudetto, Mai-Nefhi)	C
	1.2 There is no engineer for O&M of each water resources and dam.	- Recruitment of an engineer. ・Purchase of a vehicle for management.	- The management of each water source and dam is strengthened. - The management of preservation of water source is strengthened.	- Engineer ×1 - 4WD pickup or motorcycle ×1	A or B
	1.3 The preservation of water source (patrol, cleaning, etc.) is not managed. 1.4 A daily record about checking and repairing is not kept. 1.5 Water quality test (turbidity, pH, electrical conductivity, etc.) is not practiced in each dam.	- Recruitment of workers. - Arrangement of daily reporting. - OJT on daily reporting. - Purchase of water quality analysis equipment.	- The O&M of facilities is strengthened and information is shared. - The causes of a breakdown and leakage are clarified and repaired quickly. - The water quality management is strengthened.	- 2 workers × 5 dams - Training of daily reporting - Water quality equipment（turbidity, EC）× 5 dams (Toker, Adi-Sheka, Mai-Serwa, Stretta Vaudetto, Mai Nefhi) - Training for water quality test	A
			- The cause of water quality problem (filth, agricultural chemicals, etc.) is detected in the early stages.	- Annual water quality analysis (incl. herbicides and pesticides)	C
	1.6 There are no drawings such as dam bodies and plan of lakes, except for Toker Dam.	- Arrangement of the drawings.	- The remaining water quantity at the dam can be understood, and restriction on water intake can be implemented.	- A survey company for survey and drafting the drawings × 4 dams (Adi-Sheka, Mai-Serwa, Stretta Vaudetto, Mai Nefhi)	C
	1.7 There are so much sediments into each dam lake, Stretta Vaudetto Dam in particular.	- Dredging the sediments of each dam lake.	- Storage capacity of the dam increases, and quantity of water intake increases.	- Contracting a construction company for dredging the sediments	C
2. Intake facility (Intake pump station)	**Physical Conditions**				
	2.1 Malfunction/Deterioration of the pump equipment a) Adi-Sheka Pump Station b) Mai –Serwa Pump Station	- Renewal of the facility	- Interruption time of pump operation is reduced. - Increasing water supply and improvement in stable water supply.	- Design engineer - Pump with electrical facility Adi-Sheka PS: Q = 450 m^3/h Mai-Serwa PS: Q = 200 m^3/h x 2 nos.	B

Facilities	Issues	Countermeasures			Urgency
		Components	**Effects**	**Necessary Resources**	
	2.2 Tokor Pump Station a) Limited operation hour (10 h/day) of diesel engine driven pump due to the overheat of diesel engine and availability of diesel. b) The diesel fuel cost is a huge financial burden on AWSD.	- Replacement with the electric motor driven pump.	- Pump operation hours is extended, increasing water supply amount. - Improvement in financial condition of AWSD, thus improvement in business stability and sustainability.	- Design engineer - Electric motor driven pump with associated electrical facilities Q = 990 m^3/h, H = 235 m x 2 nos.	B
	O&M Conditions				
	2.3 O&M activity according to the O&M manual is not being conducted.	- Training on O&M activity according to the O&M manual.	- Life span of the facility is extended, thus improvement in business stability and sustainability.	- Technical guidance trainer - Trainee	A
	2.4 Check and maintenance record is not maintained properly.	- Training on checking the facility condition and repairing.	- Enabling to establish the proper renewal plan of the facility, thus improvement in business stability and sustainability.	- Technical guidance trainer - Trainee	A
	2.5 Delay of replacement of spare parts.	- Prepare a stock of spare parts. - Timely procurement of the spare parts.	- Interruption of pump operation is reduced. - Increasing water supply and improvement in stable water supply.	- Budgeting for procurement of spare parts.	B
	2.6 Drawings and technical documents of the facility are not being filed and updated.	- Establishment of information management system.	- Enabling to establish the proper renewal plan of the facility. - The cause of facility failure can be detected easily, thus enabling the quick repair. - Improvement in business stability and sustainability.	- Recruitment of personnel with experience in information management. - Installation of personal computers.	A
	2.7 The water flow amount is not measured and recorded.	- Installation of instrumentation facility. - Training on measurement and recording.	- Upgrading of the water flow monitoring. - Enabling to grasp the water leakage, thus enabling to work out the leakage reduction plan.	- Instrumentation system for the three intake facilities (Adi-Sheka, Mai-Serwa, Tokor) - Trainer on instrumentation	A

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	2.8 The pump operation record is not compiled as a database.	- Training on recording and database construction.	- By monitoring the pump operation, the proper renewal plan of the facility can be established. - Improvement in business stability and sustainability.	- Trainer on recording and database construction. - Installation of personal computers.	A
3. Raw water transmission facility	**Physical Conditions**				
	3.1 Open channel from Adi-Sheka to Beleza. a) The soil enters the channel due to heavy rainfall and the water transmission is interrupted every year. b) The six tunnels are all deteriorated.	- It is difficult to protect the open channel from the soil entering. - The channel should be replaced to the pipeline as a fundamental solution.	- Enabling to send the raw water throughout the year. - Increasing in water supply amount. - Improvement in stable water supply.	- Design engineer - Pipeline (D300 L = 8 km)	B
	3.2 Deterioration of pipeline of asbestos cement pipe. a) Raw water transmission pipeline from Beleza to Stretta Vaudetto WTP. b) Raw water transmission pipeline from Mai-Serwa Dam to Stretta Vaudetto WTP.	- Renewal to PVC pipeline.	- Reduction of water leakage. - Reduction of pipe burst accident, thus improvement in stable water supply.	- Design engineer - Pipeline (Beleza to Stretta Vaudetto WTP D300 L= 2 km) (Mai-Serwa to Stretta Vaudetto WTP D300 L = 2.7 km)	B
	O&M Conditions				
	3.3 Drawings and technical documents of the facility is not being filed and updated.	- Establishment of information management system.	- Enabling to establish the proper renewal plan of the facility. - The cause of facility failure can be detected easily, thus enabling the quick repair. - Improvement in business stability and sustainability.	- Recruitment of personnel with experience in information management. - Installation of personal computers.	A
	3.4 Checking and maintenance record is not maintained properly.	- Training on checking of facility condition and repairing.	- Enabling to establish the proper renewal plan of the facility, thus improvement in business stability and sustainability	- Technical guidance trainer - Trainee	A
	3.5 The water flow amount is not	- Installation of	- Upgrading of the water flow	- Instrumentation system for the three	

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	measured and recorded.	instrumentation facility. - Training on measurement and recording.	monitoring - Enabling to grasp the water leakage, thus enabling to work out the leakage reduction plan.	raw water transmission facilities. (Adi-Sheka, Mai-Serwa, Tokor) - Trainer on instrumentation	A
4. Water treatment facility	**4.1 S.V. WTP**				
	Physical Conditions				
	4.1.1 The chemical mixing and injection equipment are out of order for a long time.	- Replacement of alum tank and providing gravity injection system.	- Turbidity is improved. - Workload in the filter is reduced.	- 1,000 L chemical tank × 2 nos. - Pipe laying to four receiving wells.	A
	4.1.2 Several deflectors in the flocculation basin are corroded.	- Checking and repairing of the190 deflectors.	- Flocculation is promoted by adjusting the water flow speed, and turbidity is reduced.	- Contracting a plumbing company for repairing of several deflectors.	A or B
	4.1.3 Sludge in the sedimentation basin is not discharged. Several sludge valves are inoperable.	- Elimination of clogging into the sludge pipes and exchange of sludge valves.	- Sludge in the sedimentation basin is discharged. - Turbidity is reduced so that the workload in the filter is reduced.	- Cleaning five sludge pipes and replacing/repairing five sludge valves.	A or B
	4.1.4 Backwash is not done effectively hence there is a thick sludge on the filter beds.	- Cleaning of sludge in the filter media.	- Turbidity is improved. - Workload in the filter is reduced.	- Manpower cleaning on the filter surface periodically × 6 filters - Exchange of a filter media × 6 filters	A
	4.1.5 Water of approximately 1 m^3/h is leaking on the clear water reservoir.	- New construction of the filtration facilities and the clear water reservoir.	- The water quality is improved and safe water is supplied.	- Contracting a consultant company for the design of new facilities.	C
	4.1.6 Land subsidence of approximately 5 cm is confirmed at the building of filtration and clear water reservoir.				
	4.1.7 The structure of filter basin is deteriorated due to old age.				
	4.1.8 Most of valves in the filter basin are deteriorated due to old age.				
	4.2 Toker WTP				
	Physical Conditions				
	4.2.1 WTP is operated manually in 2007	- Repairing of the central	- Work force is reduced.	- Placing an order with a consultant	-

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	because the central control system was out of order.	control system.	However, the manual operation is effective under the current power supply condition.	company.	
	4.2.2 The sodium hypochlorite generation apparatus was out of order in 2009.	- Study the introduction of liquid chlorine.	- Use of the sodium hypochlorite generation apparatus is not appropriate under the current power condition.	- Placing an order with a consultant company.	C
	O&M Conditions				
	4.2.3 Jar test is not practiced.	- OJT on Jar test.	- The water quality management is strengthened and safe water is supplied.	- Lecturer on Jar test	A
	4.3 Mai Nefhi WTP				
	Physical Conditions				
	4.3.1 The chemical mixing and injection equipment are out of order for a long time.	- Installation of a chemical tank for alum and injection equipment.	- Turbidity is improved. - Workload in the filter is reduced.	- 1,000 L chemical tank × 2 nos. - Pipe laying to the receiving well - Dosing pump × 2 nos.	A
	4.3.2 The pulsator is not functioning because of the failure of vacuum pumps and equipment.	- Rehabilitation of overall equipment. - Repairing of leakage.	- The water quality is improved and safe water is supplied.	- 3 vacuum pumps and equipment - Most of equipment at the vacuum tower × 2 towers - Most of valves in pulsator × 2 systems. - Cracking valve, the partialization box and the clogging indicator × 6 filters. - Most of valves in the filter basin ×6 filters. - Spare pumps of backwash and air blow.	C
	4.3.3 Water is leaking at the link channel between the pulsators and filters.				
	4.3.4 The cracking valve, partialization box, and the clogging indicator in each filtration basin are out of order.				
	4.3.5 There are no spare pumps of backwash and air blow.				
	4.3.6 Most of valves in the filter basin are deteriorated due to old age.				
	4.3.7 Sludge remained on the surface of filter sand.	- Cleaning the sand surface.	- Safe drinking water is supplied.	- Closely monitoring backwashing results.	A
	4.3.8 Many breakthrough (holes) are found.				

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	4.4 Common Issues in the Three WTPs				
	Physical Conditions				
	4.4.1 There are no water meters to manage the inflow and outflow at the WTPs.	- Installation of inflow and outflow water meters.	- The rates of water leakage and non-revenue water are revealed, and target planning can be drafted. - Stable water quality is supplied because water quantity is controlled. Chemical injecting quantity is injected properly. - The quantity of water supply is controlled deliberately at the time of drought.	- Stretta Vaudetto ：φ300 water meter × 3 nos., φ500 water meter × 1 no. - Toker：φ500 water meter × 2 nos., φ150 water meter × 1 no. - Mai Nefhi：φ500 water meter × 2 nos.	C A
	4.4.2 Chlorine gas is injected directly into the clear water reservoir or the receiving basin by the plastic tube without the chlorinator.	- Installation of chlorinator.	- Chlorine gas injecting quantity is injected properly. - Staff's health problem with regard to chlorine is reduced.	- Chlorinator × 3 WTPs - OJT	A or B
	O&M Conditions				
	4.4.3 Water quality test is not practiced at the WTPs.	- Recruitment of water quality analyst. - Purchasing of water quality equipment. - OJT on water quality analysis.	- The water quality management is strengthened and safe water is supplied. - The cause of the water quality problem (filth, agricultural chemicals, etc.) is detected in the early stages. - Chlorine gas injecting quantity is injected properly by measuring the residual chlorine.	- Water quality analyst × 3 WTPs - Water quality equipment (pH, turbidity, EC, total coliform bacteria, general bacteria, residual chlorine, Jar testing) × 3 WTPs - Lecturer on water quality test	A
	4.4.4 A daily record about checking, repairing, and operating is not kept.	- Arrangement of daily reporting - OJT on daily reporting	- The O&M of the facilities is strengthened and information is shared. - The causes of the breakdown and leakage are clarified and repaired quickly.	- Training on daily reporting	A

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	4.4.5 There is no engineer for the O&M of the three WTPs.	- Recruitment of an engineer - Purchasing of a vehicle for management.	- The management of the WTPs is strengthened. - The problem is settled early because information is transmitted to the headquarters early. - Technique is shared among the three WTPs.	- Engineer × 1 - 4WD pickup or motorcycle × 1	A
	4.4.6 There are very few young and middle-aged workers and lack of core engineers.	- Recruitment of young and middle-aged workers.	- The technical capacity is transferred and continued. - Customer's complaints are dealt quickly. - The O&M of the facilities is reinforced.	- Improvement of salary treatment.	C
	4.4.7 There is no staff for the chemical dosing test.	- Recruitment of dosing test staff - OJT on dosing test (Jar test)	- The water quality management is strengthened and safe water is supplied.	- Technician × 2 persons (Stretta Vaudetto and Mai Nefhi) - Lecturer on Jar test	B
	4.4.8 AWSD does not properly file the past drawings and documents, although some of them are kept in the cabinet.	- Production of the drawings (Stretta Vaudetto). - Arrangement of the drawings and documents (Toker and Mai Nefhi).	- For information to be shared, the breakdown and leakage in case of emergency are corresponded quickly. - A future pipeline repairing plan can be drafted. - A future water supply plan can be drafted.	- Placing an order with a consultant company (Stretta Vaudetto). - Establishment of a depository.	A
	4.4.9 Spare parts are not purchased timely.	- Inventory is checked periodically.	- Customer's complaints are dealt quickly. - The breakdown and leakage in the facilities are repaired quickly. - The rate of water leakage and non-revenue water are reduced. - Stable quantity of water and safe water is supplied. - Securing hard currency.	- Budgeting for the procurement of spare parts.	C

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
5. Treated water transmission facility	**Physical Conditions**				
	5.1 Malfunction/Deterioration of pump equipment Treated water transmission pump at Stretta Vaudetto WTP.	- Renewal of the pump facility.	- Interruption time of pump operation is reduced. - Increasing water supply and improvement in stable water supply.	- Design engineer - Pump with electrical facility Q = 170 m^3/h x 3 nos.	B
	5.2 Reduced pump capacity Treated water transmission pump at Mai Nefhi WTP.	- To identify possible causes (e.g., worn out of impellor).	- The transmission water amount is increased.	- Repair of pumps/motors.	B
	5.3 Deterioration and reduced flow capacity of treated water transmission pipeline a) The treated water transmission pipeline from Mai Nefhi WTP deteriorates and suffers from frequent water leakage accident. b) The flow capacity of the pipeline has been reduced.	- Renewal of the pipeline.	- Reduction in pipe burst accident. - Increasing transmission of water amount, thus increasing the water supply amount.	- Design engineer - Pipeline (D500 L = 16 km)	B
	5.4 Malfunction of chlorine injection facility at Sembel PS Proper chlorination is not conducted.	- Renewal of the chlorine injection facility.	- Reducing water quality degradation.	- Chlorine injector	A
	5.5 The reservoir has large openings.	- To provide closures.	- Safe water is provided.	- Closure	A
	O&M Conditions				
	5.6 O&M activity according to its manual is not being conducted.	- Training on O&M activity according to its manual.	- Life span of the facility is extended, thus improvement in business stability and sustainability.	- Technical guidance trainer - Trainee	A
	5.7 Checking and maintenance record is not kept properly.	- Training on checking of facility condition and repairing.	- Enabling to establish the proper renewal plan of the facility, thus improvement in business stability and	- Technical guidance trainer - Trainee	A

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
			sustainability.		
	5.8 Delay of replacement of spare parts.	- Conducting inventory survey of spare parts and keep stocks. - Timely procurement of the spare parts.	- Interruption of pump operation is reduced. - Increasing water supply and improvement in stable water supply.	- Budgeting for procurement of spare parts.	B
	5.9 Drawings and technical documents of the facilities are not being filed and updated.	- Establishment of information management system.	- Enabling to establish the proper renewal plan of the facility. - The cause of facility failure can be detected easily, thus enabling its quick repair. - Improvement in business stability and sustainability.	- Recruiting personnel with experience in information management. - Installation of personal computers.	A
	5.10 The water flow rate is not measured and recorded.	- Installation of the instrumentation facility. - Training on measurement and recording.	- Upgrading of the water flow monitoring. - Enabling to grasp the water leakage, thus enabling to work out the leakage reduction plan.	- Instrumentation system for the three treated water transmission facilities (Stretta Vaudetto, Toker, Mai Nefhi) - Trainer on instrumentation	A
	5.11The pump operation record is not compiled as a database.	- Training on recording and database construction.	- By monitoring the pump operation, the proper renewal plan of the facility can be established. - Improvement in business stability and sustainability.	- Trainer on recording and database construction. - Installation of personal computers.	A
6. Distribution facility	**Physical Conditions**				
	6.1 Shortage of distribution reservoir There is no distribution reservoir in Stretta Vaudetto System.	- Construction of distribution reservoir.	- The proper distribution during the peak demand is made possible, thus increasing in water supply amount.	- Design engineer - Distribution reservoir (V= 1,400 m^3 or more)	B

Facilities	Issues	Countermeasures			Urgency
		Components	**Effects**	**Necessary Resources**	
	6.2 Deterioration of existing distribution reservoir. a) Existing three reservoirs in Tokor System are deteriorated. There are leakages in the tank. The valves are all deteriorated and not functioning.	- Renewal of the reservoir	- The proper distribution during the peak demand is made possible, thus increasing in water supply amount.	- Design engineer - Construction of reservoir (Monopolio: 300 m^3 x 2 nos.) (Tsetserat: 500 m^3 x 2 nos.) (Hazhaz: 500 m^3 x 2 nos.)	B
	6.3 Deterioration of the distribution pump station. The pump facilities in the two distribution pump stations in Tokor System are deteriorated and the pump capacity is reduced.	- Renewal of the pump facility	- Increasing in water pressure in the distribution pipe, thus extending the water supply area.	- Design engineer - Pump equipment in Mai Chohot PS (Q = 150 m^3/h) and Denden PS (Q = 300 m^3/h)	B
	6.4 Deteriorated pipeline There remains an approximately 3,000 m of aged GI pipelines.	- Replacement of the pipe	- Reduction of water leakage. Increasing in flow capacity of the pipe, thus extending the water supply area.	- Design engineer - PVC pipe (D75-D200, L = 3,000 m)	C
	6.5 Delay of extension of distribution pipeline. The extension of distribution pipeline in the newly developed area in the west and south part of Asmara is delayed.	- Installation of pipeline	- Expansion of the water supply area.	- Design engineer - PVC pipe (D200-D300, L = 6,500 m)	C
	O&M Conditions				
	6.7 O&M activity according to its manual is not being conducted.	- Training on O&M activity according to its manual	- Life span of the facility is extended, thus improvement in business stability and sustainability.	- Technical guidance trainer	A
	6.8 Checking and maintenance record is not kept properly.	- Training on checking of facility condition and repairing.	- Enabling to establish the proper renewal plan of the facility, thus improvement in business stability and sustainability.	- Technical guidance trainer	A

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	6.9 Delay of replacement of spare parts.	- Conducting inventory survey of spare parts and keep stocks. - Timely procurement of the spare parts.	- Interruption of facility operation is reduced. - Increasing the water supply and improvement in stable water supply.	- Budgeting for the procurement of spare parts.	B
	6.10 Drawings and technical documents of the facilities are not being filed and updated.	- Establishment of information management system.	- Enabling to establish the proper renewal plan of the facility. - The cause of facility failure can be detected easily, thus enabling the quick repair. - Improvement in business stability and sustainability.	- Recruitment of personnel with experience in information management. - Installation of personal computers.	A
	6.11Drawings of the distribution pipeline are not being filed and updated.	- Establishment of information management system. - Updating of pipeline information (pipe material, diameter, valve location, etc.).	- Enabling information sharing, thus enabling quick repair on the facility's failure or leakage. - Enabling proper valve operation for distribution control. - Enabling to establish the proper renewal plan of the facility and water distribution plan.	- Recruitment of personnel with experience in information management. - Installation of personal computers. - Metal pipe detector, non-metal pipe detector, metal detector	A
	6.12 The water flow amount is not measured and recorded.	- Installation of the instrumentation facility. - Training on measurement and recording.	- Upgrading of the water flow monitoring. - Enabling to work out the leakage reduction plan.	- Instrumentation system for the three distribution systems (Stretta Vaudetto System, Tokor System, Mai Nefhi System) - Trainer on instrumentation	A
	6.13 The pump operation record is not compiled as a database.	- Training on recording and database construction.	- By monitoring the pump operation, the proper renewal plan of the facility can be established. - Improvement in business stability and sustainability.	- Trainer on recording and database construction. - Installation of personal computers.	A

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	6.14 The water quality control is not conducted.	- Establishment of water quality management system.	- Enabling to upgrade the water quality of the supplied water.	- Water quality test equipment and chemicals. - Recruitment of water quality monitoring staff.	A
7. Service facility	**Physical Conditions**				
	7.1 Shortage of house connections Approximately two to three households are using one house connection.	- Installation of new connections.	- Upgrading of water supply service level.	- Design engineer - Service facility including water meter	C
	7.2 Deterioration of the water meter The water volume is measured less than the actual consumed amount.	- Replacement of water meter.	- Reduction of non-revenue water, thus improvement in business stability and sustainability.	- Staff for inspection and replacement of water meter - Water meter (approx. 30,000 nos.)	C
	O&M Conditions				
	7.3 Checking and maintenance record is not maintained properly.	- Training on checking of facility condition and repairing.	- Enabling to establish the proper renewal plan of the facility, thus improvement in business stability and sustainability.	- Technical guidance trainer - Trainee	A
	7.4 Delay of replacement of the water meter.	- Prepare the stock of water meter. - Timely procurement of the water meter.	- Upgrading the accuracy of measuring water volume, thus reduction in non-revenue water, and improvement in business stability and sustainability	- Budgeting for procurement of water meter.	B
	7.5 The water quality control is not conducted.	- Establishment of water quality management system.	- Enabling to upgrade the water quality of the supplied water.	- Water quality test equipment and chemicals. - Recruitment of water quality monitoring staff.	A
	7.6 Drawings and technical documents of the facility are not being filed and updated.	- Establishment of information management system.	- Enabling to establish the proper renewal plan of the facility. - The cause of facility failure can be detected easily, thus enabling the quick repair. - Improvement in business stability and sustainability.	- Recruitment of personnel with experience in information management. - Installation of personal computers.	A

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
8. Common O&M issue	8.1 Poor performance of the technicians who repair the mechanical and electrical equipment.	- Capacity development of the technicians.	- Enabling quick repair of the facility, thus improvement in stability of water supply.	- Trainer on repair of mechanical and electrical equipment.	A or B
	8.2 Shortage of technicians who are engage in leakage detection and repair, and installation of new house connections.	- Recruitment of new staff and continual employment of staff.	- Enabling quick repair of the facility, thus improvement in stability and service level of water supply.	- Experienced staff who provides training to the new junior staff. - Junior staff	A or B
	8.3 Shortage of engineer for water quality control.	- Recruitment of new staff and continual employment of staff.	- Enabling to upgrade the water quality management of AWSD.	- Experienced staff who provides training to the new junior staff. - Junior staff	A or B
	8.4 Shortage of CAD operator.	- Recruitment of new staff and continual employment of staff. - Training on CAD operation.	- Upgrading of the water distribution pipeline drawings.	- Experienced staff who provides training to the new junior staff. - Junior staff	A
	8.5 Aging of the AWSD employees.	- Recruitment of new junior staff and continual employment of staff.	- Enabling the succession of the technical information/knowledge, thus improvement in business sustainability.	- Junior staff	C
	8.6 Absence of vehicle for the supervision and execution of the O&M works.	- Procurement of vehicle for O&M works.	- Upgrading the technical management of water supply works, thus improvement in business stability, sustainability and advancement.	- Vehicle (4WD pickup double cabin)	B
	8.7 Shortage of construction machineries/equipment and tools causing delay of the works.	- Procurement of construction machinery/ equipment and tools.	- Upgrading of the technical management of the water supply works, thus improvement in business stability, sustainability and advancement. - Enabling quick repair of the facility, thus improvement in stability and service level of water supply.	- Construction equipment (Excavator, truck with crane, welder, etc.)	B

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
9. Business administration	9.1 Grasping of the water supply amount It takes more than six months to bill the water amount. Thus, timely grasping of the water supply amount is not conducted.	- Reduction in the period for settlement of the consumed water volume through the establishment of an AWSD branch office. - Establishment of information management system.	- Upgrading of the business monitoring, thus improvement of business stability and sustainability. - Enabling to grasp the water leakage, thus enabling to work out the leakage reduction plan.	- Branch office (three locations) - Installation of personal computers.	B
	9.2 Water tariff Water tariff has not been changed since 2003. Thus, AWSD is in the chronic state of deficit.	- Revision of water tariff (Approval of Zoba is necessary).	- Improvement in financial condition, thus improvement in business stability and sustainability.	- Supporting staff for financial management.	B
	9.3 Water rationing Present supply capacity of AWSD is far below the potential demand. Thus, water rationing is executed.	- Increasing supply capacity.	- Water rationing is abolished.	- Recruitment of technical staff - Renewal/construction of the water supply facility.	C
	9.4 Water supply and demand balance It is projected that the water demand will exceed the available intake amount in the present water sources.	- Increasing water source facility and water supply facility.	- Water supply and demand balance is improved.	- Recruitment of technical staff - Renewal/construction of the water resource/supply facility.	C
	9.5 Electric Power Supply The operation of the water supply facility is being affected by the frequent interruption of power supply.	- Electricity is supplied for 24 h/day.	- Improvement in the stability of water supply.	- Arrangement of power supply by EEC.	C

Note: Urgency A: Countermeasure can be conducted immediately, Urgency B: To be conducted, Urgency C: Countermeasure needs a long-term approach.
Source: Survey Team

3.2.2 Consideration of Assistance Item

The survey team indicated “Issues and Countermeasures in AWSD” shown in Table 3.2.1 and carried out discussion with the stakeholders in Eritrea.

In the process of the discussion, the survey team extracted the items shown “Urgency A: The countermeasure that can be commenced immediately”, and classified those items into [X]: Information Management, [Y]: Water Quality Improvement, [Z]: Increasing Water Supply and [-]: Others (Human resource mainly). The results are shown in Table 3.3.1 as “Issues and Countermeasures (Urgency A)”.

As a result of the discussion, unless the collection and filing of data are done by [X] shown in the Table 3.3.1, the sustainability of the maintenance cannot be expected even if [Y] and [Z] are done. Therefore, [X] should be the top priority. Its contents are shown in Table 3.3.2 as “Priority Issues”. (Attached to Annex-2 in MD)

After having discussed its contents with the stakeholders in Eritrea, it was agreed that [X] should be the top priority. In addition, both parties confirmed the matters which request the support from the Japanese side in particular.

3.3 Conclusion

- The support by technical cooperation should be considered that [X]: Information Management of Annex-2 (shown in Table 3.3.2) is the highest priority matter based on a request from Eritrea.
- In addition, [Y] and [Z] should be considered as the next support items after [X] are executed without any challenges.

Concluded.

Table 3.3.1 Issues and Countermeasures (Urgency A) (1/4)

Facilities	Issues		Countermeasures		Effects	Urgency
			Components	Necessary Resources		
Raw water storage facilities (Dam)	**O&M Conditions**					
	Human resources [-]	1.2 There isn't an engineer for O&M of each water resources and dam.	- Recruitment of an engineer - Purchase of a vehicle of management	- Engineer × 1 - 4WD Pickup or Motorcycle × 1	- The management of each water source and dam is strengthened. - The management of preservation of water source is strengthened.	A
	Preservation [X] [Y]	1.3 The preservation of water source (patrol and cleaning etc.) isn't managed.	- Recruitment of workers - Arrangement of a daily report - OJT of the daily reporting	- 2 workers × 5 Dams - Training of daily reporting	- The preservation of water source is strengthened and information is shared. - The water quality management is strengthened.	A
	Recording [X]	1.4 A daily record of the dams about checking and repairing isn't kept.	- Arrangement of a daily report - OJT of the daily reporting	- Training of daily reporting	- The O&M of facilities is strengthened and information is shared. - The cause of a breakdown and leakage are clarified and repaired quickly.	A
	Water quality [X] [Y]	1.5 Water quality test (turbidity, pH, electrical conductivity etc.) is not practiced at each dam.	- Purchase of water quality analysis equipment	- Training of water quality test - Water quality equipment (turbidity, EC) ×5 dams(TOKER、ADI SHEKA、MAI SERWA、SV、MAI NEFHI)	- The water quality management is strengthened.	A
Water treatment facility	**Physical Conditions**					
	Chemical mixing and injection equipment [Y]	4.1.1 (S.V. WTP) The chemical mixing and injection equipment are out of order for a long time	- Replacement of alum tank and providing gravity injection system	- 1000L chemical tank × 2nos - Pipe laying to 4 receiving wells	- Turbidity is improved. - Workload in the filter is reduced.	A
		4.3.1 (Mai Nefhi WTP) The chemical mixing and injection equipment are out of order for a long time.	- Installation of a chemical tank for alum and a injection equipment	- 1000L chemical tank × 2nos - Pipe laying to the receiving well - Dosing pump × 2nos	- Turbidity is improved. - Workload in the filter is reduced.	A
	Filter [Y] [Z]	4.1.4 (S.V. WTP) Back-wash isn't done effectively so that there are thick sludge on the filter beds.	- Cleaning of sludge on the filter media	- Manpower cleaning on the filter surface periodically × 6 filters - Exchange of a filter media × 6 filters	- Turbidity is improved. - Workload in the filter is reduced.	A
		4.3.7 (Mai Nefhi WTP) Sludge remained on surface of filter sand	- Cleaning the sand surface	- Closely monitoring backwashing results	- Safe drinking water is supplied	A
		4.3.8 (Mai Nefhi WTP) Many breakthrough (holes) are found.				

Category: [X]: Information Management, [Y]: Water Quality Improvement, [Z]: Increasing Water Supply, [-]: Others

Table 3.3.1 Issues and Countermeasures (Urgency A) (2/4)

Facilities	Issues		Countermeasures		Effects	Urgency
			Components	Necessary Resources		
Water treatment facility	**sludge valve** [Y]	4.1.3 (S.V. WTP) Sludge in the sedimentation basin is not discharged. And several sludge valves are inoperable.	- Elimination of clogging into the sludge pipes and exchange of sludge valves	- Cleaning 5 sludge pipes and replacing/repairing 5 sludge valves	- Sludge in the sedimantation basin is discharged. - Turbidity is reduced so that workload in the filter is reduced.	A
	Bulk meter [X]	4.4.1 (3 WTPs) There are no water meters to manage the inflow and outflow at the W.T.Ps.	- Installation of inflow and outflow water meters.	- SV : φ300 water meter × 3 nos, φ 500 water meter × 1 no - Toker : φ500 water meter × 2 nos, φ150 water meter × 1 no - Mai Nefhi : : φ500 water meter × 2 nos	- The rate of water leakage and non-revenue water are revealed, and target planning can be drafted. - Stable water quality is supplied because water quantity is controlled and chemical injecting quantity is injected properly. - The quantity of water supply is controlled deliberately at the time of a drought.	A
	Chlorinator [Y]	4.4.2 (3 WTPs) Chlorine gas is injected directly into the clear water reservoir or the receiving basin by the plastic tube without the chlorinator.	- Installation of chlorinator	- chlorinator × 3 W.T.Ps - OJT	- Chlorine gas injecting quantity is injected properly. - The healthy obstacle with chlorine to staff is reduced.	A
	O&M Conditions					
	Jar test [Y]	4.2.3 (Toker WTP) Jar test is not practiced.	- OJT of Jar test	- Lecturer of Jar test	- The water quality management is strengthened and safe water is supplied.	A
	Water quality [X] [Y]	4.4.3 (3 WTPs) Water quality test is not practiced at the W.T.Ps.	- Recruitment of water quality analyst - Purchase of water quality equipment - OJT of water quality analysis	- Water quality analyst × 3 W.T.Ps - Water quality equipment (pH, Turbidity, EC, Total coliform bacteria, General bacteria, Residual chlorine, Jar test) × 3 W.T.Ps - Lecturer of water quality test	- The water quality management is strengthened and safe water is supplied. - A cause of the water quality problem (filth and agricultural chemicals, etc.) is detected in early stages. - Chlorine gas injecting quantity is injected properly by measuring the residual chlorine.	A
	Recording [X]	4.4.4 (3 WTPs) A daily record about checking, repairing and operating isn't kept	- Arrangement of a daily report - OJT of the daily report	- Training of daily reporting	- The O&M in facilities is strengthened and information is shared. - The cause of a breakdown and leakage are clarified and repaired quickly.	A

Category: [X]: Information Management, [Y]: Water Quality Improvement, [Z]: Increasing Water Supply, [-]: Others

Preparatory Survey on Asmara Water Supply Development

Table 3.3.1 Issues and Countermeasures (Urgency A) (3/4)

Facilities	Issues		Countermeasures		Effects	Urgency
			Components	Necessary Resources		
Water treatment facility	Human resources [-]	4.4.5 (3 WTPs) There isn't an engineer for O&M of 3 W.T.Ps	- Recruitment of an engineer - Purchase of a vehicle of management	- Engineer × 1 - 4WD Pickup or Motorcycle × 1	- The management of the W.T.Ps is strengthened. - A problem is settled early because information is transmitted to the headquarters early. - Technique is shared among 3 W.T.Ps.	A
	Drawings and documents [X]	4.4.8 (3 WTPs) AWSD are not properly filing past drawings and documents, although some of them are kept in the cabinet.	- Producing of drawings (SV) - Arrangement of drawings and documents (Toker and Mai Nefhi)	- Placing an order with a consultant company (SV) - Establishment of depository	- For information to be shared, a breakdown and leakage in case of emergency are corresponded quickly. - A future pipeline repairing plan can be drafted. - A future water supply plan can be drafted.	A
Intake, Transmission, Distribution, and Service facility	**Physical Conditions**					
	Chlorinator [Y]	5.4 Malfunction of chlorine injection facility at SembelPS	- Renewal of the chlorine injection facility	- Chlorine injector	- Reducing water quality degradation	A
	Reservoir [Y]	5.5 The reservoir at Sembel PS has large openings.	- To provide closures	- Closure	- Safe water is provided	A
	O&M Conditions					
	Proper O&M [Z]	2.3, 5.6, 6.7 O&M activity according to the O&M manual is not being conducted.	- Training for OM activity according to the OM manual	- Technical guidance trainer	- Life span of the facility is extended, thus improvement in business stability and sustainability	A
	Bulk meter [X]	2.7, 3.5, 5.10, 6.12 The water flow amount is not measured and recorded	- Installation of instrumentation facility - Training on measurement and recording	- Instrumentation system for three intake facility (Adi-Sheka, Mai-Serwa, Tokor) and three transmission mains and distribution network - Trainer on instrumentation	- Upgrading of the water flow monitoring - Enabling to grasp the water leakage, thus enabling to work out leakage reduction plan	A
	Recording [X]	2.4, 3.4, 5.7, 6.8, 7.3 Check and maintenance record is not maintained properly	- Training on checking of facility condition and repairing	- Technical guidance trainer	- Enabling to establish the proper renewal plan of the facility, thus improvement in business stability and sustainability	A
		2.8, 5.11, 6.13 The pump operation record is not compiled as a database	- Training on recording and database construction	- Trainer on recording and database construction - Installation of personal computers	- By monitoring the pump operation, the proper renewal plan of the facility can be established. - Thus, improvement in business stability and sustainability.	A

Category: [X]: Information Management, [Y]: Water Quality Improvement, [Z]: Increasing Water Supply, [-]: Others

Table 3.3.1 Issues and Countermeasures (Urgency A) (4/4)

Facilities	Issues		Countermeasures		Effects	Urgency
			Components	Necessary Resources		
Intake, Transmission, Distribution, and Service facility	**Drawing management** [X]	2.6, 3.3, 5.9, 6.10 Drawings and technical documents of the facilities are not being filed and updated	- Establishment of information management system	- Recruitment of the personnel with experience of information management - Installation of personal computers	- Enabling to establish the proper renewal plan of the facility. - The cause of facility failure can be detected easily, thus enabling the quick repairing. - Thus, improvement in business stability and sustainability.	A
		6.11, 7.6 Drawings of the distribution pipeline is not being filed and updated	- Establishment of information management system - Updating of pipeline information (pipe material, diameter, valve location, etc.)	- Recruitment of the personnel with experience of information management - Installation of personal computers - Metal pipe detector, Non-metal pipe detector, Metal detector	- Enabling information sharing, thus enabling quick repair of the facility failure or leakage. - Enabling proper valve operation for distribution control. - Enabling to establish the proper renewal plan of the facility and water distribution plan.	A
	Water quality control [Y]	6.14, 7.5 The water quality control is not conducted.	- Establishment of water quality management system	- Water quality test equipment and chemicals - Recruitment of water quality monitoring staff	- Enabling to upgrade the water quality of the supplied water.	A
Common O&M issue	**Human resources** [-]	8.4 Shortage of the technicians who are engaged in leakage detection and repair and installation of new house connections	- Recruitment of the new staff and continual Employment of the staff	- Experienced staff who provide training to the new junior staff - Junior staff	- Enabling quick repair of the facility, thus improvement in stability and service level of water supply.	A
		8.5 Shortage of chemist/biologist for water quality control	- Recruitment of the new staff and continual Employment of the staff	- Experienced staff who provide training to the new junior staff - Junior staff	- Enabling to upgrade the water quality management of AWSD.	A
		8.6 Shortage of the CAD operator	- Recruitment of the new staff and continual Employment of the staff - Training of CAD operation	- Experienced staff who provide training to the new junior staff - Junior staff	- Upgrading of water distribution pipeline drawings.	A
	Capacity of employee [-]	8.3 Poor performance of the technicians who repair the mechanical and electrical equipment	- Capacity development of the technicians	- Trainer for repair of mechanical and electrical equipment	- Enabling quick repair of the facility, thus improvement in stability of water supply.	A

Category: [X]: Information Management, [Y]: Water Quality Improvement, [Z]: Increasing Water Supply, [-]: Others

Source: Study Team

Preparatory Survey on Asmara Water Supply Development

Table 3.3.2 Priority Issues (Information management*) (1/2)

(Attached as Annex-2 in MD)

Facilities	Issues		Countermeasures			Areas assistance requested to JICA
			Components	Effects	Necessary Resources	
Raw water storage facilities (Dam)	**O&M Conditions**					
	Preservation [X] [Y]	1.3 The preservation of water source (patrol and cleaning etc.) isn't managed.	- Recruitment of workers - Arrangement of a daily report - OJT of the daily reporting	- The preservation of water source is strengthened and information is shared. - The water quality management is strengthened.	- 2 workers × 5 Dams - Training of daily reporting	
	Recording [X]	1.4 A daily record of the dams about checking and repairing isn't kept.	- Arrangement of a daily report - OJT of the daily reporting	- The O&M of facilities is strengthened and information is shared. - The cause of a breakdown and leakage are clarified and repaired quickly.	- Training of daily reporting	
	Water quality [X] [Y]	1.5 Water quality test (turbidity, pH, electrical conductivity etc.) is not practiced at each dam.	- Purchase of water quality analysis equipment	- The water quality management is strengthened.	- Training of water quality test '- Water quality equipment (turbidity, EC) ×5 dams(TOKER、ADI SHEKA、MAI SERWA、SV、MAI NEFHI)	✔ ✔
Water treatment facility	**Physical Conditions**					
	Bulk meter [X]	4.4.1 (3 WTPs) There are no water meters to manage the inflow and outflow at the W.T.Ps.	- Installation of inflow and outflow water meters.	- The rate of water leakage and non-revenue water are revealed, and target planning can be drafted. - Stable water quality is supplied because water quantity is controlled and chemical injecting quantity is injected properly. - The quantity of water supply is controlled deliberately at the time of a drought.	- SV： φ300 water meter × 3 nos, φ500 water meter × 1 no '- Toker： φ500 water meter × 2 nos, φ 150 water meter × 1 no '- Mai Nefhi： ： φ500 water meter × 2 nos	✔ ✔ ✔
	O&M Conditions					
	Water quality [X] [Y]	4.4.3 (3 WTPs) Water quality test is not practiced at the W.T.Ps.	- Recruitment of water quality analyst - Purchase of water quality equipment - OJT of water quality analysis	- The water quality management is strengthened and safe water is supplied. - A cause of the water quality problem (filth and agricultural chemicals, etc.) is detected in early stages. - Chlorine gas injecting quantity is injected properly by measuring the residual chlorine.	- Water quality analyst × 3 W.T.Ps - Water quality equipment (pH, Turbidity, EC, Total coliform bacteria, General bacteria, Residual chlorine, Jar test) × 3 W.T.Ps - Lecturer of water quality test	✔
	Recording [X]	4.4.4 (3 WTPs) A daily record about checking, repairing and operating isn't kept	- Arrangement of a daily report - OJT of the daily report	- The O&M in facilities is strengthened and information is shared. - The cause of a breakdown and leakage are clarified and repaired quickly.	- Training of daily reporting	

Category: [X]: Information Management, [Y]: Water Quality Improvement / *Data Collection and Information Management

Table 3.3.2 Priority Issues (Information management*) (2/2)

(Attached as Annex-2 in MD)

Facilities	Issues		Countermeasures			Areas assistance requested to DPs
			Components	Effects	Necessary Resources	
Water treatment facility	**Drawings and documents** [X]	4.4.8 (3 WTPs) AWSD are not properly filing past drawings and documents, although some of them are kept in the cabinet.	- Producing of drawings (SV) - Arrangement of drawings and documents (Toker and Mai Nefhi)	- For information to be shared, a breakdown and leakage in case of emergency are corresponded quickly. - A future pipeline repairing plan can be drafted. - A future water supply plan can be drafted.	- Placing an order with a consultant company (SV) - Establishment of depository	
Intake, Transmission, Distribution, and Service facility	**O&M Conditions**					
	Bulk meter [X]	2.7, 3.5, 5.10, 6.12 The water flow amount is not measured and recorded	- Installation of instrumentation facility - Training on measurement and recording	- Upgrading of the water flow monitoring - Enabling to grasp the water leakage, thus enabling to work out leakage reduction plan	- Instrumentation system for three intake facility (Adi-Sheka, Mai-Serwa, Tokor) and three transmission mains and distribution network - Trainer on instrumentation	✔
	Recording [X]	2.4, 3.4, 5.7, 6.8, 7.3 Check and maintenance record is not maintained properly	- Training on checking of facility condition and repairing	- Enabling to establish the proper renewal plan of the facility, thus improvement in business stability and sustainability	- Technical guidance trainer	
		2.8, 5.11, 6.13 The pump operation record is not compiled as a database	- Training on recording and database construction	- By monitoring the pump operation, the proper renewal plan of the facility can be established. - Thus, improvement in business stability and sustainability.	- Trainer on recording and database construction - Installation of personal computers	✔
	Drawing management [X]	2.6, 3.3, 5.9, 6.10 Drawings and technical documents of the facilities are not being filed and updated	- Establishment of information management system	- Enabling to establish the proper renewal plan of the facility. - The cause of facility failure can be detected easily, thus enabling the quick repairing. - Thus, improvement in business stability and sustainability.	- Recruitment of the personnel with experience of information management - Installation of personal computers	✔
		6.11, 7.6 Drawings of the distribution pipeline is not being filed and updated	- Establishment of information management system - Updating of pipeline information (pipe material, diameter, valve location, etc.)	- Enabling information sharing, thus enabling quick repair of the facility failure or leakage. - Enabling proper valve operation for distribution control. - Enabling to establish the proper renewal plan of the facility and water distribution plan.	- Recruitment of the personnel with experience of information management - Installation of personal computers - Metal pipe detector, Non-metal pipe detector, Metal detector	✔ ✔

Category: [X]: Information Management, [Y]: Water Quality Improvement / *Data Collection and Information Management

Source: Survey Team

Preparatory Survey on Asmara Water Supply Development