Appendices

1. Minutes of Discussions
2. List of Contacted Person
3. List of Collected Data
4. Reference
    1) Presentation materials in the first field survey
    2) Presentation materials in the second field survey
    3) Calculation for available intake water amount from each dam
    4) Electric power condition
    5) Schematic drawings of each dam and WTP
    6) Water demand projection
    7) Pipeline network analysis
    8) Water quality standards in Eritrea
    9) Flow chart of environmental assessment procedure
    10) Answer to the Questionnaire
    11) Photos

Appendix 1.

MD(First Field Surcey)

MINUTES OF DISCUSSIONS
ON
THE PREPARATORY SURVEY
OF
ASMARA WATER SUPPLY DEVELOPMENT
IN THE STATE OF ERITREA

In response to the request of the Government of the State of Eritrea (hereinafter referred to as "Eritrea"), the Government of Japan decided to conduct a Preparatory Survey on Asmara Water Supply Development (hereinafter referred to as "the Survey") and entrusted the survey to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA dispatched to Eritrea the Preparatory Survey Team (hereinafter referred to as "the Survey Team"), which is headed by Mr. Yoshiki Omura, Senior Advisor, JICA, and is scheduled to stay in the country from 22nd March to 3rd May 2015.

The Survey Team held the discussions with the officials concerned of Eritrea. In the series of discussions and field surveys, both sides confirmed the items described in attached sheets. The Survey Team will proceed to further work and assess technical feasibilities of the requested components within the framework of Japan's grant aid scheme.

Asmara, 26th March 2015

Mr. Yoshiki Omura
Leader
Preparatory Survey Team
Japan International Cooperation Agency

Dr. Giorgis Teklemikael
Minister of National Development

Mr. Tesfai Ghebreselassie
Minister of Land, Water and Environment

ATTACHMENT

1. Objective of the Survey

1-1) The Survey team explained the following objectives of the Survey, and the Eritrean side understood it.

- To confirm the present state and issues of the existing water supply facilities in Asmara and examine the requested components.
- To assess technical feasibilities of the requested components within the framework of Japan's grant aid scheme.
- To explain the general outline of Japan's grant aid scheme.

1-2) The Survey Team explained that the present survey does not imply the commitment of project implementation by the Japanese Government nor JICA and the Eritrean side understood it.

2. Target Areas of the Survey

The target area of the Survey is the city of Asmara and its suburbs as shown **Annex-1**.

3. Institutions concerned

The institutions concerned to support the survey are as follows:

- Ministry of National Development
- Ministry of Land, Water and Environment
- Ministry of Foreign Affairs
- Zoba Maekel Administration
- Asmara Water Supply and Sewerage Department

Asmara Water Supply and Sewerage Department is responsible for technical aspects of the Survey.

4. Items requested by Eritrea

4-1) The original request of the Eritrean side for Japan's grant aid scheme is attached as **Annex-2**.

4-2) The Eritrean side explained following priority of the request:

1st : Construction of New S.V. W.T.P (16,000m3/day).

2nd: Rehabilitation of the Existing Distribution Reservoirs and Construction of two Distribution Reservoirs.

3rd: Renewal of the Raw Water Transmission Pipeline from Mai-Serwa Dam to Stretta Vaudetto W.T.P.

4th: Renewal of the Treated Water Transmission Pipeline from Mai-Nefhi W.T.P to New Sembel Pump Station.

5th: Rehabilitation and Extension of Primary and Secondary Distribution Networks.

5. Japan's grant aid scheme

5-1) The Survey Team explained the general outline of Japan's grand aid scheme and major undertakings to be taken by the Eritrean side for information.

5-2) The Survey Team pointed out the following lessons learnt by the previous water supply project and general pre-conditions to implement the Japan's grant aid.

- Lessons learnt
  - Insufficiently manned facilities
  - Inadequate human resources development,
  - Scarcity of spare parts.
- General pre-conditions to implement the grant aid
  - Land acquisition
  - Adequate water source
  - Uninterrupted power supply
  - Appropriate system for operation and maintenance of related facilities

5-3) The Survey Team also explained items as shown 5-2) should be duly considered in the feasibility analysis conducted by them.

6. Schedule of the Survey

6-1) The consultant members of the Survey Team will conduct the 1st field survey in the country until 3rd May 2015 to collect necessary data. They will also make an excursion to the Republic of Kenya for discussions with JICA Kenya Office in the middle of April.

6-2) JICA will examine technical feasibilities of the requested components and their appropriateness for Japan's grant aid until the the end of May 2015.

6-3) JICA will dispatch another mission in order to explain the results of examination to the Eritrean side around June 2015.

7. Other Relevant Issues

7-1) Counterpart Personnel of the Survey

The Survey Team requested the Eritrean side that counterpart personnel from related institutions shall be assigned to ensure the smooth implementation of the Survey and the Eritrean side agreed it.

7-2) Provision of necessary data and materials

The Survey Team requested the Eritrean side to provide necessary data and materials to the Survey Team and the Eritrean side agreed it.

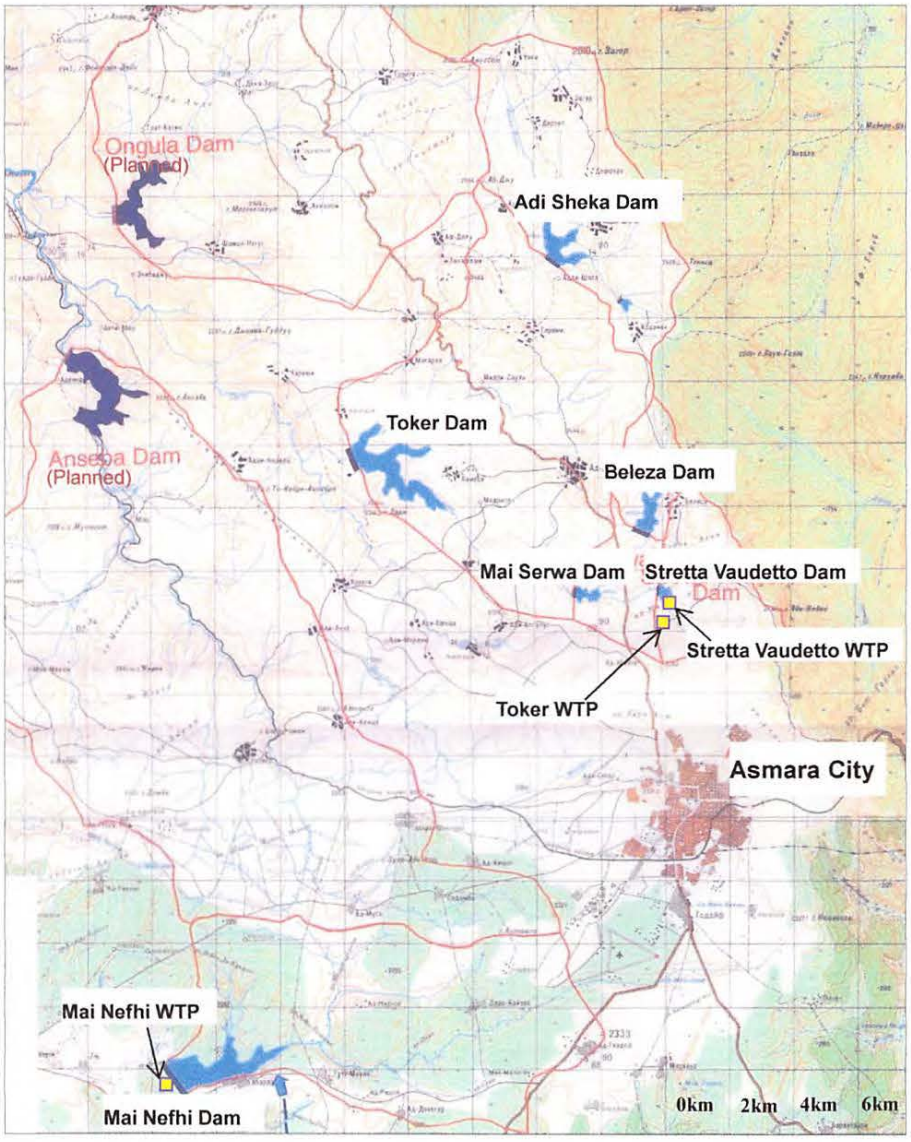
(END)

Annex-1 : Target Areas of the Preparatory Survey

Annex-2 : The original request of the Eritrean side for Japan's grant aid scheme

Annex-3 : Japan's Grant Aid Scheme

Annex-1 : Target Areas of the Preparatory Survey



Annex-2: The original request of the Eritrean side for Japan's grant aid scheme

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**	

Annex-3: Japan's Grant Aid Scheme

The Government of Japan (hereinafter referred to as "the GOJ") is implementing the organizational reforms to improve the quality of ODA operations, and as a part of this realignment, a new JICA law was entered into effect on October 1, 2008. Based on this law and the decision of the GOJ, JICA has become the executing agency of the Grant Aid for General Projects, for Fisheries and for Cultural Cooperation, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures:

- Preparatory Survey (hereinafter referred to as "the Survey")
  - the Survey conducted by JICA
- Appraisal & Approval
  -Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- Authority for Determining Implementation
  -The Notes exchanged between the GOJ and a recipient country
- Grant Agreement (hereinafter referred to as "the G/A")
  -Agreement concluded between JICA and a recipient country
- Implementation
  -Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the

Project.

- Preparation of an outline design of the Project.
- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes (hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals".

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex 3.

(6) Proper Use

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) Export and Re-export

The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). JICA will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

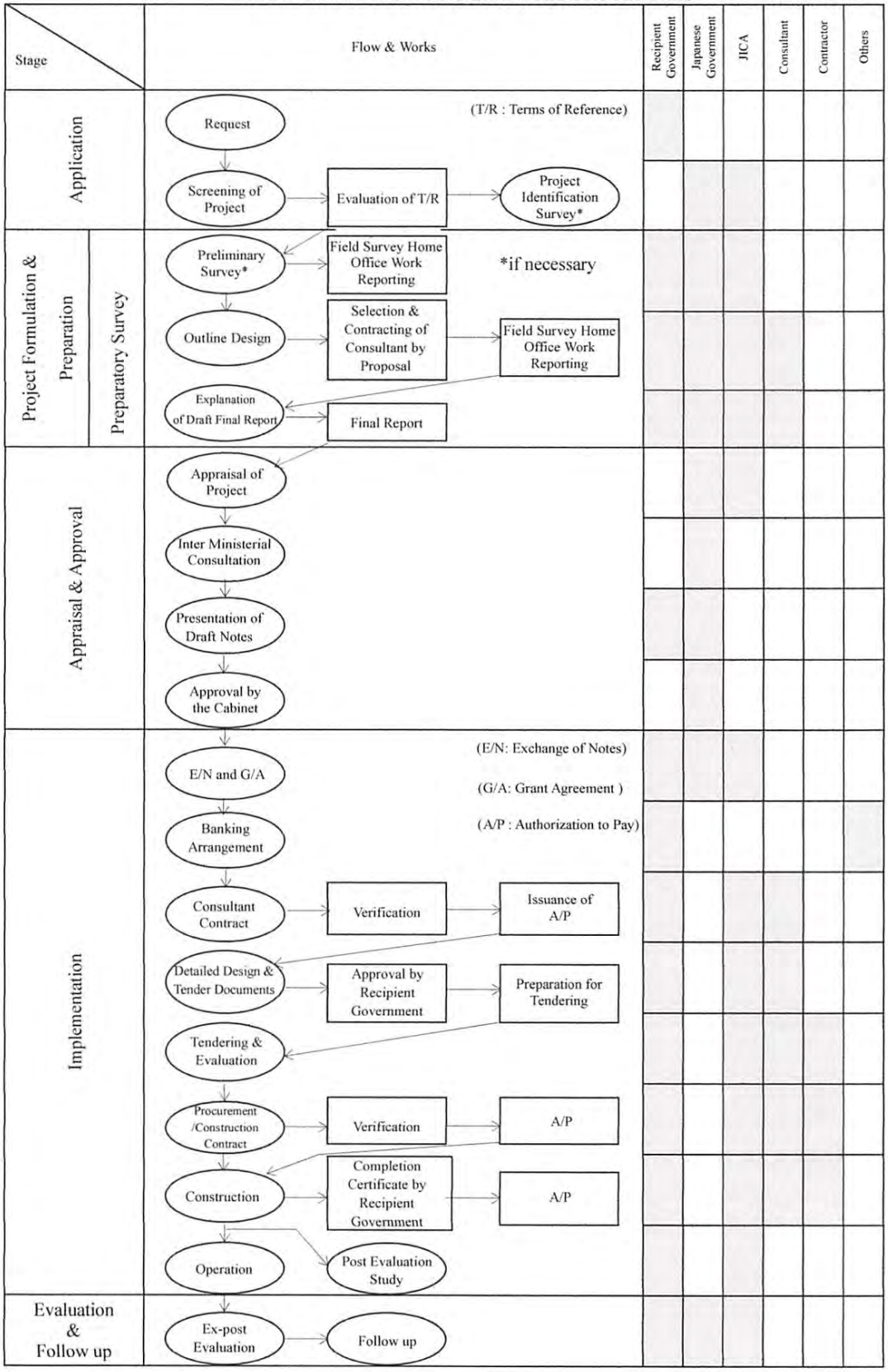
The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions paid to the Bank.

(10) Social and Environmental Considerations

A recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA socio-environmental guidelines.

Attachment 1 for Annex-3

FLOW CHART OF JAPAN's GRANT AID PROCEDURES



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Appendix 1.

MD(Second Field Survey)

MINUTES OF DISCUSSIONS
ON
THE PREPARATORY SURVEY
OF
ASMARA WATER SUPPLY DEVELOPMENT
IN THE STATE OF ERITREA

In response to the request of the Government of the State of Eritrea (hereinafter referred to as "Eritrea"), the Government of Japan decided to conduct a Preparatory Survey on Asmara Water Supply Development (hereinafter referred to as "the Survey") and entrusted the survey to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA dispatched to Eritrea the Second Preparatory Survey Team (hereinafter referred to as "the Survey Team"), which is headed by Mr. Akihiro Miyazaki, Director, Water Resources Group, Global Environment Department, JICA, and is scheduled to stay in the country from 31st May to 6th June 2015.

The Survey Team held the discussions with the officials concerned of Eritrea. In the series of discussions and field surveys, both sides confirmed the items described in the attachment.

Asmara, 5th June 2015

Mr. Akihiro Miyazaki
Leader
Preparatory Survey Team
Japan International Cooperation Agency

Dr. Giorgis Teklemikael
Minister of National Development

Mr. Tesfai Ghebreselassie
Minister of Land, Water and Environment

ATTACHMENT

1. Objectives of the Survey

The Eritrean side and the Survey team confirmed the following objectives of the Survey;

a) To report the findings from the First Survey and the current issues of the existing water supply facilities in Asmara.
b) To suggest measures to tackle the issues that the water supply facilities face with and JICA's possible cooperation.

2. Findings of the First Survey

The Survey team reported the findings of the previous Survey (from 22nd March to 3rd May 2015) as Annex-1, and explained technical aspects and feasibility of the Grant aid project "Asmara Water Supply Development" (hereinafter referred to as "the Grant aid project") as follows. And the Eritrean side understood the situation.

2-1 Technical aspects of the requested project

The Survey team explained that JICA examined effectiveness and sustainability to consider whether the Grant aid project was technically appropriate for Grant aid or not. From this viewpoint, the Survey team concluded impact of the Grant aid project might be less sustainable due to the following obstacles,

a) Lack of appropriate operation and maintenance of the existing water supply facilities

The existing water supply facilities have to be improved in terms of operation and maintenance. The current issues are shown as follows:

- Due to shortage of workers, leading engineers and younger employees, in particular, to be engaged in operation and maintenance, sustainable operation of water services are not provided.
- Due to shortage of spare-parts and equipment for operation and maintenance, the water treatment processes are not properly functioning.
- Due to frequent outages of electricity supply, water treatment process and pump operation are intermittently conducted.
- Due to inappropriate operations at water treatment plants such as improper dosage

of chemicals, unsafe quality of water might be supplied.

b) Lack of Information

Water service information is essential for conducting Outline Design. However, the Survey team could not find the following information;

- As-built drawings of water treatment plants, excluding Toker WTP,
- Records of chemicals dosing / water intake / production / water quality,
- As-built drawings of raw water and clear water transmission mains, excluding Toker WTP , and
- Updated detailed drawings of distribution networks.

2- 2 Technical appropriateness of the Grant aid project

Both parties agreed that the Grant aid project could be effective and sustainable if the obstacles discussed in 2-1 are overcome. Thus, JICA may consider Outline Design of the Grant aid project in case that the obstacles are overcome.

In addition, the Survey team explained that JICA considered proper operation and maintenance of the existing facilities as the first thing to be achieved by the Eritrean side. The Eritrean side understood it.

3. Priority issues

3-1 Priority components

Both parties agreed to prioritize the components to tackle for solving the current problems in order to secure proper operation and maintenance as in Annex-2. The Survey team explained its opinion that collecting precise data and storing information should be prioritized, and the Eritrean side accepted it.

The Eritrean side requested provision of the pumps described in items 2.1, 5.1 and 5.2 in Annex-1 as urgent components. The Survey team will transfer the request to JICA headquarters.

3-2 Potential cooperation by JICA

Both parties understood the importance of technical cooperation for information management (including data collection) in order to conduct proper operation and maintenance as Annex-2.

4. Further process

Both parties confirmed the further process as below:

a) The Eritrean side

- To take necessary actions on prioritized components in Annex-2, and
- To submit a request to the Government of Japan for technical cooperation based on this "Minutes of Discussions" by the end of July 2015.

b) The Survey team

- To report the intention of the Eritrean side to JICA headquarters and the Government of Japan.

c) JICA

- To prepare technical cooperation on the basis of the request by Eritrea.

End.

Annex-1 : Issues and Countermeasures

Annex-2 : Priority issues (Information management)

Issues and Countermeasures

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
1. Raw water storage facilities (Dam)	**O&M Conditions**				
	1.1 There isn't a water level indicator at each dam except Toker dam.	- Installation of the 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、SV、MAI NEFHI)	C
	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	- 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 and cleaning etc.) isn't managed. 1.4 A daily record about checking and repairing isn't kept.	- Recruitment of workers - Arrangement of a daily report - OJT of the daily reporting - Purchase of water quality analysis equipment	- The O&M of facilities is strengthened and information is shared. - The cause 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、SV、MAI NEFHI) - Training of water quality test	A
	1.5 Water quality test (turbidity, pH, electrical conductivity etc.) is not practiced at each dam.		- A cause of the water quality problem (filth and agricultural chemicals, etc.) is detected in 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 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、SV、MAI NEFHI)	C
	1.7 There are much sediment into each dam lake, S.V dam in particular.	- Dredging sediments of each dam lake.	- Storage capacity of the dam increases, and quantity of water intake increases.	- Contracting a construction company for dredging in sediments	C

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

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
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 m3/h Mai-serwa PS: Q= 200 m3/h x 2nos.	B
	2.2 Tokor Pump Station a) Limited operation hour (10 hours/day) of diesel engine driven pump due to overheat of diesel engine and availability of diesel b) The diesel fuel cost is a huge financial burden on the 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 m3/h H=235m x 2nos.	B
	O&M Conditions				
	2.3 O&M activity according to the O&M manual is not being conducted.	- Training for OM activity according to the OM 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 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
	2.5 Delay of replacement of spare parts	- Prepare the 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 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 repairing - Thus, improvement in business stability and sustainability	- Recruitment of the personnel with experience of information management - Installation of personal computers	A

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

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	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 leakage reduction plan	- Instrumentation system for three intake facility (Adi-Sheka, Mai-Serwa, Tokor) - Trainer on instrumentation	A
	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. - Thus, improvement in business stability and sustainability	- Trainer on recording and database construction - Installation of personal computers	A
3. Raw water transmissio n 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 disturbed 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 replace to the pipeline as a fundamental solutions	- Enabling to send the raw water throughout the year - Increasing in water supply amount - Improvement in stable water supply	- Design engineer - Pipeline (D300 L=8km)	B
	3.2 Deterioraiton of pipe line of asbestos cement pipe a) Raw water transmission pipeline from Beleza to S.V. WTP b) Raw water transmission pipeline from Mai Serwa dam to S.V. 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 SV WTP D300 L= 2km) (Mai Serwa to SV WTP D300 L= 2.7km)	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 repairing - Thus, improvement in business stability and sustainability	- Recruitment of the personnel with experience of information management - Installation of personal computers	A

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

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	3.4 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 - Trainee	A
	3.5 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 raw water transmission facility (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.	- 1000L chemical tank×2nos - Pipe laying to 4 receiving wells	A
	4.1.2 Several deflectors in the flocculation basin are corroded working.	- Checking and repairing of 190 deflectors	- Flocclation is promoted by adjusting 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. And several sludge valves are inoperable.	- Elimination of clogging into the sludge pipes and exchange of sludge valves	- Sludge in the sedimantation basin is discharged. - Turbidity is reduced so that workload in the filter is reduced.	- Cleaning 5 sludge pipes and replacing/repairing 5 sludge valves	A or B
	4.1.4 Back-wash isn't done effectively so that there are thick sludge on the filter beds.	- Cleaning of sludge on 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 m3/hours is leaking at 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 design of new facilities.	C
	4.1.6 Land subsidence of approximate 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.				

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

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	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 W.T.P is operated manually from 2007 because the central control system was out of order.	- Repairing of the central control system	- Work force is reduced. However, the manual operation is effective under current power supply condition	- Placing an order with a consultant company	-
	4.2.2 The Sodium hypochlorite generation apparatus was out of order in 2009.	- Study 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 of Jar test	- The water quality management is strengthened and safe water is supplied.	- Lecturer of 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 a injection equipment	- Turbidity is improved. - Workload in the filter is reduced.	- 1000L chemical tank×2nos - Pipe laying to the receiving well - Dosing pump ×2nos	A
	4.3.2 The Pulsator isn't 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 system - Cracking valve, the partialization box and the clogging indicator ×6 filters - Most of valves in the filter basin ×6 filters	C
	4.3.3 Water is leaking at the link channel between Pulsators and filters.				
	4.3.4 The cracking valve, the partialization box and the clogging indicator in each filtration basin are out of order.				

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

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	4.3.5 There are no spare pumps of back-wash and air-blow.			- Spare pumps of back-wash 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 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.				
	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 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, 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. - The healthy obstacle with chlorine to staff is reduced.	- chlorinator × 3 W.T.Ps - OJT	A or B
	O&M Conditions				
	4.4.3 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.	- Water quality analyst × 3 W.T.Ps - Water quality equipment (pH, Turbidity, EC, Total coliform bacteria, General bacteria, Residual chlorine, Jar testing) ×3 W.T.Ps - Lecturer of water quality test	A

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

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
			- Chlorine gas injecting quantity is injected properly by measuring the residual chlorine.		
	4.4.4 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	A
	4.4.5 There isn't an engineer for O&M of 3 W.T.Ps	- Recruitment of an engineer - Purchase of a vehicle of management	- 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.	- 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.	- Recruit of young and middle-aged workers	- The technical capacity is transferred and continued. - The customer's complaints are dealt with quickly. - The O&M in facilities is reinforced.	- Improvement of salary treatment	C
	4.4.7 There isn't a staff for chemical dosing test.	- Recruitment of dosing test staff - OJT of dosing test (Jar test)	- The water quality management is strengthened and safe water is supplied.	- Technician × 2 persons (SV and Mai Nefhi) - Lecturer of Jar test	B
	4.4.8 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	A

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

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	4.4.9 Spare parts aren't purchased timely.	- Inventory is checked periodically.	- The customer's complaints are dealt with quickly. - A breakdown and leakage in 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 procurement of spare parts	C
5. Treated water transmission facility	**Physical Conditions**				
	5.1 Malfunction/Deterioration of pump equipment Treated water transmission pump at S.V. 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 m3/h x 3nos.	B
	5.2 Reduced pump capacity Treated water transmission pump at Mai Nefhi WTP	- To identify possible causes (worn out of impellor, for example)	- 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 is deteriorate 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 water amount, thus increasing the water supply amount	- Design engineer - Pipeline (D500 L=16km)	B
	5.4 Malfunction of chlorine injection facility at SembelPS 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

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

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	O&M Conditions				
	5.6 O&M activity according to the O&M manual is not being conducted.	- Training for OM activity according to the OM manual	- Life span of the facility is extended, thus improvement in business stability and sustainability	- Technical guidance trainer - Trainee	A
	5.7 Check 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 - Trainee	A
	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 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 repairing - Thus, improvement in business stability and sustainability	- Recruiting the personnel with experience of information management - Installation of personal computers	A
	5.10 The water flow rate 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 treated water transmission facility (S.V., 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. - Thus, improvement in business	- Trainer on recording and database construction - Installation of personal computers	A

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

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
			stability and sustainability		
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 m3 or more)	B
	6.2 Deterioration of existing distribution reservoir a) Existing three reservoirs in Tokor system are deteriorated. There are leakages and 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: 300m3 x 2nos) (Tsetserat: 500 m3 x 2nos) (Hazhaz: 500 m3 x 2nos)	B
	6.3 Deterioration of the distribution pump station The pump facilities in the two distribution pump station in the Tokor System are deteriorated and the pump capacity are reduced.	- Renewal of the pump facility	- Increasing in water pressure in the distribution pipe, thus extending water supply area	- Design engineer - Pump equipment in Mai Chohot PS (Q = 150 m3/h) and Denden PS (Q = 300m3/h)	B
	6.4 Deteriorated pipe line There remain approx. 3,000 m of aged GI pipelines.	- Replacement of the pipe	- Reduction of water leakage Increasing in flow capacity of the pipe, thus extending water supply area	- Design engineer - PVC pipe (D75-D200 L=3,000m)	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 water supply area	- Design engineer - PVC pipe (D200-D300 L=6,500m)	C

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

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	O&M Conditions				
	6.7 O&M activity according to the O&M manual is not being conducted.	- Training for OM activity according to the OM manual	- Life span of the facility is extended, thus improvement in business stability and sustainability	- Technical guidance trainer	A
	6.8 Check 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
	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 water supply and improvement in stable water supply	- Budgeting for procurement of spare parts	B
	6.10Drawings and technical documents of the facilities 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 repairing - Thus, improvement in business stability and sustainability	- Recruiting the personnel with experience of information management - Installation of personal computers	A
	6.11Drawings 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	A
	6.12The 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 to work out leakage reduction plan	- Instrumentation system for three distribution system (S.V. system, Tokor system, Mai Nefhi system) - Trainer on instrumentation	A

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

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	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	A
	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 suppy 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 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 - 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, thus 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

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

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	7.6 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 repairing - Thus, improvement in business stability and sustainability	- Recruitment of the personnel with experience of information management - Installation of personal computers	A
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 for repair of mechanical and electrical equipment	A or B
	8.2 Shortage of the technicians who engage in leakage detection and repair and installation of new house connections	- Recruitment of the new staff and continual employment of the staff	- Enabling quick repair of the facility, thus improvement in stability and service level of water supply	- Experienced staff who provide training to the new junior staff - Junior staff	A or B
	8.3 Shortage of engineer for water quality control	- Recruitment of the new staff and continual employment of the staff	- Enabling to upgrade the water quality management of AWSD	- Experienced staff who provide training to the new junior staff - Junior staff	A or B
	8.4 Shortage of the CAD operator	- Recruitment of the new staff and continual employment of the staff - Training of CAD operation	- Upgrading of water distribution pipeline drawings	- Experienced staff who provide training to the new junior staff - Junior staff	A
	8.5 Aging of the AWSD employees	- Recruitment of the new junior staff and continual employment of the staff	- Enabling succession of the technical information/knowledge, thus improvement in business sustainability	- Junior staff	C
	8.6 Absence of the vehicle for supervision and execution of the O&M works	- Procurement of Vehicle for O&M works	- Upgrading of the technical management of the 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,	- Procurement of construction machinery/	- Upgrading of the technical management of the water supply	- Construction equipment (Excavator, truck with crane, welder, etc.)	B

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

Facilities	Issues	Countermeasures			Urgency
		Components	Effects	Necessary Resources	
	causing delay of the works	equipment and tools	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		
9. Business Administration	9.1 Grasping of the water supply amount It takes more than 6 months for billing the water amount. Thus, the timely grasping of the water supply amount is not conducted.	- Reduction of period for settlement of the consumed water volume by establishment of the branch office of AWSD - 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 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, the water rationing is in execution.	- 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 Operation of the water supply facility are being affected by the frequent interruption of power supply	- Electricity is supplied for 24 hours/day.	- Improvement in stability of water supply	- Arrangement of power supply by EEC	C

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

Priority Issues (Information management*)

Facilities	Issues		Countermeasures			Assistance requested to JICA
			Components	Effects	Necessary Resources	
Raw water storage facilities (Dam)	**O&M Conditions**					
	Preservation [X] [Y]	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]	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]	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, S.V, MAI-NEFHI)	✔

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

Priority Issues (Information management*)

Facilities	Issues		Countermeasures			Assistance requested to JICA
			Components	Effects	Necessary Resources	
Water treatment facility	**Physical Conditions**					
	Bulk meter [X]	(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.	- S.V : 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	✔
	O&M Conditions					
	Water quality [X] [Y]	(3 W.T.Ps) 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]	(3 W.T.Ps) 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

Priority Issues (Information management*)

Facilities	Issues		Countermeasures			Assistance requested to JICA
			Components	Effects	Necessary Resources	
Water treatment facility	**Drawings and documents** [X]	(3 W.T.Ps) AWSD are not properly filing past drawings and documents, although some of them are kept in the cabinet.	- Producing of drawings (S.V) - 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.	- Contract with a consultant company for measurement and draft (S.V)	
					- Establishment of depository	
Intake, Transmission, Distribution, and Service facility	**O&M Conditions**					
	Bulk meter [X]	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, Toker) and three transmission mains and distribution network	✔
					- Trainer on instrumentation	

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

A1-33

Annex-2
Appendix 1

Priority Issues (Information management*)

Facilities	Issues		Countermeasures			Assistance requested to JICA
			Components	Effects	Necessary Resources	
Intake, Transmission, Distribution, and Service facility	**Recording** [X]	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	
		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]	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	✔
		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

Appendix 2.

List of Contacted Person

Appendix 2　Contacted Person

Institution	Position	Name
Water Resources Department, Ministry of Land, Water and Environment		
	Director General, Water Resources Department (WRD)	Mebrahtu Iyassu
	Director, Water Supply Division, WRD	Misghina G/Selassie
	Unit Leader, Database, GIS & Remote Sensing Information Services unit	Tecle Yemane
	Unit Leader, Laboratory Unit	Efrem Teferi
Asmara Water Supply and Sewerage Department (AWSD)		
	Department Head, AWSD	Ghebrekidan Gabretsiun
	Division Head, Water Supply Division	Kidane Kifle
	Unit Leaer, Water Distribution Unit	Omaneli
	Unit Leader, New Connection and Maintenance Unit	Orede
	Unit Leader, Dams and Treatment Plants Unit	Binyam
	Unit Leader, Planning and Supervision Unit	Yohannes Mulu
	Division Head, Administration and Finance Division	Tsuhaye
	Unit Leader, Personnel Unit	Baraphat
	Unit Leader, Finance Unit	Estifanos Andezion
	Unit Leader, Customer's Unit	Kidane
	Unit Leader, General Service Unit	Zenikel
	Unit Leader, Store Unit	Araya
Eritrean Electric corporation (ECC)		
	General Manager, EEC	Abraham W. Michael
Zoba Maekel Administration		
	Director of Environment, Management & Assessment	Mulubrham G/yohannes
	Division Head, Town Planning Division, Infra. Dept.	Medhanie Teklemariam
Asmara International Airport Meteorological services		
	Head of Meteorological Unit	Isaac Fesseha

Appendix 3.

List of Collected Data

Appendix 3 Collected Data

No	Name	Type of data	Issued by
	A. Laws, Regulations, etc.		
A1	ASMARA WATER CONTRACT	PDF	AWSD
A2	DRAFT THE ERITREAN ENVIRONMENTAL MANAGEMENT PROCLAMATION NO. 2002	Word	Zoba
A3	Finalised National Environmental Assessment procedures and guidlenes NEAPG edited	Word	Zoba
A4	Zero Draft - Environmental Law	Word	Zoba
A5	Proclamation No.2005 Massawa	PDF	GOE
A6	To-ward Establishing Eritrean Water Quality Standards	Word	WRD
A7	Roles and Responsibilities of Parties involed in Water Supply Projects	Word	WRD
A8	Eritrea Water Resources Policy	PDF	WRD
A9	Action Plan for Integrated Water Resources Management in Eritrea	PDF	WRD
A10	Proclamation No.162 Eritrea Water Proclamation	PDF	GOE
A11	National Water Supply Action Plan 2013 - 2017	Word	WRD
	B. Reports, Technical materials		
B1	Ertrean Electric Corporation, General Information	PDF	EEC
B2	Ertrean Electric Corporation, Existing Thermal Power Plants and Power Grid System	PDF	EEC
B3	Ertrean Electric Corporation, Existing Tariff as May 10,2008	PDF	EEC
B4	SUNRIDGE GOLD CORPORATION ASMARA PROJECT - Hydrometeorolgy Report Dec 2012	PDF	Mining Service
B5	Durfo-Sedao	PDF	Societe Eletrica dell Africa Orientale
B6	AWSD Annual Report 2013 (Tigrinya)	Word	AWSD
B7	AWSD Annual Report 2014 (Tigrinya)	Word	AWSD
B8	AWSD 2014 Plan (Tigrinya)	Word	AWSD
B9	Asmara Infrastructure Development Study Phase-2: Feasibility Study Water Sector	Word/Excel/ PDF	Department of Urban Development, Ministry of Public Works
B10	Asmara Infrastructure Development Study Phase-3: Detailed Design and Tender Documents Water Sector	Word/Excel/ PDF	Department of Urban Development, Ministry of Public Works
B11	Job Description of Zoba and Sub-zoba (Extract)	PDF	Zoba Maekel Administration
B12	State of Eritrea Five Year Indicative Development Plan 2014 - 2018	Word	Ministry of National Development
	C. Map, Drawings		
C1	AWSD Drawing List	Excel	Prepared by the survey team
C2	Hydrology Station Map	JPEG	WRD
C3	Water Supply Network latest	Auto-CAD	AWSD
C4	Toker River Water Supply Project As built drawings (Toker Pumping Station)	Auto-CAD	Natural Resources Consulting Engineers
C5	Toker River Water Supply Project As built drawings (Raw water transmission pipeline)	Auto-CAD	Natural Resources Consulting Engineers
C6	Adi Nefas WTP Design Drawings	Auto-CAD	Biwater
C7	Adi Nefas Treated Water Transmission Pipeline Design Drawings	Auto-CAD	Biwater
C8	Asmara Development Map	Auto-CAD	Infrastructure Dept. Zoba Maekel
C9	Acquedotto Abaeda-Sembel	PDF	Municipalita Di Asmara
C10	Maekel Region	PDF	Eritrean Mapping and Infrormation Center
	D. Statistics, Data		
D1	Met Data Afdeyu Station Data	Excel	WRD
D2	Met Data Embaderho & Adinfas Data	Excel	WRD
D3	Met Data Asmara Airport	Excel	WRD
D4	Zoba Maekel Flow Data	Excel	Mining Service
D5	Asmara groundwater resources related data	Word/Excel	WRD
D6	Hydrometeorology	Excel	WRD
D7	Landuse	JPEG/Excel	WRD
D8	Population of Zoba Maekel as of 2015	PDF	Zoba Maekel

Appendix 4.

1) Presentation Material in the First Field Survey ①

Water Supply Planning
Outline of Survey

1. Service Condition of AWSD
2. Facility Condition of AWSD
3. Water Demand and Supply Capacity
4. Distribution Facility
5. Operation of AWSD
6. Criteria for Implementation of the Project

JICA Preparatory Survey on
Project for Asmara Water Supply Development

1. Service Condition of AWSD

We will grasp the present service condition of AWSD and make it the baseline condition of the water supply planning.

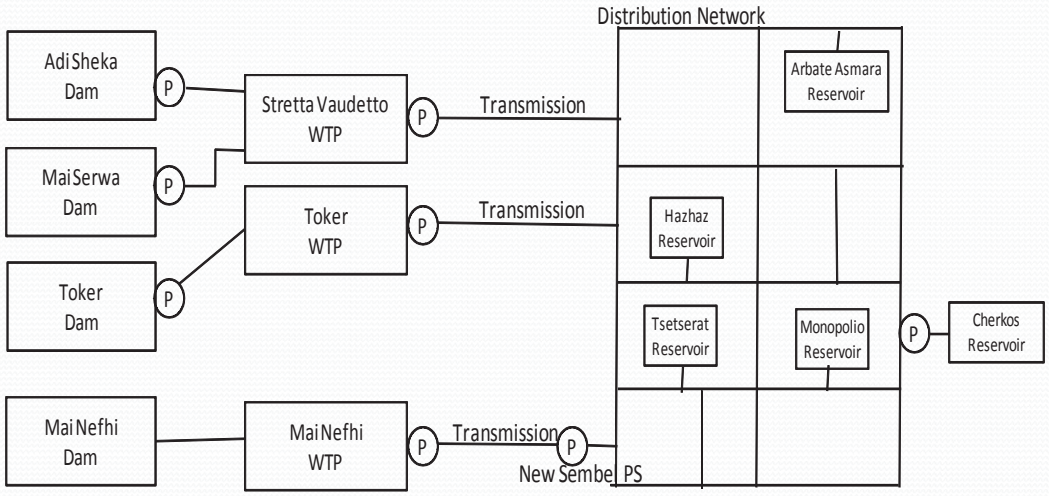
According to AWSD, the service condition as of 2009 was as follows:

Population in service area	: 576,807
Served population	: 538,550 (Service ratio: 93 %)
Billed Volume	: 3,896,588 m3 (10,675 m3/day) (including 837,581 m3 of water tanker supply)
Production Volume	: 6,052,616 m3 (16,582 m3/day)
Intake Volume	: 8,029,567 m3 (21,998 m3/day)

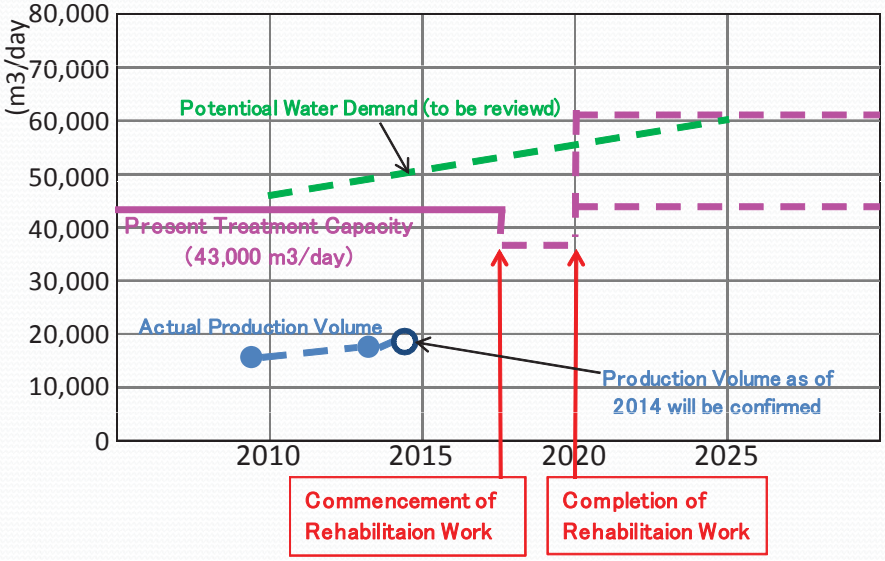
We will update the above information using the data as of 2014.

2. Facility Condition of AWSD

We will grasp the present conditions (operational& functional condition, aging status, etc.) and problems on the facilities and make it the basic information for facility improvement planning.



3. Water Demand and Supply Capacity



The facility rehabilitation/expansion plan will be proposed considering :

- Production volume (actual and future prospects),and
- Potential water demand

4. Distribution Facility

We will :

- Confirm the present condition of the distribution facilities as well as pump and valve control manners and function of the distribution reservoirs
- Check if the distribution facility has the sufficient capacity for the present and future demand

5. Sustainable Operation of AWSD

We will confirm the operational condition of AWSD that are important for sustainable operation of AWSD:

- Annual business plan
- Number of Connections (domestic and non-domestic)
- Annual revenue and expense
- Organizing condition of customer ledger
- Tariff collection system
- Repair record of customer meter
- Procurement record of material/equipment for O&M

We will confirm the procurement condition of the spare parts of the facility (Source of supply, purchase arrangement, budgeting procedure, etc.) that are indispensable for proper operation and maintenance of the facility.

6. Criteria for Implementation of the Project

- Priority (Necessity & Urgency)
- Prospect for Generation of the Project Effect
- Assurance about Effective Utilization of the Facility
- Assurance about Proper Operation and Maintenance including Staff Arrangement and Supply of Spare Parts

Appendix 4.

1) Presentation Material in the First Field Survey ②

Preparatory Survey on the Project for Asmara Water Supply Development

Water Supply Facility / Operation and Maintenance

by Koji Yoshikawa in JICA Study Team

Assigned area:

1, Water resource (Dam) Inc. environmental and social considerations

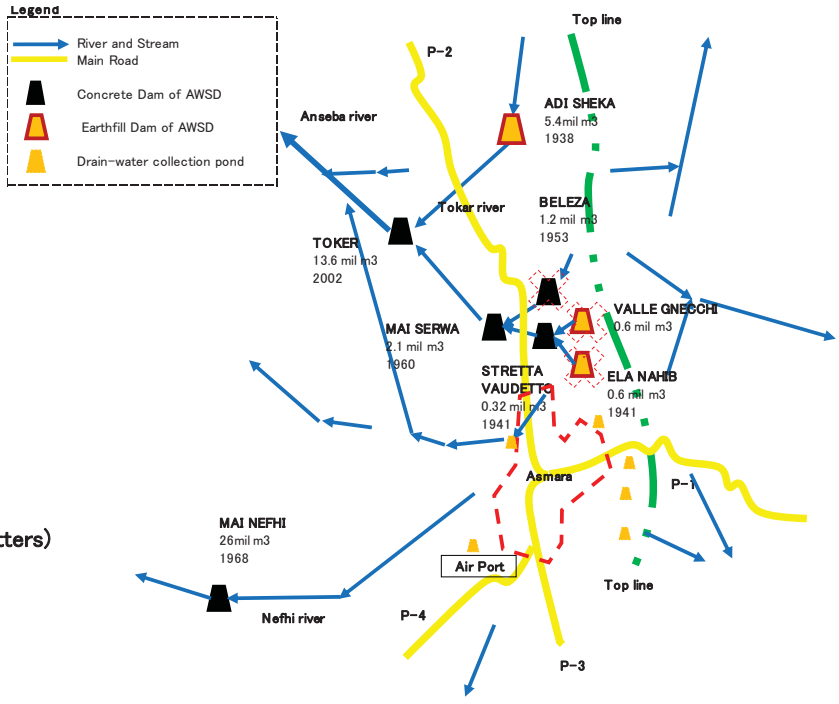
2, Water Treatment Plant Inc. environmental and social considerations

3, Operation and Maintenance (O&M)

1-1 Water resource (Dam)

1 ,TOKER (2002)
2, ADI SHEKA (1938)
3, MAI SERWA (1960)
4, STRETTA VAUDETTO (1941)
5, BELEZA (1953)
6, VALLE GNECCHI (?)
7, ELA NAHIB (1941)
8, MAI NEFHI (1968)

5nos Dams - Running (Red letters)
3nos Dams - No Running (Black letters)



1-2 Objective of the survey of dam

- **To classify the various factors or elements of each dam.**

  Various factors or elements of Dam ;

  River name, Intended use, Structure type,

  Dam size (Length, Height, Upper wide, Bottom wide, Dam volume),

  Catchment area, Water surface area,

  Gross storage capacity, Effective storage capacity,

  Landownership, Ownership of structure, Water rights,

  Conservation-Management for catchment area, Management for structure

- **To infer the available amount of water taken from each dam.**

1-3 Matters for Investigation of Dam

Data of water Level of each dam
Design Report (Inc. Drawings) of each dam
Customary water right or water right in Anseba River and Nefhi River basins
Topographical map in Maekel (Central) region (approx. scale 1:5000)
Various factors or elements of each dam
Condition of each dam's lake sediments
Condition of each dam body
Frequency of water discharge and sludge discharge from each dam
Condition of upper and lower sides of river at each dam
Condition of access road to each dam
Electric power circumstance for each raw-water pump

1-4 Survey Method

Questionnaire
Hearing survey
On-Site Survey

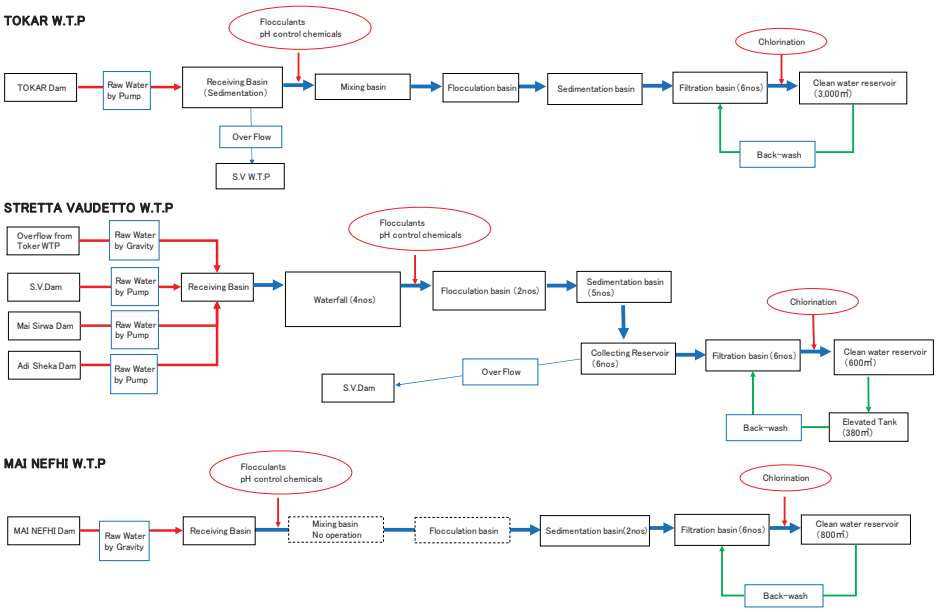
2－1 Water Treatment Plant (W.T.P)

1, TOKER (2002)

2, STRETTA VAUDETTO (1941)

3, MAI NEFHI (1967)

3nos W.T.Ps － Operation



2-2 Objective of the survey of W.T.P

- To classify the current condition and problem of each facility in each W.T.P.

W.T.P Facilities:

Receiving basin, Mixing basin, Flocculants (ALUM), pH control chemicals, Flocculation basin, Sedimentation basin, Filtration basin, Air-brow, Back-wash, Clean water reservoir, Chlorination, Control system, Water quality laboratory, Sludge disposal lagoon, Electric power circumstance (EEC and Generator)

- To select the facilities and equipment for rehabilitation.

2-3 Matters for Investigation of W.T.P

Problem of each facility in each W.T.P

Inlet and Outlet flow of each W.T.P

Design Report (Inc. Drawings) of each W.T.P

Data of inlet and outlet water qualities of each W.T.P

Condition of each building in each W.T.P

Safety measure of chlorine in each W.T.P

Condition of sludge disposal in each WTP

Electric power circumstance in each W.T.P

Condition of access road to each W.T.P

Condition of land of New W.T.P

2-4 Survey Method

Questionnaire

Hearing survey

On-Site Survey

3-1 Operation and Maintenance (O&M)

Water supply system in AWSD

Water Resource (Dam)

Intake Facility

Raw-water Facility

W.T.P Facility

Clean-Water Facility

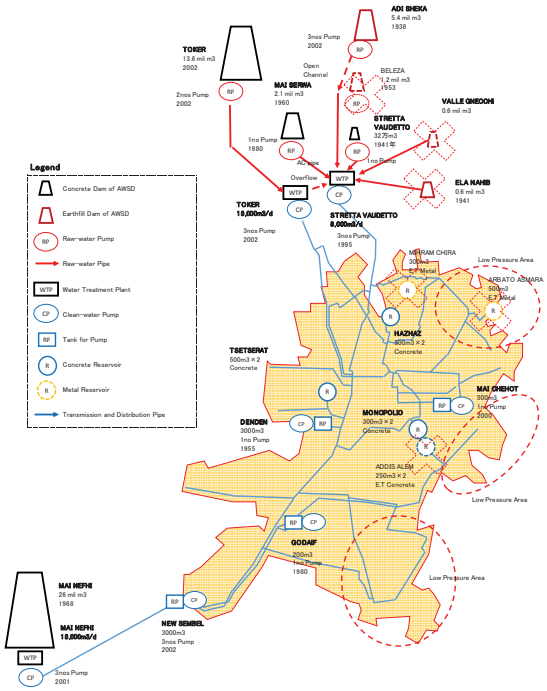
Distribution Facility

Service-pipe Facility

Water tariff collection

Pipe repair work

Water quality test



3-2 Objective of the survey of O&M

- **To classify the current condition of O&M of each facility.**

  Facilities

  Resource, Intake, Raw-water, W.T.P, Clean-Water, Distribution, Service-pipe

- **To classify the current condition**

  for water tariff collection, pipe repair work and water quality test.

- **To select the necessary capacity development.**

3-3 Matters for Investigation of O&M

Problem of O&M of each facility

Problem in Dam and Treatment Plants Unit

Condition of water quality test.

Problem in Water Distribution Unit.

Problem in New Connection and Maintenance Unit.

Number of pipe repair team and staff composition

Activity for leak Detection and pipe repair work

Presence or absence of a computerized mapping system (CAD or GIS)

Problem in Administration and Finance Division

Flow chart of water tariff collection system

Record and plan for staff training

3-4 Survey Method

Questionnaire

Hearing survey

On-Site Survey

Appendix 4.

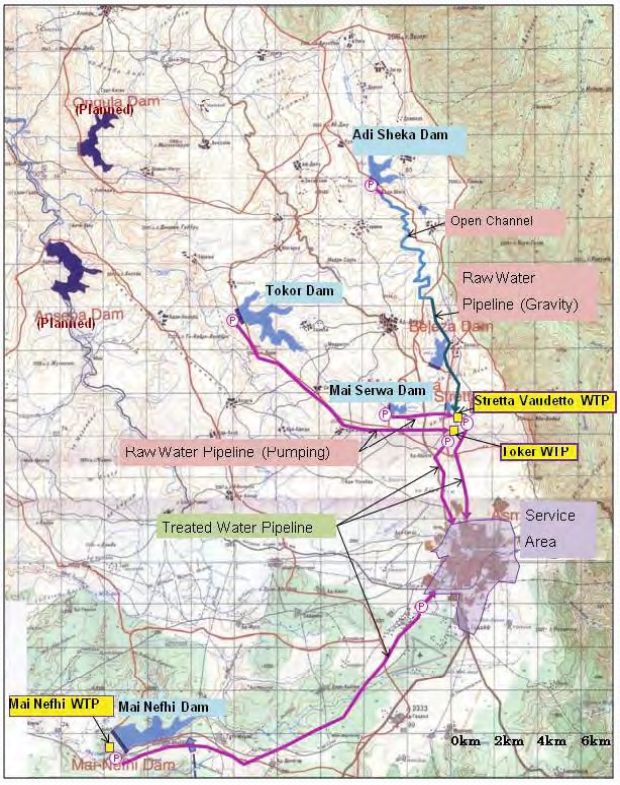
2) Presentation Material in the Second Field Survey ①

Water Supply Planning
Results of Site Survey

1. Water Supply Condition in Asmara
2. Operational Condition of AWSD
3. Facility Conditions of AWSD
4. Water Demand and Water Balance

JICA Survey Team

1. Water Supply Condition in Asmara
1.1 Outline of Water Supply Facility

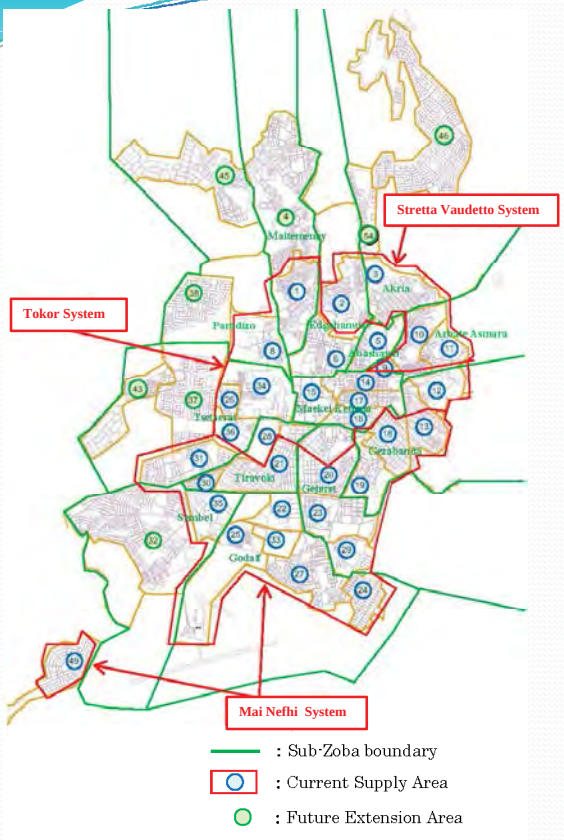


Stretta Vaudetto System:
Dam: Adi Sheka Dam, Mai Serwa Dam
WTP Capacity: 8,000 m3/day

Tokor System:
Dam: Tokor Dam
WTP Capacity: 18,000 m3/day

Mai Nefhi System:
Dam: Mai Nefhi Dam
WTP Capacity: 20,000 m3/day

1.2 Service Area



Population in AWSD piped service area

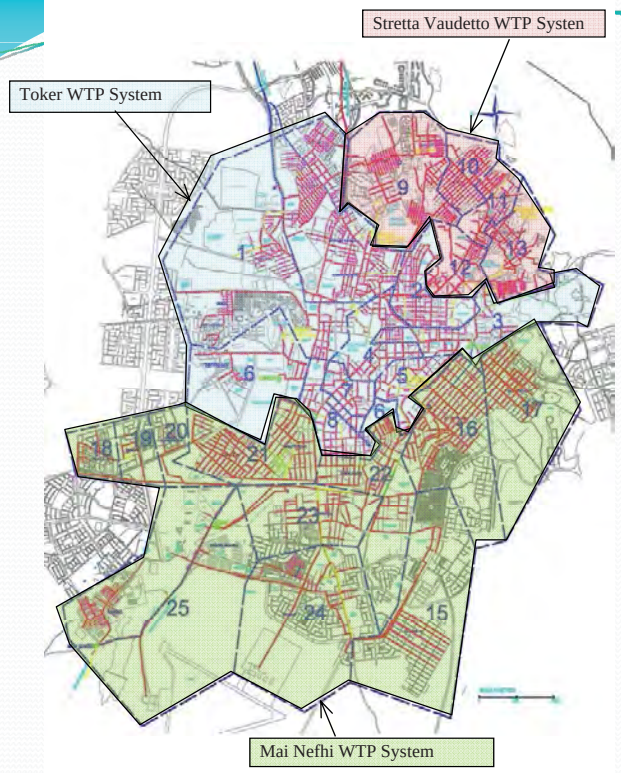
Sub-Zoba	2008 Census	2015 Census	Annual growth rate
Paradiso	29,442	32,457	1.0140
Maitemenai	24,482	24,257	0.9987
Edaga Hamus	32,179	34,016	1.0080
Akiria	51,182	55,057	1.0105
Abazhawl	40,342	40,957	1.0022
Arbate Asmara	35,197	34,484	0.9971
Tsetserat	19,851	22,532	1.0183
Maekel Ketema	21,312	21,868	1.0037
Tiravolo	20,955	21,260	1.0021
Geza banda	36,306	36,092	0.9992
Sembel	16,861	20,076	1.0252
Godaif	43,280	44,645	1.0044
Gejeret	39,487	39,728	1.0009
Outside of Asmara			
Daero Paulos TD	6,650	6,900	1.0053
	417,526	**434,329**	**1.0057**

1.3 Service Condition

	Unit	2014	Remarks
1. Population in Service Area	**No.**	**434,329**	427,429+6,900
2. Served Population in Service Area		**409,329**	434,329 - 25,000(assumed)
By Piped Supply	No.	339,472	409,329 – 69,857
By water truck	No.	69,857	339,971 x (3/4) x 1000/365/10
3. Population outside of Asmara served by water truck	**No.**	**23,286**	339,971 x (1/4) x 1000/ 365/10
4. Number of connection	**No.**	**35,483**	
Domestic	No.	29,722	Answer to questionnaire
Non-domestic	No.	5,761	Ditto
5. Billed water	**m3/year**	**2,611,509**	**7,155 m3/day**
Piped supply (Domestic)	m3/year	1,552,317	Answer to questionnaire
Piped supply (Non-domestic)	m3/year	519,144	Ditto
Sold to water truck (Domestic)	m3/year	339,971	2014 Annual report
Sold to truck (Non-domestic)	m3/year	200,077	Ditto
6. Water production (sent from WTP)	**m3/year**	**6,659,541**	**18,245 m3/day**
Stretta Vaudetto WTP	m3/year	756,575	2014 Annual report
Toker WTP	m3/year	2,740,396	Ditto
Mai Nefhi WTP	m3/year	3,162,570	Ditto
7. Ratio of Non-revenue water ((6. -5.)/6.) x 100	%	61	

- Approx. 2-3 households are using one house connection.
- Per capita consumption of domestic water is: (1,552,317 m3/year)/339,472 = 12.5 l/c/d
  Actual consumed water volume may be more than the billed water, due to old water meter.
- It takes more than 6 months for recording the billed water, so it is difficult to timely monitor the actual amount of water consumption.
- The amount of water production in Stretta Vaudetto WTP and Mai Nefhi WTP is estimated by the operation hours of the transmission pump, not by the bulk meter. It may be overestimated than the actual amount. Thus, the actual leakage amount cannot be known.

1.3 Service Condition



Water Ration Schedule

Zone No.	Area	Days
Tokor System		
1	Maitemenai, Edaga Hamus, Vilaggio, Adi segdo, Paradizo, Embagaliano	5
2	Abashawl+shuk, Around Saint Mary Church	3
3	Center Town (Marcato)	3
4	Taba (Cinema Roma + muagna)	3
5	Monopolio + Mufti	3
6	Denden Camp (Algien + Tsetserat)	3
7	Alformaio	3
8	Around San Francesco Church	3
1 Cycle =26 days		
Stretta Vaudetto System		
9	Haz HAz, Mihram Chira, Viya Jida	3
10	Akria (Left, Right)	3
11	Akria (Saint Gebriel church), Edaga Arbi	3
12	Around 2nd Police Station (Hadish Adi), Geza Brhanu (Geza Banda Habesha)	3
13	Arbaete Asmara, Debozito	3
1 Cycle = 15 days		
Mai-Nefhi System		
Brached from Mai Nefhi WTP – Sembel PS Transmission Pipeline		
14	Daero Paulos	3days/week
From Sembel PS via Godaif PS		
15	Kehawta	6
16	Geza Banda (Adis Alem)	6
17	Mai Chihot	6
1 Cycle =18 days		
From Sembel PS		
18	Space, Enda Germen	3
19	Enda Shewit, Michael Tedros	2
20	Jekaranda, Space 1	4
21	Tiravolo, Campopolo	3
22	Around Asmara Brewery, Around Enda Kisha	3
23	Barjima, Gejeret, Around Enda Nora (Lime Factory)	4
24	Godaif	3
25	Sembel+Dembe Sembel	Every day
1 Cycle =22 days		

Due to current insufficient supply capacity, water is being rationed as shown above.
Supply hours: approx 12 hours/day

2. Operational Condition of AWSD
2.1 Organization and Staffing, Machinery

Division	Permanent Staff	Contract Staff	National Service	Total
Head of AWSD	1			1
Water supply division Water Distribution unit New connection and maintenance unit Dam and treatment plant unit Planning and supervision unit	55	129	74	258 (Engineer: 2) (Assistant Engineer: 2)
Administration and Finance division Personnel unit Finance unit Customer's unit General service unit Store unit	35	46	63	144 (Bachelor of Administration: 1) (Accountant: 2)
Sewerage division	7	9	18	34 (Engineer: 1) (Assistant Engineer: 1)
Total	98	184	155	437

Only four engineers in Water Supply Division, so it is difficult to conduct proper technical management of water supply works.

Machinery	Type	Number
Truck with crane	Renault (France)	1
Back hoe	Rulong (China)	1
Dump truck	Fiat 110 (Italy)	1
Pick up double cabin	Tiyota Hilux 4WD	1

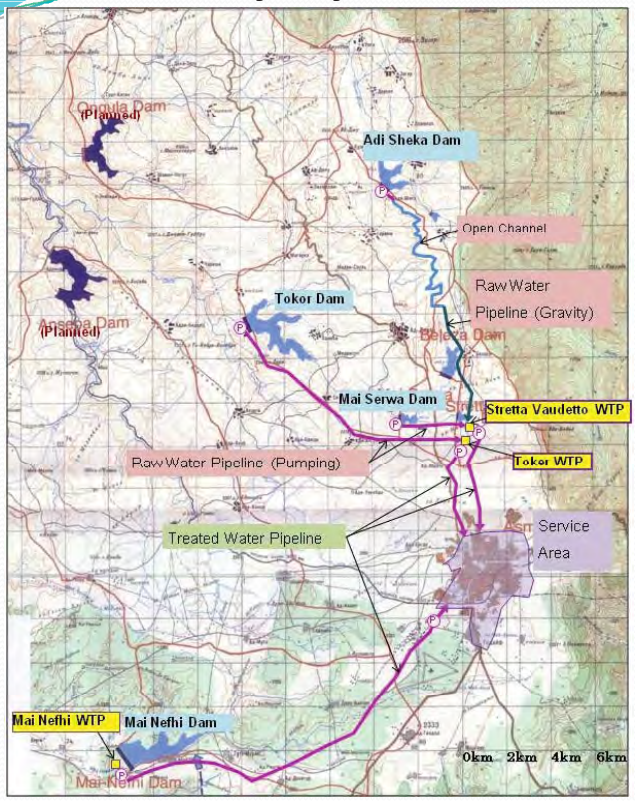
Shortage of transportation facility and construction machinery for proper O&M works of water supply works.

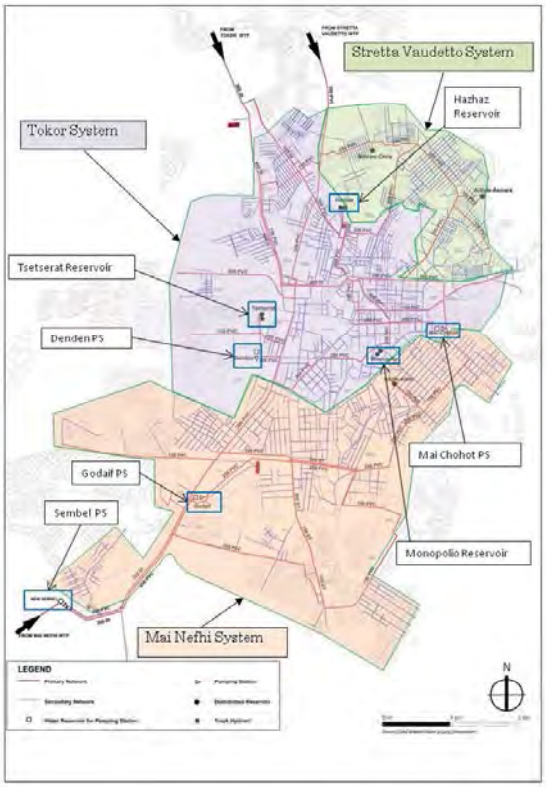
2. Operational Condition of AWSD
2.2 Revenue and Expenditure

	2012		2013		2014	
Revenue	(Thousand Nakfa)	%	(Thousand Nakfa)	%	(Thousand Nakfa)	%
Water (Domestic)	17,971	35	23,154	31	20,693	24
Water (Non-domestic)	21,175	41	12,678	17	11,665	14
Water sold to water truck	5,017	10	5,377	7	4,183	5
Others(Connection Fee, Penalty, etc.)	7,388	14	33,608	45	44,744	52
Subsidy, etc.	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 Tokor pump station	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
Others	579	0.5	2,304	5	3,835	7
Total	53,963	100	43,000	100	53,655	100

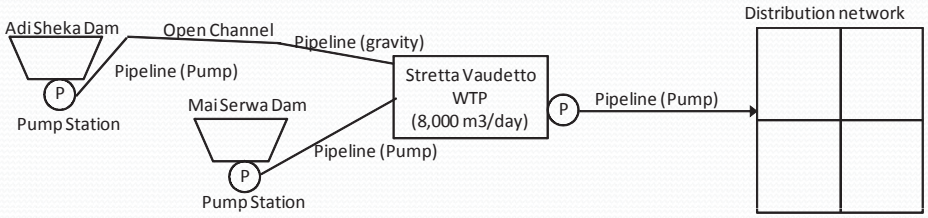
- The fuel cost of Tokor PS is a huge financial burden.
- In 2013 and 2014, large amount of penalty for late payment was paid. In 2014, many new connection were installed. That's why the revenue exceed the expenditure in 2013 and 2014.
- Water tariff has not been changed since November 2003.

3. Facility Condition of AWSD
3.1 Facility Layout



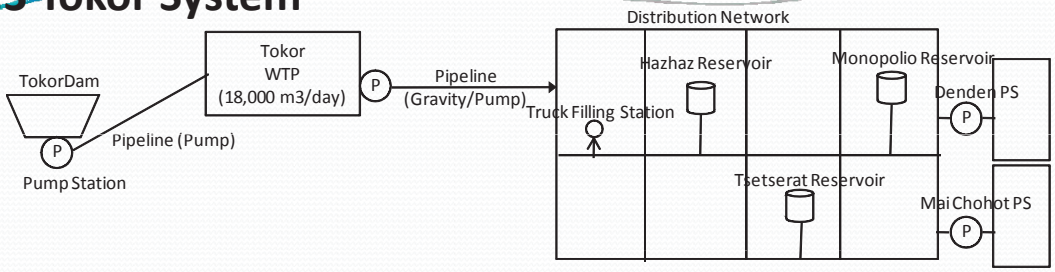


3. Facility Condition of AWSD
3.2 Stretta Vaudetto System



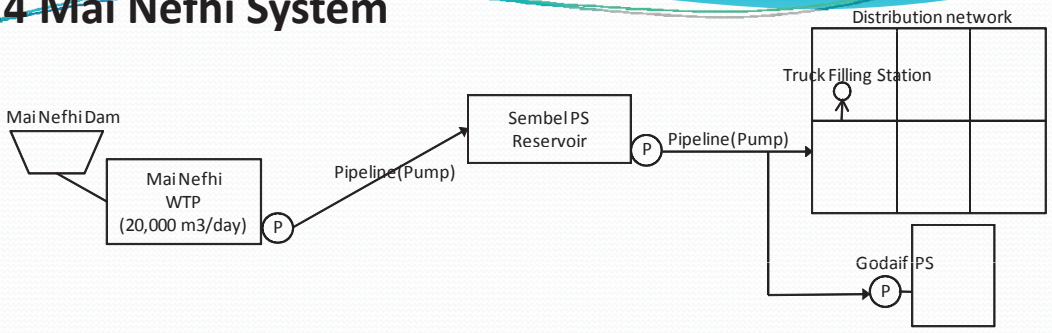
Facility	Present Condition/Problems
Raw water transmission pump station at Adi Sheka Dam	One pump including control panel is deteriorated. Instrumentation facility deteriorated.
Raw water transmission channel and pipeline from Stretta Vaudetto WTP	The soil enters into the open channel due to heavy rainfall every year. Six tunnels are deteriorated. Several concrete lining peeled off. There remains 2 km of deteriorated asbestos cement concrete pipe.
Raw water transmission pump station at Mai Serwa Dam	All facilities of pump station are heavily deteriorated.
Raw water transmission pipeline to Stretta Vaudetto WTP	The pipeline are of deteriorated asbestos cement concrete pipe.
Stretta Vaudetto WTP	All facilities are heavily deteriorated. The appropriate treatment is not being done. The current capacity is half of design capacity.
Treated water transmission pump station at Stretta Vaudetto WTP	The pump station is inside the WTP and is heavily deteriorated. One pump has been replaced recently.
Treated water transmission pipeline to the distribution network	The pipeline has been replaced from asbestos pipe to PVC pipe. Exact valve information is not available.
Distribution reservoir	There is no reservoir. (Old steel reservoirs were abolished.)
Distribution primary network	The pipeline has been replaced to PVC pipe, since 1997. Exact valve information is not available.
Distribution secondary network	There remains approx. 900m of deteriorated GI pipe

3. Facility Condition of AWSD
3.3 Tokor System



Facility	Present Condition/Problems
Raw water transmission pump station at Tokor Dam	The pump is currently of diesel engine driven. Due to deterioration and huge fuel consumption of the engine, the pump operation hour is limited to 10 hours/day. Thus, the WTP cannot produce design amount of treated water (18,000 m3/day). AWSD has a plan for electrification of the pump station. But the schedule is not determined.
Raw water transmission pipeline to Tokor WTP	No particular problems
Tokor WTP	All system are manually operated since 2007. The chlorinator has been broken down. The chlorine gas is being directly injected to clear water reservoir from the gas bombe.
Treated water transmission pump	No particular problems
Treated water transmission pipeline to the distribution network	No particular problems
Distribution Reservoir	Existing three reservoirs are all deteriorated. All piping are deteriorated. There are leakages from concrete tank. It is difficult to stop leakages by repairing.
Distribution primary network	The pipeline has been replaced to PVC pipe, since 1997. Exact valve information is not available.
Distribution secondary network	There remains approx. 1,100m of deteriorated GI pipe.

3. Facility Condition of AWSD
3.4 Mai Nefhi System



Facility	Present Condition/Problems
Mai Nefhi WTP	Coagulation & Sedimentation facility is broken. Also, chemical dosing facility is broken. The appropriate treatment is not being done.
Treated water transmission pump station	The pumps need replacement of pump impellor to restore the design capacity. Instrumentation and anti-water hammer facility are broken.
Treated water transmission pipeline to Sembel PS	The pipeline is of deteriorated steel pipe which was laid more than 40 years ago. The leakage from the pipeline occurs every year. The leakage may not be managed by the current temporally expedient measures, for the future. A pipeline to the newly constructed reservoir will be branched from this transmission pipeline. The water allocation measure need to be established.
Sembel pump station	The chlorine injection facility is broken.
Distribution reservoir	New distribution reservoir (1,600 m3) was constructed at sembel area.
Distribution primary network	The pipeline has been replaced to PVC pipe, since 1997. Exact valve information is not available.
Distribution secondary network	There remains approx. 1,200m of deteriorated GI pipe.

4. Water Demand and Water Balance
4.1 Water Demand

	2015 Potential Demand	2020 Demand Projection	2025 Demand Projection
Conditions/Assumptions			
Population in Service Area	434,329	446,744	459,513
AWSD service ratio	98 %	98 %	98 %
Piped water	80 %	82 %	84 %
Water truck	18 %	16 %	14 %
Served population (piped water)	348,628	364,557	386,285
Served population (water truck)	77,797	75,026	65,359
Per capita consumption (piped water)	50 l/c/d	50 l/c/d	50 l/c/d
Per capita consumption (water truck)	15 l/c/d	15 l/c/d	15 l/c/d
Water Consumption			
Domestic (piped water) (m3/day)	16,506	17,347	18,356
Domestic (water truck) (m3/day)	1,566	1,508	1,402
Non-domestic(piped water) (m3/day)	4,511	4,723	4,998
Non-domestic (water truck) (m3/day)	411	431	456
Total consumption (m3/day)	23,054	24,009	25,212
Water Demand			
Water loss rate (%)	33%	33%	32%
Total Water Demand (m3/day)	**34,409**	**35,834**	**37,076**

- Population in 2020 and 2025 was estimated based on the annual growth rate between 2008 and 2015 (0.57 %/year).
- Water loss rate on the condition that the water is always filled in the pipeline, was assumed to be 33 %, referring to the Feasibility study report in 2006.

4. Water Demand and Water Balance

4.2 Water Balance

		2015 Potential Demand	2020 Demand Projection	2025 Demand Projection
Stretta Vaudetto System				
Water Demand (m3/day)	(A)	5,627	5,816	6,456
2014 Actual supply (m3/day)	(B)	2,073		
Balance	(B)/(A)	0.37		
Supply Capacity (after rehabilitation) (m3/day)	(C)		8,000	8,000
Balance	(C)/(A)		1.38	1.24
Tokor System				
Water Demand (m3/day)	(A)	15,498	16,189	16,409
2014 Actual supply (m3/day)	(B)	7,508		
Balance	(B)/(A)	0.48		
Supply Capacity (after rehabilitation) (m3/day)	(C)		16,040	16,040
Balance	(C)/(A)		0.99	0.98
Mai Nefhi System				
Water Demand (m3/day)	(A)	13,287	13,829	14,211
2014 Actual supply (m3/day)	(B)	8,665		
Balance	(B)/(A)	0.65		
Supply Capacity (after rehabilitation) (m3/day)	(C)		17,360	17,360
Balance	(C)/(A)		1.26	1.22

- The actual supply in 2014 falls far below the potential demand.
- The supply capacity of Tokor system will be limited to the estimated source capacity (16,040 m3/day) The water demand after 2020 is estimated to exceed the source capacity.
- The supply capacity of Mai Nefhi system will be limited to the estimated source capacity (17,360 m3/day)

Appendix 4.

2) Presentation Material in the Second Field Survey ②

Preparatory Survey on the Project for Asmara Water Supply Development

Water Supply Facilities / Operation and Maintenance

by Koji Yoshikawa, JICA Study Team

Outline of field survey results and analysis：

1. **Available quantity of water taken from each dam.**
2. **Current state of each Water Treatment Plant (W.T.P).**
3. **Current state of operation and maintenance (O&M) in each facility**
4. **Problems of O&M in AWSD**

1

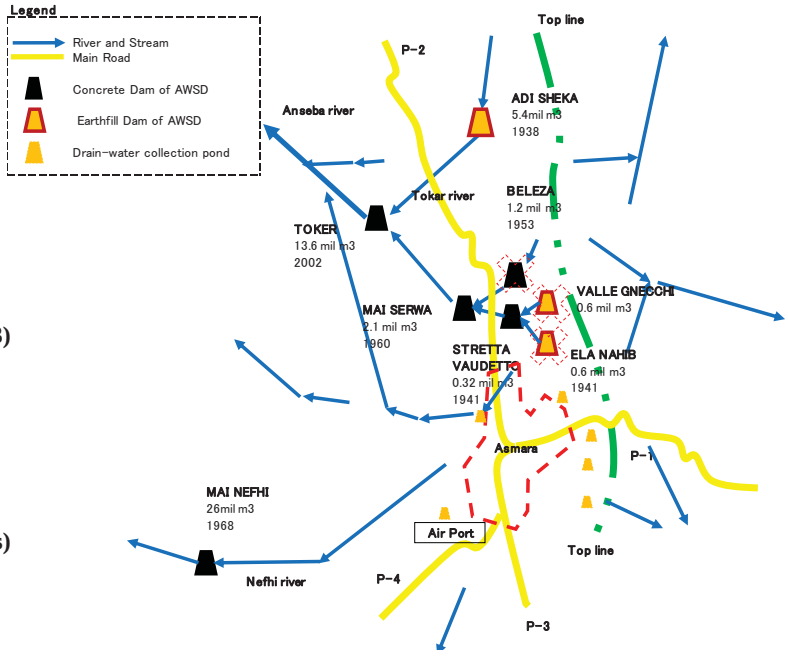
1. Available quantity of water taken from each dam.

1-1. Existing Dams

1. **TOKER (13,000,000m3)**
2. **ADI SHEKA (5,400,000m3)**
3. **MAI SERWA (2,100,000m3)**
4. **STRETTA VAUDETTO (320,000m3)**
5. **BELEZA (1,200,000m3)**
6. **VALLE GNECCHI (600,000m3)**
7. **ELA NAHIB (600,000m3)**
8. **MAI NEFHI (26,000,000m3)**

5nos Dams - Running (Red letters)

3nos Dams - No Running (Black letters)



2

1-2. Principal Terms of Calculation

- **Average annual rainfall is 419 mm**

  Data; Monthly rainfall for 22 years (1992 -2014) at Asmara meteorological station

- **Catchment area**

Valle Gnecchi	3.0km2	Stretta Vaudetto	9.0km2	Mai Serwa	8.8km2	Toker	69.6km2
Ela Nahib	4.3km2	Beleza	6.1km2	Adi Sheka	37.3km2	Mai Nefhi	94.5km2

- **Evaporation coefficient is 4.0㎜/day**

  Reference from 「Sunridge Gold Corporation Asmara Project Hydrometeorology report 12,2

- **Runoff coefficient is 0.21 (Mai Nefhi 0.19)**

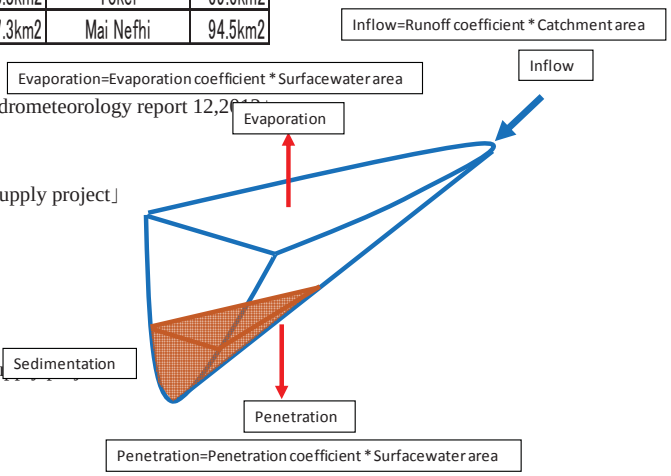
  Reference from 「Technical memorandum in Toker river water supply project」

- **Penetration coefficient (Inference)**

  Concrete Dam is 1mm/day, Earth Dam is 4mm/day

- **Sedimentation is 470m3/km2/year**

  Reference from 「Technical memorandum in Toker river water su



3

1-3. Result of Available quantity of water taken from each dam

W.T.P Group	Dam's Name	Potential quantity of water intaken (m3/day)	Available quantity of water intaken (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 mm, the available quantity of water intaken is below the design quantity of water intaken.
Mai Nefhi W.T.P	Mai Nefhi	17,360	**17,360**	

The best plan is to take water from 2 dams of Mai Serwa and Adi Sheka by reason of the various factors for Stretta Vaudetto W.T.P.

The available quantity of water is inferred 8,770m3/ day.

Therefore, 8,000m3/ day is proper for Stretta Vaudetto W.T.P (Design capacity 8,000m3/day).

16,000m3/ day is proper for Toker W.T.P (Design capacity 18,000m3/day).

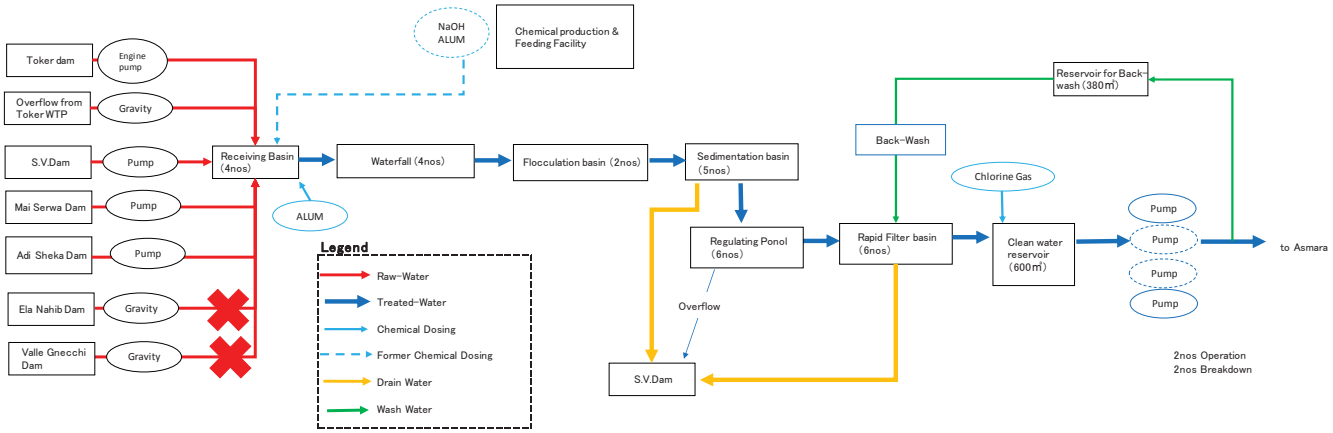
18,000m3/ day is proper for Mai Nefhi W.T.P (Design capacity 20,000m3/day).

4

2. Current state of each Water Treatment Plant (W.T.P).

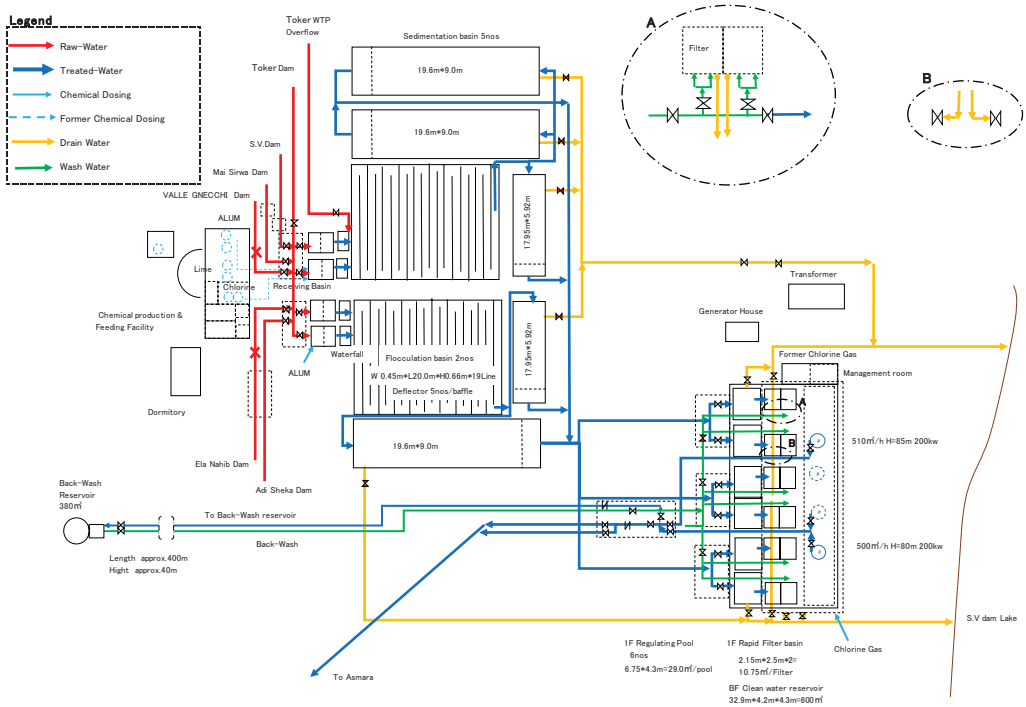
2-1. Stretta Vaudetto W.T.P (8,000m3/day)

- **Current Flow of Stretta Vaudetto W.T.P**



5

- **Schematic Drawing of Stretta Vaudetto W.T.P**



6

・Current state of Stretta Vaudetto W.T.P

・The chemical mixing and injection equipment are out of order for a long time. Therefore appropriate water treatment is not done at all.

・Solid alum is sporadically dosed into the receiving well directly without adjusting its concentration.

・The chlorinator is out of order for a long time. And chlorine gas is injected directly into the clear water reservoir by the rubber tube.

・Several deflectors in the flocculation basin are corroded.

・Sludge in the sedimentation basin is not discharged because the sludge discharge pipe is laid the easier slope. Several sludge valves are inoperable.

・Back-wash isn't done effectively so that there are thick sludge on the filter beds. Therefore the filter beds have break through cracks and holes.

・Water of approximately 1 m3/hours is leaking at the clear water reservoir.

・Land subsidence of approximately 5 cm is confirmed at the building of filtration and clear water reservoir.

・Most of valves are deteriorated due to old age.

・The water conveyance pump at Adi Sheka stops for 2 months in the rainy season because much soil inflow into the open channel.

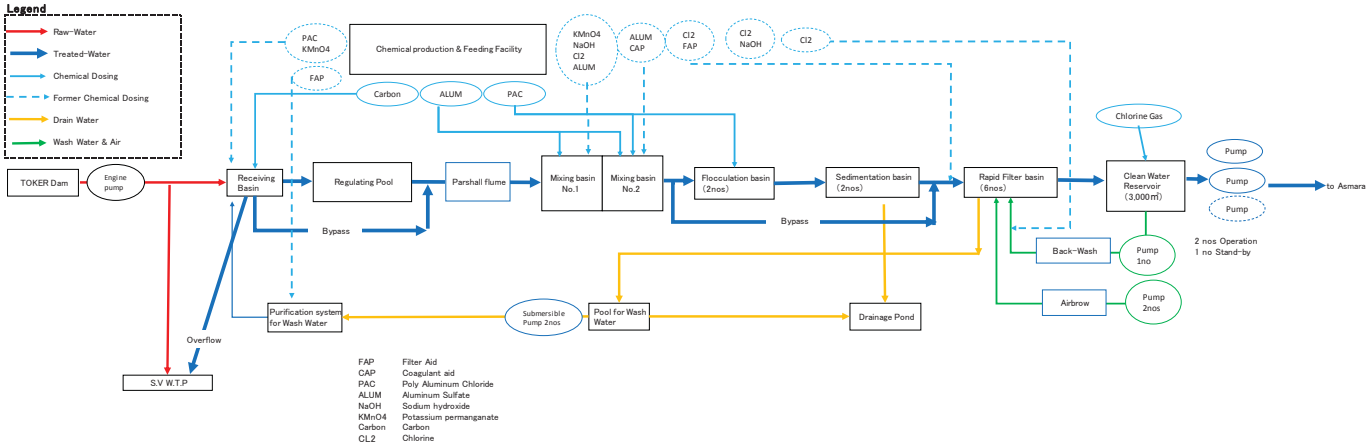
・A total coliform bacteria and fecal coliform bacteria are detected.

・Two transmission pumps are deteriorated due to old age.

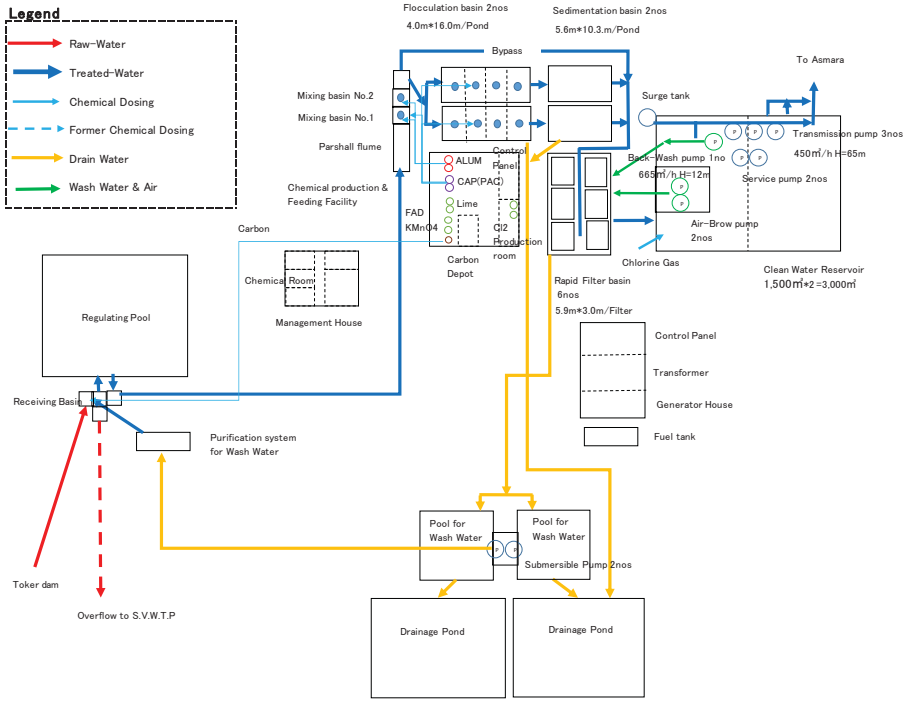
・The transmission pump (500m3/h) is operated only about 10 hours/day because of a blackout.

2-2. Toker W.T.P (18,000m3/day)

・Current Flow of Toker W.T.P



・Schematic Drawing of Toker W.T.P



9

・Current state of Toker W.T.P

・W.T.P is 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 present.

・In case of a electric power cut, solid alum is dosed into the mixing basin directly.

・A total coliform bacteria is detected.

・A Sodium hypochlorite generation apparatus was out of order in 2009, and chlorine gas is injected directly into the clean water reservoir without a chlorinator by the rubber tube.

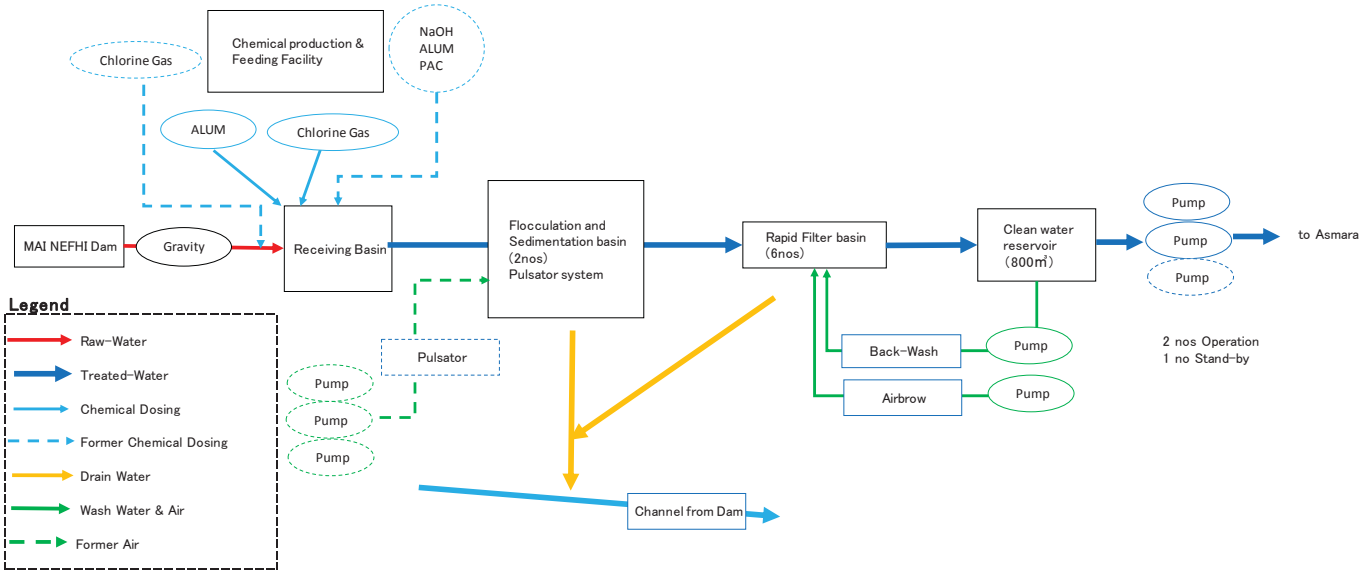
・Only the water of 9,900m3/day (990m3/hour ×10 hours) is supplied to the W.T.P from Toker dam in spite of the design capacity of 18,000m3/ day due to deterioration and huge fuel consumption of the engine

・Jar test is not practiced.

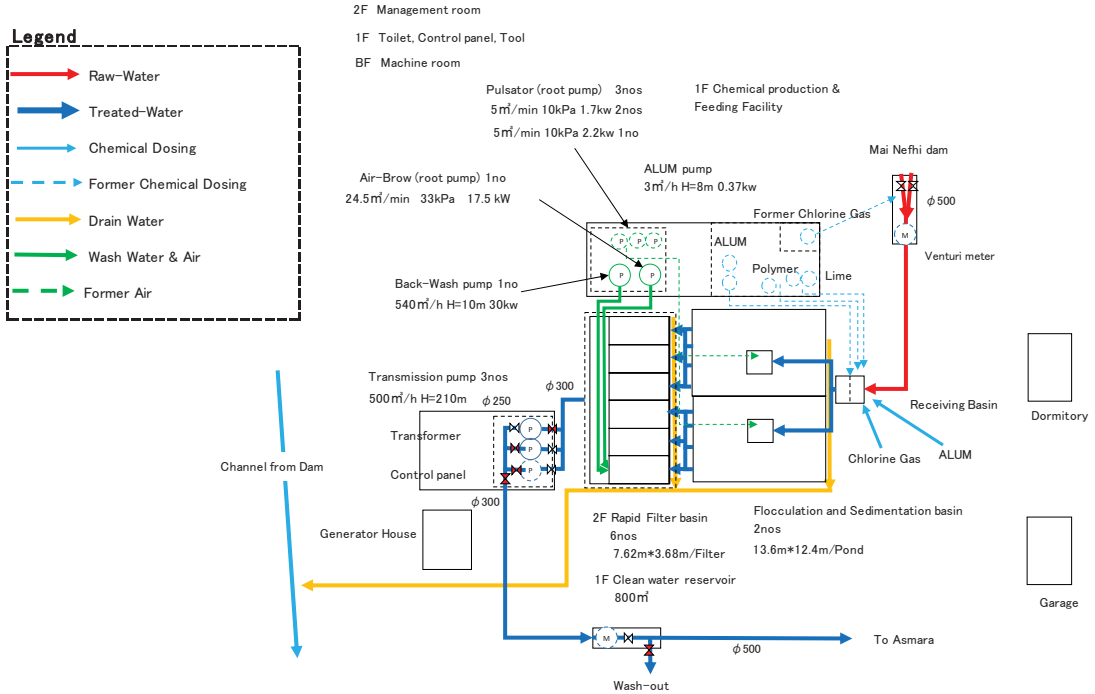
10

2-3. Mai Nefhi W.T.P (18,000m3/day)

・Current Flow of Mai Nefhi W.T.P



・Schematic Drawing of Mai Nefhi W.T.P



・Current state of Mai Nefhi W.T.P

・After the chemicals (alum and lime) mixing, the chemicals injection and the pulsator pumps were out of order more than 20 years ago, France donated the equipment of the chemicals (alum, lime and polymer) production and the chemicals injection equipment and the pulsator pump in 2000. But those were out of order 1 year later.

・Solid alum is sporadically dosed into the receiving well directly without adjusting its concentration.

・The chlorinator is out of order for a long time. And chlorine gas is injected directly into the receiving well by the rubber tube.

・The Pulsator isn't functioning because of the failure of vacuum pumps.

・Most of equipment at the vacuum tower are out of order for corrosion.

・Water is leaking at the link channel between Pulsators and filters.

・The crack valve, the partialization box and the clogging indicator(pressure) in each filtration basin are out of order.

・Most of valves are deteriorated due to old age.

・Water is leaking at the transmission pumps and the valves.

・The water quality is satisfied with the national water quality standard.

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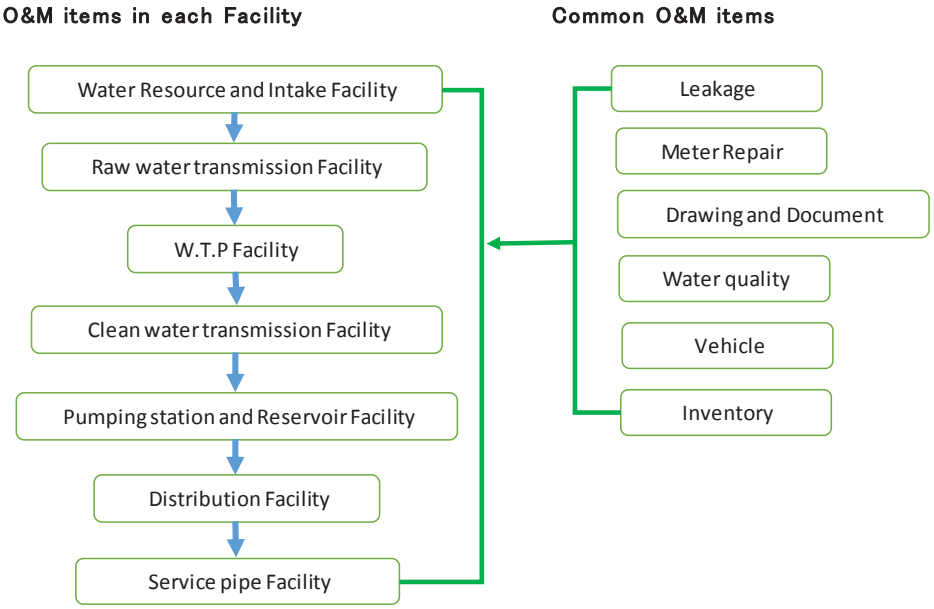
3. Current state of O&M in each facility

3-1. Flow chart of O&M in each facility



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3-2. Current state of O&M in each facility

a) Water source and Intake Facilities

- There isn‘t an engineer for managing the O&M of each water resources and dam.
- There are no vehicles to manage each water source and intake facilities.
- There aren't any young and middle-aged workers (Average age is 50 - 60).
- The preservation of water source isn't managed.
- A daily record about checking, repairing and operating isn't kept.
- There isn’t a water level indicator.
- There is no water meter to manage the outflow at each intake facility.
- There is no water quality equipment (turbidity, pH, electrical conductivity etc.) at each dam.
- Spare parts aren't purchased timely.

15

b) W.T.P Facilities

- No one understands the current state of O&M in 3 W.T.Ps at AWSD.

（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.
- There aren't any young and middle-aged workers (Average age is 50 - 60).
- A daily record about checking, repairing and operating isn't arranged.
- There isn't any equipment and staff for chemical dosing test.
- There are no water meters to manage the inflow and outflow at the W.T.Ps.
- There is no water quality equipment at the W.T.Ps.
- Spare parts aren't purchased timely.

16

c) Raw water and treated water transmission and distribution（Inc. Pumping stations and Reservoirs）

・No one understands the current state of O&M each pipeline and pumping station and reservoir at AWSD.

(There isn't an engineer for managing the O&M of each pipeline and pumping station and reservoir.)

・There are no vehicles to manage the pipeline.

・There aren't any young and middle-aged workers (Average age is 50 - 60).

・A daily record about checking, repairing and operating isn't kept.

But, AWSD has managed the water leakage repairing record.

・The mechanician who repairs a pump doesn't have enough technical capacity.

・There are no water meters to manage the inflow and outflow at each pumping station and reservoir.

・Spare parts aren't purchased timely.

・A repair of water leakage is behind schedule due to shortage of construction vehicles and repair machines and tools.

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d) Water Leakage

・AWSD has only worked to handle a lot of current complaints, and can't do other work.

・There aren't any young and middle-aged workers (Average age is 50 - 60).

・Spare parts aren't purchased timely.

・Most of repair of pipe clogging are left.

・There is no leak detection equipment, and there are no staff.

・A repair of water leakage is behind schedule due to shortage of construction vehicles and repair machines and tools.

e) Meter Repair

・AWSD has repaired the water meter to the customer complaints by using the meter checking machine.

・There are no water meters in the warehouse. For that reason there are a lot of remaining works of new connection and meter repair.

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f) Drawing and Document

・AWSD are not kept any past drawings and documents completely.

（Most of past drawings and documents are lost.）

・There are few staff who can operate CAD.

・The pipeline drawing of transmission and distribution pipelines isn’t managed.

（There are no staffs who manage and correct the CAD drawing ）

g) Water quality

・There isn't a water quality laboratory in AWSD.

・There is no water quality equipment in AWSD.

・There are no engineers of water quality test in AWSD.

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h) Vehicle and Machine

・There aren’t the construction vehicles sufficiently.

・There aren’t the vehicles to manage sufficiently.

・There aren’t the tools and the repair machines sufficiently.

・The mechanician which repairs the vehicle doesn't have enough technical capacity.

i) Inventory

・Inventory is managing correctly.

・Spare parts aren’t purchased timely.

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4. Problems of O&M in AWSD

- **Shortage of human resources**
  - Young and middle-aged workers
  - Engineers for O&M
  - Staff of water quality test
  - Staff of chemical dosing test
- **Capacity development**

- Staff of water quality test.
- Staff of chemical dosing test.
- Pump machanician.
- Staff of CAD operation.

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- **Purchase of spare parts timely.**
  - **Arrangement of daily record at each facility about checking, repairing and operating etc.**
  - **Update of pipeline drawing (Inc. Valve etc.) by CAD.**
- **Management of past drawings and documents.**
- **Measurement of inflow and outflow at required facilities.**
- **Implementation of water quality test at required facilities.**
  - **Shortage of construction vehicles and machines and tools.**
  - **Shortage of vehicles to manage.**
- **Electric power cut.**

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Appendix 4.

3) Calculation for Available Intake Water Amount from Each Dam

4. Reference

4.3. Calculation for available quantity of water intake from each dam

(1) Amount of rainfall

The scatter chart of annual amount of rainfall from 1903 to 2014 is indicated in figure-1.

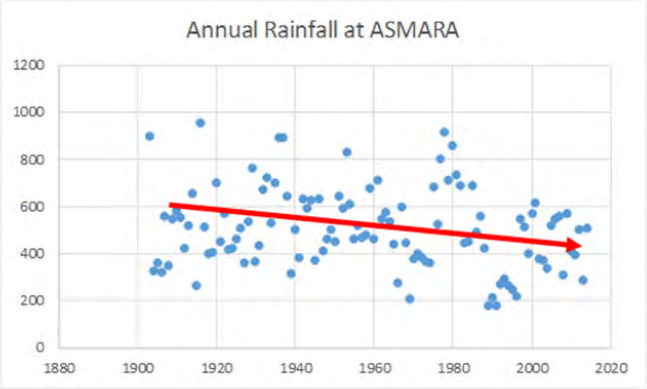


Figure-1: Scatter chart of annual amount of rainfall from 1903 to 2014

The variation in climate is big in Asmara, but a downward trend of rainfall is seen every year. It was estimated at 500mm/ year in around 1980, but it can be estimated at 400mm/ year in recent years. The annual and monthly amount of rainfall at Asmara airport meteorological station is indicated in table-1 and figure-2.

Table-1: Annual and monthly amount of rainfall at Asmara airport meteorological station

Unit: mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1992	0.0	0.0	4.8	5.8	0.0	38.6	103.6	102.4	0.0	12.0	0.3	0.0	267.5
1993	0.0	3.8	56.4	39.2	31.5	0.0	86.5	42.3	5.7	25.9	0.0	0.0	291.3
1994	0.0	0.0	2.8	23.4	36.2	7.8	67.4	100.1	19.6	6.2	0.0	0.0	263.5
1995	0.0	0.0	0.0	64.5	22.2	0.0	127.6	26.2	7.2	0.0	0.0	0.0	247.7
1996	1.8	0.0	15.7	25.6	31.9	21.5	57.4	20.3	0.1	0.0	44.5	0.0	218.8
1997	0.0	0.0	9.6	5.2	57.2	22.8	226.7	78.3	0.0	119.0	31.6	0.0	550.4
1998	0.0	0.0	68.5	40.4	1.4	0.0	159.5	236.9	1.2	5.0	0.0	0.0	512.9
1999	28.0	0.0	0.0	28.2	2.8	21.6	199.3	109.5	6.7	0.9	2.2	0.8	400.0
2000	0.0	0.0	3.9	96.4	15.8	32.2	258.1	108.3	19.1	26.8	12.2	0.0	572.8
2001	0.0	0.0	9.2	38.5	21.0	76.2	206.1	253.2	4.9	2.2	0.0	6.5	617.8
2002	0.0	0.0	0.0	11.8	13.5	28.6	88.9	178.9	44.6	0.0	8.7	0.0	375.0
2003	0.0	15.0	3.9	11.7	38.9	12.7	140.9	145.9	0.0	0.0	0.0	0.0	369.0
2004	0.0	25.7	0.0	61.4	18.8	25.7	75.3	107.7	13.8	11.6	0.0	0.0	340.0
2005	0.0	0.0	49.7	39.2	35.0	22.6	212.4	154.6	6.0	0.0	0.0	0.0	519.5
2006	0.0	0.0	10.6	99.4	37.5	6.5	151.2	116.0	110.3	1.9	14.8	2.2	550.4
2007	0.0	0.0	0.0	28.3	45.1	38.5	224.4	158.8	51.5	11.0	0.0	0.2	557.8
2008	1.0	0.0	0.0	86.6	27.1	45.1	24.6	102.3	21.3	0.0	0.3	0.2	308.5
2009	0.0	6.9	3.2	23.6	18.5	0.0	311.2	187.9	0.0	7.8	11.8	0.0	570.9
2010	9.3	0.0	25.1	23.0	34.6	0.8	129.8	178.7	11.5	0.0	0.0	0.0	412.8
2011	0.0	0.0	25.0	34.8	10.2	23.3	94.1	202.8	0.0	0.0	1.8	0.0	392.0
2012	0.0	0.0	0.0	23.2	26.7	36.4	230.2	170.3	17.0	0.0	0.0	0.0	503.8
2013	0	0	4.2	67	46	60.7	40.4	44.9	18.6	3.1	4.2	0	289.1
2014	0	0	33.6	49.8	37.1	15.8	121.8	161.8	54.8	26.5	7.7	0	508.9
AVE	**1.7**	**2.2**	**14.2**	**40.3**	**26.5**	**23.4**	**145.1**	**129.9**	**18.0**	**11.3**	**6.1**	**0.4**	**419.1**

There is a lot of amount of rainfall of July and August every year. The annual average rainfall from 1992 to 2014 will be 419mm. In addition, the year of 300mm/ year comes in five years interval. The special year was 289 mm/year in 2013. It was fresh in the memory of the AWSD

staff, and the water level went down to a remainder of 5m at the lowest intake gate (No.5 gate) at Toker dam.

The pump capacity was designed as the average annual rainfall 500mm at the time of dam construction. From this, each coefficient in the calculation of the quantity of water intake from each dam is inferred.

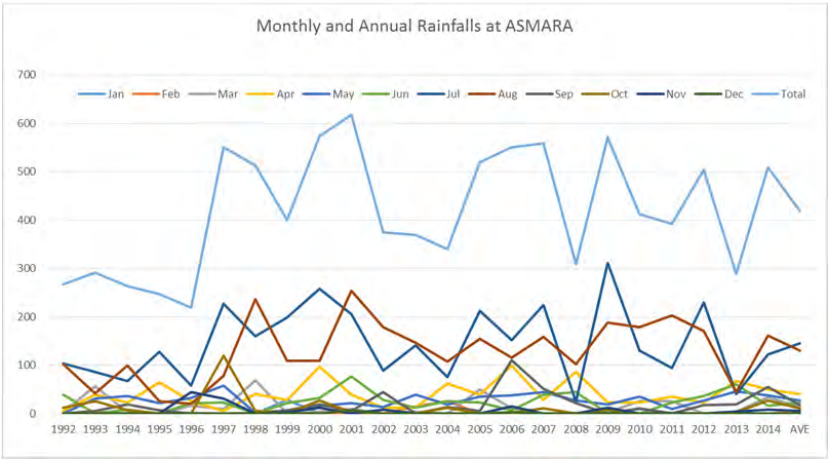


Figure-2: Annual and monthly amount of rainfall at Asmara airport meteorological station

The average monthly and annual rainfall from 1992 to 2014 is used as the calculation of the available quantity of water intake from each dam. In addition, the rainfall data of 2013 is used as the lowest rainfall for 10 years.

(2) Location of each dam

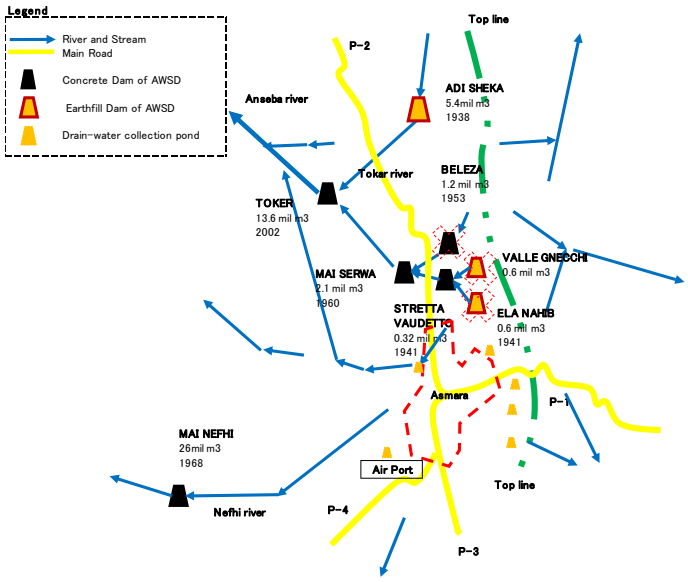


Figure-3: Location map of each dam

(3) Condition of sedimentary soil in each dam

Table-2: Condition of sedimentary soil in each dam

Dam Name	Construction Year	Gross storage capacity (m3)	Sedimentary soil (m3)	Ratio of Sedimentary soil for Gross storage capacity	Effective storage capacity (m3)
Valle Gnecchi	1941	600,000	104,340	17%	496,000
Ela Nahib	1941	600,000	149,554	25%	450,000
Stretta Vaudetto	1941	320,000	194,666	61%	125,000
Beleza	1953	1,200,000	177,754	15%	1,022,000
Mai Serwa	1960	2,100,000	315,446	15%	1,785,000
Adi Sheka	1938	5,400,000	1,349,887	25%	4,050,000
Toker	2002	13,000,000	425,256	3%	12,575,000
Mai Nefhi	1968	26,000,000	2,087,505	8%	23,912,000
Total		**49,220,000**			**44,503,000**

The annual sedimentary soil is inferred 470m3/km2/year in “Technical memorandum of Toker river water supply project”. In addition, the annual sedimentary soil in the S.V dam is inferred 292m3/km2/year from the reason that the water overflows every year in the rainy season due to the small storage capacity of the dam. Thus, the sedimentary soil from the S.V dam is deposited into the Mai Serwa dam in the downstream.

The sedimentary soil is too much in S.Vdam and should be dredged or excavated in the dry season. However, this is not a big problem because the overflowed water is stored up in the Mai Serwa dam which has a big water storage capacity in the downstream.

In addition, it's necessary to repair the clogged sludge pipe in Mai Nefhi and Mai Serwa dams, and to discharge the sedimentary soil periodically.

(4) Available quantity of water intake from each dam

The basic concept of available quantity of water intake is indicated in Figure-4.

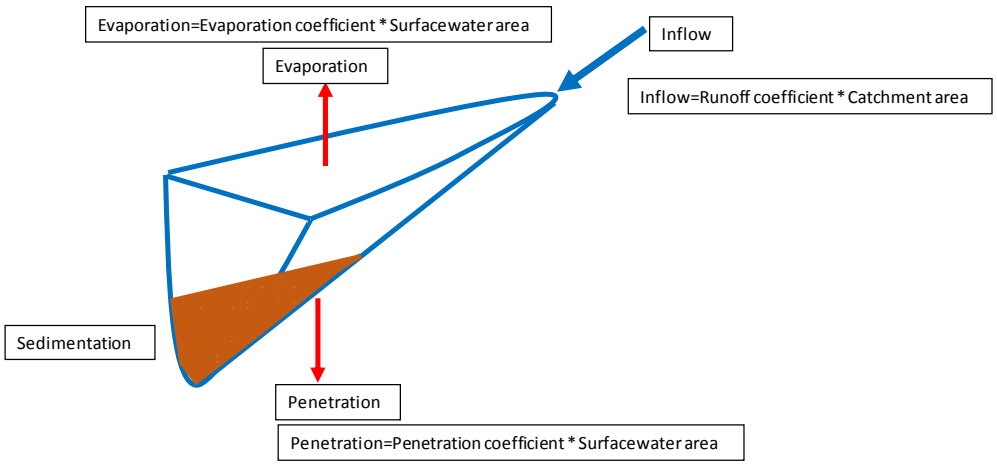


Figure-4: Basic concept of available quantity of water intake

In addition, the important factors in this calculation are runoff coef. (Outflow coefficient) and monthly rainfall.

a) Calculation of each factor

・Evaporation coefficient

The evaporation coefficient is the average of 3.2-5.5mm/day in “Sunridge Gold Corporation Asmara Project Hydrometeorology report Dec, 2012” and is adopted 4.0mm/day in this calculation.

・Runoff coefficient

Mai Nefhi dam

The runoff coefficient is stated 0.19 in “Technical memorandum of Toker river water supply project”. And 0.19 is adopted in this calculation because the storage capacity which is calculated by using 0.19 and the capacity of existing pump are approximately the same.

Toker dam

The average runoff coefficient is inferred at 0.21 because the river flow quantity is more than 7,480,000m3/ in “Technical memorandum of Toker river water supply project”.

Other dams

0.21 is inferred by the reason that the calculation that the existing pump is operated for 22 hours per day in the average annual rainfall of 500 mm.

・Penetration coefficient

The penetration coefficient is inferred at 1mm/day in a concrete dam because the dam and bedrock are adhered together.

And the penetration coefficient is 4mm/day in an earth-fill dam because the dam is built on bedrock.

b) Available quantity of water intake from each dam

Table-3: Available quantity of water intake from each dam
in lowest annual rainfall (in 2013) 289.1mm

Dam Name	Dam								Raw-Water Transmission			Water Treatment Plant				
	Various factors or elements			Annual					Operation time	Possible quantity of water take from dam in case of considering monthly rainfall		W.T.P Name	Possible quantity of water take from dam in case of considering monthly rainfall (m3/d)		Design treatment capacity (m3/d)	Operation time
	Effective storage capacity (m3)	Catchment area (km2)	Water surface area (km2)	Average rainfall (mm)	Storage volume by rain (m3)	Loss volume by penetration (m3)	Loss volume by evaporation (m3)	Effective storage capacity (m3)	Plan (h)	(m3/h)	(m3/d)		Existing operation facilities only	Inc. non-operation facilities		Plan (h)
VALLE GNECCHI	496,000	3.0	0.08	289	200,404	116,800	116,800	0	22	0	0	S.V WTP	5,130	5,350	8,000	22
										Gravity	non-operation					
ELA NAHIB	450,000	4.3	0.15	289	295,316	219,000	219,000	0	22	0	0					
										Gravity	non-operation					
Stretta Vaudetto	125,000	9.0	0.13	289	576,090	47,450	189,800	57,071	22	9	200					
							Overflow	281,769	1.2 hours operation of 1 no raw-water pump (180m3/h)							Max 22 hours oparation in case of back-wash etc
BELEZA	1,022,000	6.1	0.18	289	411,447	65,700	262,800	82,947	22	10	220					
											EEC使用					
Mai Serwa	1,785,000	8.8	0.18	289	575,367	65,700	262,800	246,867	22	63	1,390					
				In case of considering overflow from S.V dam				528,636	7.0 hours operation of 1 no raw-water pump (200m3/h)							
Adi Sheka	4,050,000	37.3	0.36	289	2,346,740	525,600	525,600	1,295,540	22	161	3,540					
									7.9 hours operation of 1 no raw-water pump (450m3/h)							
Toker	12,575,000	69.6	0.18	289	4,266,596	65,700	262,800	3,938,096	22	490	10,780	Toker WTP	10,780	10,780	18,000	22
									10.9 hours operation of 1 no raw-water pump (990m3/h)							
Mai Nefhi	23,912,000	94.5	0.80	289	5,378,127	292,000	1,168,000	3,918,127	22	487	10,710	Mai Nefhi WTP	10,710	10,710	20,000	22
									10.7 hours operation of 2 nos treated-water pump							
Total	**44,415,000**							**9,737,470**					**26,620**	**26,840**	**46,000**	

There are 3 dams (Beleza (EEC use), Mai Serwa and Adi Sheka dam) only where the water intake is possible through a year in the S.V W.T.P system. The total quantity of water intake 5,350m3/day is less than the design treatment capacity 8,000m3/day of existing S.V W.T.P.

In addition, the quantity of water intake 10,780m3/day from the Toker dam.is less than the design treatment capacity 18,000m3/day of Toker W.T.P.

Furthermore, the quantity of water intake 10,710m3/day from the Mai Nefhi dam is less than the design treatment capacity 20,000m3/day of the Mai Nefhi W.T.P.

At the time of 2013, it was able to supply water without a big problem because each dam has a big storage capacity and the water which was stored up in the last year or the year before last.

But when such a year continues for 2 years, there will be a serious water shortage.

Table-4: Available quantity of water intake from each dam
in average annual rainfall 419.1mm from 1903 to 2014

Dam Name	Dam								Raw-Water Transmission			Water Treatment Plant					
	Various factors or elements			Annual					Operation time	Possible quantity of water take from dam in case of considering monthly rainfall		W.T.P Name	Possible quantity of water take from dam in case of considering monthly rainfall (m3/d)			Design treatment capacity (m3/d)	Operation time
	Effective storage capacity (m3)	Catchment area (km2)	Water surface area (km2)	Average rainfall (mm)	Storage volume by rain (m3)	Loss volume by penetration (m3)	Loss volume by evaporation (m3)	Effective storage capacity (m3)	Plan (h)	(m3/h)	(m3/d)		Existing operation facilities only		Inc. non-operation facilities		Plan (h)
VALLE GNECCHI	496,000	3.0	0.08	419	290,520	116,800	116,800	56,920	22	7	150	S.V WTP	9,210	8,770	10,090	8,000	22
										Gravity	non-operation						
ELA NAHIB	450,000	4.3	0.15	419	428,111	219,000	219,000	-9,889	22	0	0						
										Gravity	non-operation						
Stretta Vaudetto	125,000	9.0	0.13	419	835,141	47,450	189,800	241,164	22	20	440						Max 22 hours oparation in case of back-wash etc
							Overflow	356,727	2.5 hours operation of 1 no raw-water pump (180m3/h)								
BELEZA	1,022,000	6.1	0.18	419	596,463	65,700	262,800	267,963	22	33	730						
											EEC使用						
Mai Serwa	1,785,000	8.8	0.18	419	834,093	65,700	262,800	505,593	22	107	2,350		Mai Serwa and Adi Sheka and S.V dams only	Mai Serwa and Adi Sheka dams only			
				In case of considering overflow from S.V dam				862,320	11.8 hours operation of 1 no raw-water pump (200m3/h)								
Adi Sheka	4,050,000	37.3	0.36	419	3,402,002	525,600	525,600	2,350,802	22	292	6,420						
									14.3 hours operation of 1 no raw-water pump (450m3/h)								
Toker	12,575,000	69.6	0.18	419	6,185,162	65,700	262,800	5,856,662	22	729	16,040	Toker WTP	16,040	16,040	16,040	18,000	22
									16.2 hours operation of 1 no raw-water pump (990m3/h)								
Mai Nefhi	23,912,000	94.5	0.80	419	7,796,517	292,000	1,168,000	6,336,517	22	789	17,360	Mai Nefhi WTP	17,360	17,360	17,360	20,000	22
									17.4 hours operation of 2 nos treated-water pump (500m3/h)								
Total	**44,415,000**							**15,647,465**					**42,610**	**42,170**	**43,490**	**46,000**	

There are 5 dams (Exc. Ela Nahib dam) where water intake is possible through the year in the S.V W.T.P system. But, the water intake from Valle Gnecchi dam should be refrained from usage as that the water is used for agriculture, the state of intake pipe line is unclear and the quantity of water intake is not too much.

And, the water intake from Beleza dam should be refrained from the reasons that EEC is using the water for cooling water to the generator and the quantity of water intake is not too much.

Furthermore, the water intake from the S.V dam should be refrained for the reasons that the sedimentary soil in the dam is too much and the quantity of water intake is not too much.

Therefore, the best plan is to take water from 2 dams which see the Mai Serwa and Adi Sheka dams for S.V W.T.P. The available quantity of water intake from the 2 dams is inferred to be 8,770m3/ day.

As a result, the design treatment capacity of 8,000m3/ day is proper for S.V. W.T.P and expansion of S.V W.T.P should be refrained from.

In addition, quantity of water intake 16,040m3/day from the Toker dam is less than the design treatment capacity of 18,000m3/day of Toker W.T.P.

Furthermore, the quantity of water intake 17,360m3/day from Mai Nefhi dam.is less than design treatment capacity of 20,000m3/day of Mai Nefhi W.T.P.

As a result, the quantity of water intake beyond the design treatment capacity should be refrained at 3 W.T.Ps.

Appendix 4.

4) Electric Power Condition

4. Reference

4.4. Electric power circumstance

(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, electricity production of up to 103MW is possible.

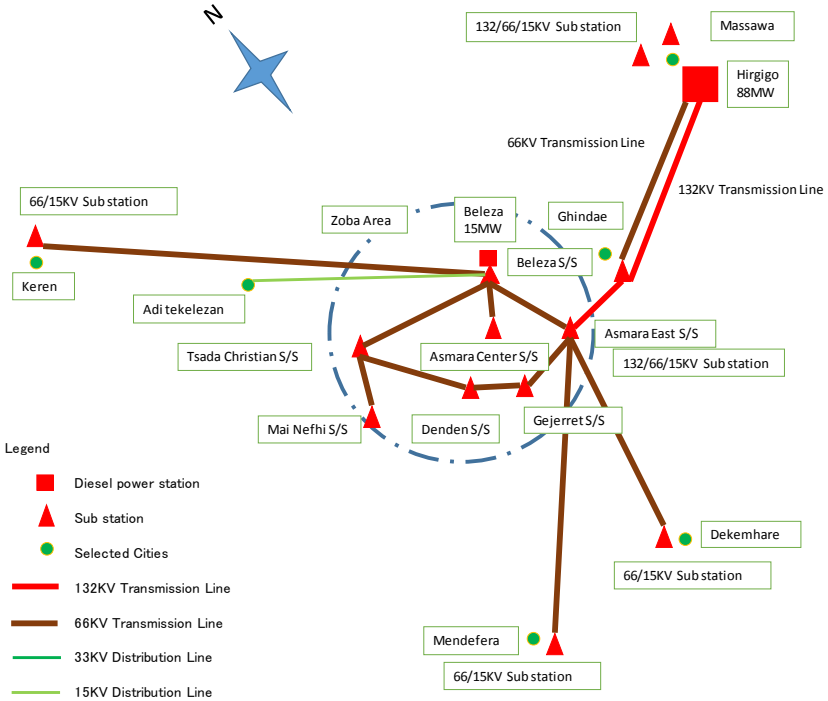


Figure-1: Power station and power transmission line for Asmara city

Electricity is transmitted to Gihindae substation in the Asmara city of 71km ahead with the power transmission line of 66KV and 132KV from Hirgigo substation, and it is transmitted to Asmara east substation with the power transmission line of 132kV in Asmara city. Then, it is transmitted to six substations in the Asmara city and Keren substation (90km) in northwestern Asmara, Dekemhare substation (35km) in southern Asmara and Mendefera substation (55km) in southwestern Asmara.

Currently, only 44MW is able to be generated at Hirgigo diesel power station because only two generators are being maintained among the four generators. Furthermore, only 5MW is able to be generated at Beleza diesel power station because the two generators are being maintained among the three generators. The quantity of current electricity demand is estimated to be 65-70MW, but only 49MW is being produced. Therefore, when the electric quantity

demanded exceeds the electric quantity supply, electricity stops accidentally or deliberately. But, the state is expected of electricity to become better than the current state 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 SFECO construction company (Chinese company) in early 2016, because EEC is thinking there will be more than 80 MW of electric demand in the future. Therefore, the electric production capacity will be 99MW (facility capacity 149MW) beyond 80 MW of future prediction of electricity demand.

In addition, a rehabilitation plan of the distribution line is planned by ABB (Construction Company) in the EU of EDF.

Electricity supplies 1MW to the cement factory in the Asmara city. The new cement plant has private power generation equipment.

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 in a difficult situation.

(2) Electric power circumstance in water supply facilities

There are 7 substations in central Zoba. The power transmission line circulates, and it is able to cover a lack even if some power transmission line or a transformer substation causes a problem.

The substation and the main water supply facilities in Asmara city are indicated in figure-2

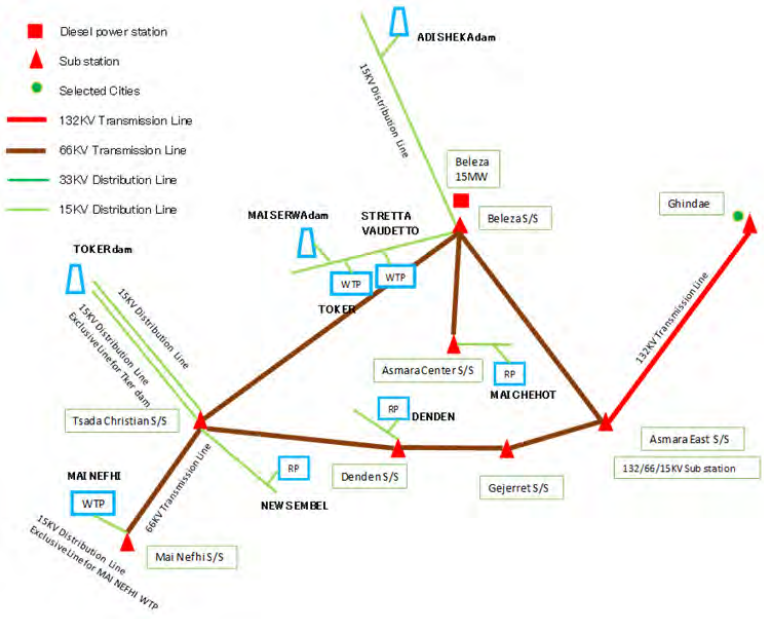


Figure-2: Substation and main water supply facilities in Asmara city

The exclusive distribution lines are drawn to Mai-Nefhi W.T.P and Toker dam. The other water supply facilities are drawn to the general power distribution lines so that electricity is delivered to each family. And the switch of general power distribution line at a substation turns off in the time of a power shortage. The exclusive distribution lines are operated at a substation, and electricity is supplied for 24 hours.

The operation time of the clear water pump in Mai Nefhi W.T.P is 18 hours per day according to the diary record. From this, the power line is the exclusive distribution line from Mai Nefhi substation, and Mai Nefhi W.T.P supplies electricity for 24 hours. However, electricity is not supplied to the New Sembel pumping station for 24 hours. Therefore it cannot supply water effectively. In other words, water supplies to the gravity area for 24hours, but only water supplies to the pump-up area for around 14 hours from the New Sembel pumping station, even if S.V W.T.P is operated for 24hours.

The operation time at S.V W.T.P is affected by the electricity situation of Adi Sheka Dam and Mai Serwa dam. Adi Sheka dam is at 12:00-24:00 operation and Mai Serwa dam is at 22:00-13:00 operation as of April, 2015. The same operation time is 3 hours between 12:00-13:00 and 22:00-24:00. In other words, Mai Serwa dam and the S.V W.T.P operate at the time due to the same power line, but Adi Sheka dam and the S.V W.T.P operate at the same time only for three hours. Therefore, the water treatment is not operated effectively.

The two power distribution lines are supplied to the direction of Toker dam in a row, and one is supplied to the villages on the way, and other is the exclusive distribution line for the raw water transmission pump at Toker dam. However, even if the pump is replaced from the existing engine pump to a motor pump in Toker dam and the operation time is changed from10 hours to 20 hours, water is not supplied for 24hours because electricity is not supplied for 24 hours to Toker W.T.P. Therefore, the exclusive distribution line is necessary for the Toke W.T.P.

In addition, it is possible to provide the one exclusive distribution line in 3 facilities (Mai Serwa dam, S.V W.T.P and Toker W.T.P) because 3 facilities are located in close by and big electricity is not necessary.

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, water supply for 24 hours in Asmara city is also possible under the current situation.

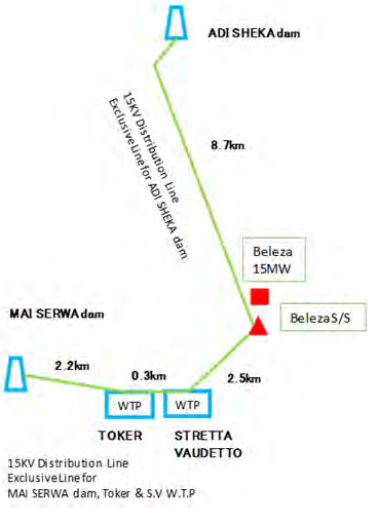


Figure-3: Exclusive distribution lines required in the future plan

The Minutes of EEC No,1

Preparatory Survey on Asmara Water Supply Development

（Water Supply Facilities / Operation and Maintenance）

Place：	Eritrean Electric corporation (ECC) in ASMARA
Date：	25 Mar,2015 (Wed) 14:30-
JICA side：	JICA; Mr. Oomura, Mr. Yamasaki, Mr. Tsurusaki, Consultant; Mr.Tamura, Mr. Yoshikawa
Eritrea side：	General Manager, ABRAHAM W. MICAEL

There are two systems as follows.

①Inter-connected (Integratied) system (ICS) 1 area in Eritrea (Asmara area)

②Self-Contained System (SCS) 5 areas in Eritrea

②SCS

SCS is operated in 5 cities (Assab 5.1MW, Adikeih 1.0MW, Akurdat 1.5MW, Barentu 1.5MW, Alebu 2.0MW).

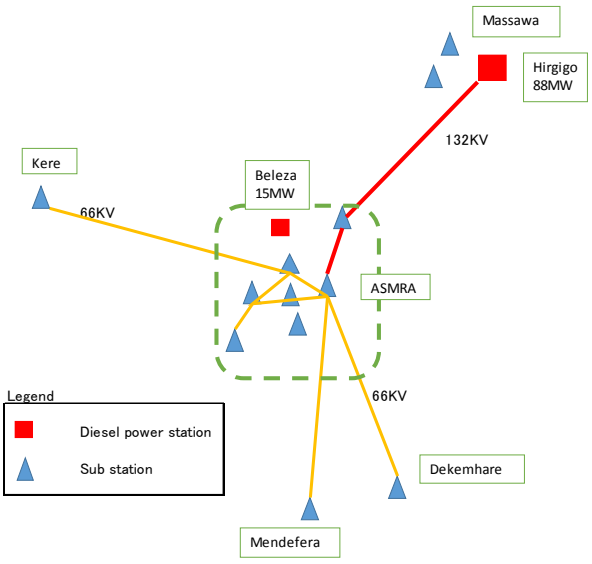
Every SCS is thermal power generation by diesel.

①ICS

There is the thermal power station with diesel at Hirgigo in Massawa, and there are four generators (22MW*4=88KW).

There is the thermal power station of the middle scale with diesel at Beleza in Asumara, and there are three generators (5MW*3=15K).

Therefore, it is possible to power production of 103MW.



The High-voltage transmission lines are two types of 132 and 66KV.

The High- voltage distribution lines are two types of 33 and 15KV.
The General distribution line is 400V.

Electricity is transmitted to Gihindae substation in the Asmara city of 71km ahead with a power transmission line of 66KV and 132KV from Hirgigo substation and it is transmitted to Asmara east substation with a power transmission line of 132kV in Asmara city. Then, it is transmitted to six substations in the Asmara city, Keren substation (90km) in northwestern Asmara, Dekemhare substation (35km) in southern Asmara and Mendefera substation (55km) in southwestern Asmara.
The total extension of 66KV transmission line is 320 ㎞.
Currently, only 44MW can generate electricity at Hirgigo diesel power station because two are maintaining among four generators. Furthermore, only 5MW can generate electricity at Beleza diesel power station because two are maintaining among three generators. The quantity of current electricity demand is estimated to be 65-70MW, but only 49MW is produced. Therefore, when the electric quantity demanded exceeds the electricity quantity supply, electricity stops accidentally or deliberately. But, the electric state is expected that it becomes better than the current state, because the maintenance of all generators is going to be finished by 2 or 3 months.
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 generating capacity will be 99MW (facility capacity 149MW) beyond 80 MW of future prediction demand.
In addition, the rehabilitation plan of the distribution line is planned at ABB (Construction Company) in the EU of EDF.
EEC is considering about geothermal power generation at Alia (Hirgigo south) and solar generation of electricity in the rural area.
Electricity supplies 1MW to the cement factory in the Asmara city.
The new cement plant is a private power generation equipment.
In addition, the power transmission line construction of 15KV to the Toker dam is finished.
In addition, there is the transmission line of 66KV to Mai Nefhi substation near Mai Nefhi dam.
Furthermore, electricity is supplied to Toker W.T.P and the S.V W.T.P from Beleza substation.

Documents:
Outline map of Existing thermal power plants and power grid system
The Eritrean Electric Corporation, General Information
The minutes of EEC No,2
Preparatory Survey on Asmara Water Supply Development
（Water Supply Facilities / Operation and Maintenance）

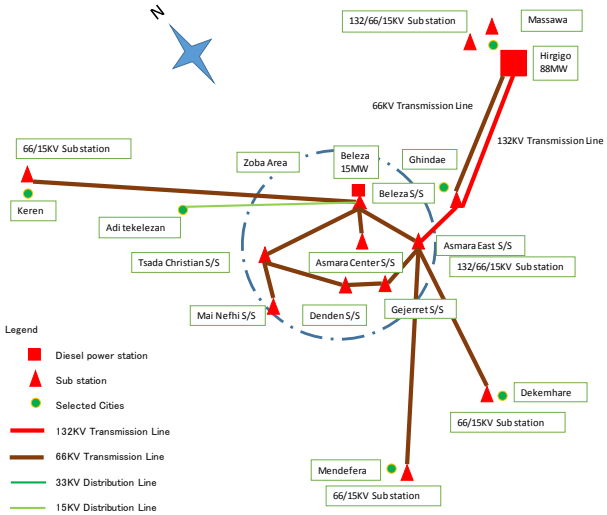
Place： Eritrean Electric corporation (ECC) (Asmara Center S/S)

Date： 21 Mar,2015 (Tue) 15:00-

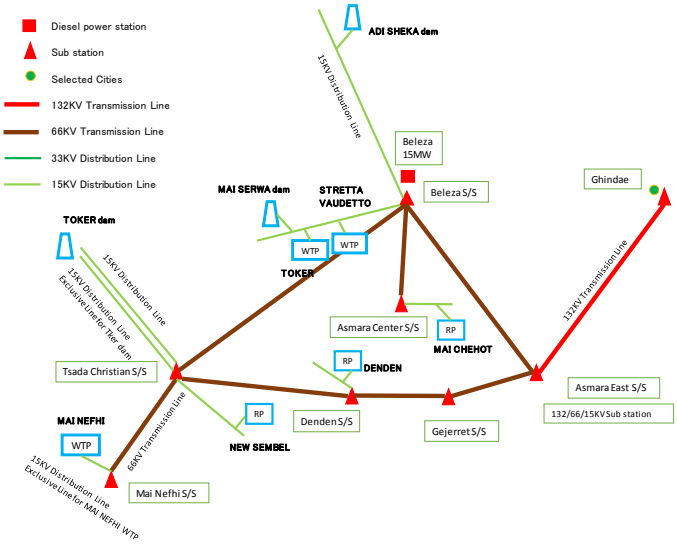
JICA side： JICA; Jica Expert Mr.Tsurusaki、Consultant; Mr. Yoshikawa

Eretria side： General Manager, ABRAHAM W. MICAEL

There are 7 substations in central zoba. The power transmission line circulates and becomes able to cover it even if some power transmission line or a transformer substation causes a problem.



The substation and main water supply facilities in Asmara city is indicated as follows.



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

The exclusive distribution line is operated at a substation and is made with a power supply system for 24 hours

However, the water supply system cannot function properly due to the power failure of city's pump stations.
If the exclusive distribution line only for the water supply system is done, EEC knows that it can supply water effectively.

The electric charge is shown as follows.
EEC also knows that the production cost and sales cost does not match, but EEC does not increases the electric charge from 2008.
The electric charge of the pump at Mai Nefhi WTP is sold the low price of Big Industries (75/76) because the pump capacity is big.
The other water facilities are the price of Small Industries (74).

Eritrean Electric Corporation
Existing Tariff as of May 10, 2008

Tariff Category		Unit Charge	Service Charge Nakfa/Month	
Code	Description	Nakfa/KWh	Single Phase	Three Phase
71	Domestic	2.52	10	20
72	General - Govement Offices - Non Govement Offices Shop, Restrants, Coffee House, Offices etc	3.25	15	41
73	Street Light	3.2	15	41
74	Small Industries - Workshop, Garages,Bakery etc - Other WTP, Pump station	2.6	-	82
75/76	Big Industries - Mai-Nefhi WTP	1.8	-	85

Documents:
Existing Tariff of Eritrean Electric Corporation

Appendix 4.

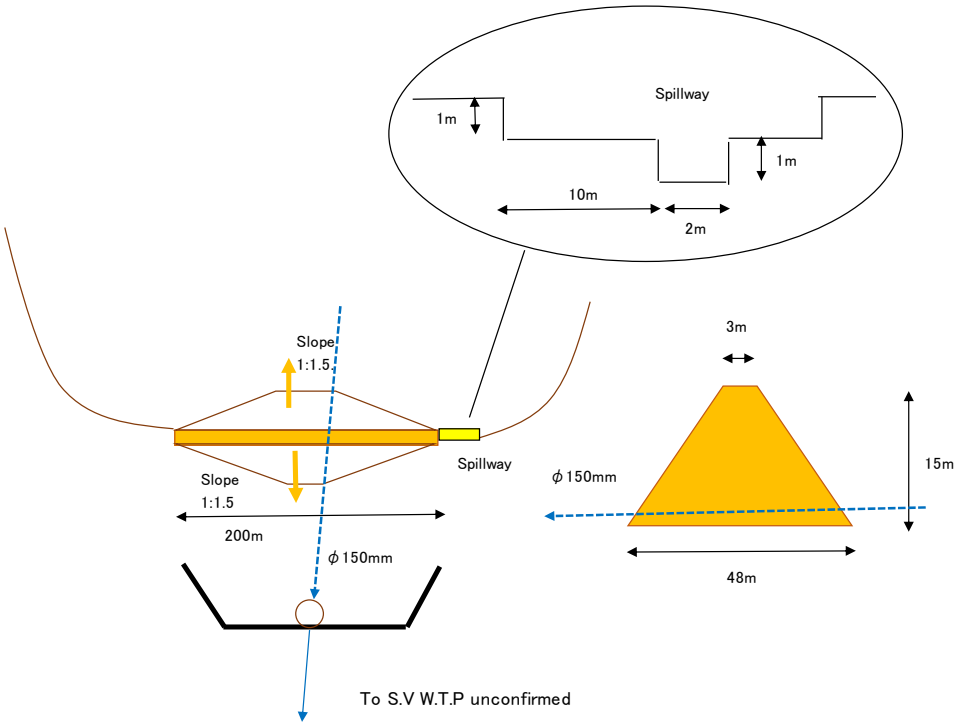
5) Schematic Drawings of each Dam and WTP

4. Reference

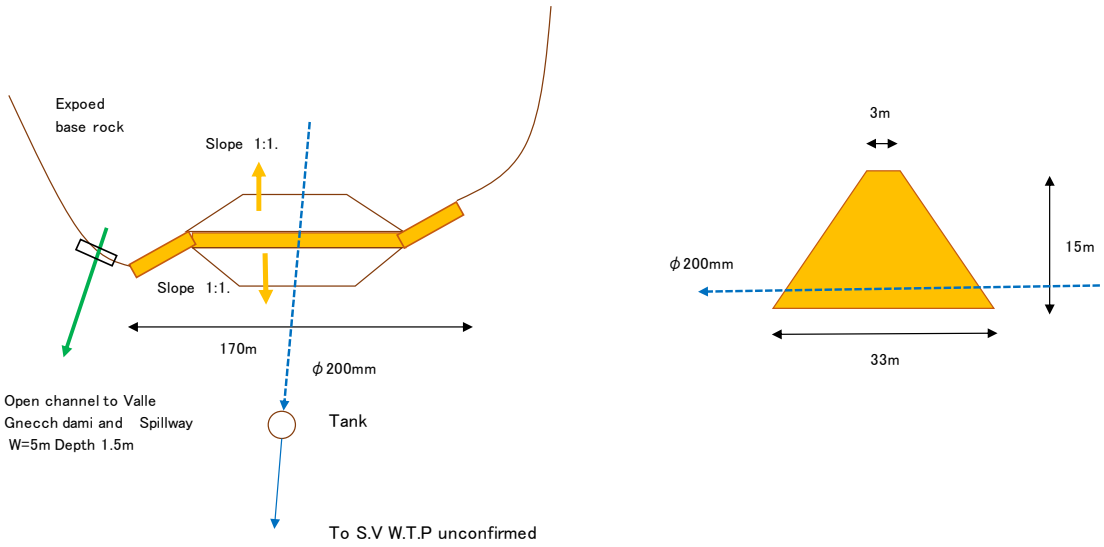
4.5. Schematic Drawing of each dam and W.T.P

（１）Schematic Drawing of each dam（Non-Scale）

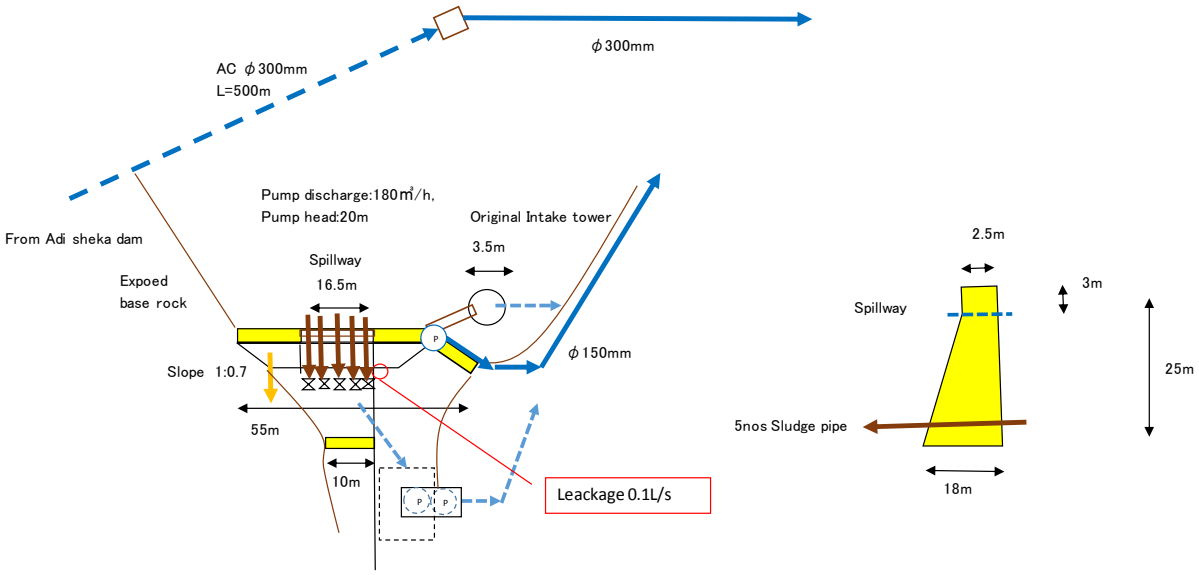
VALLE GNECCHI dam



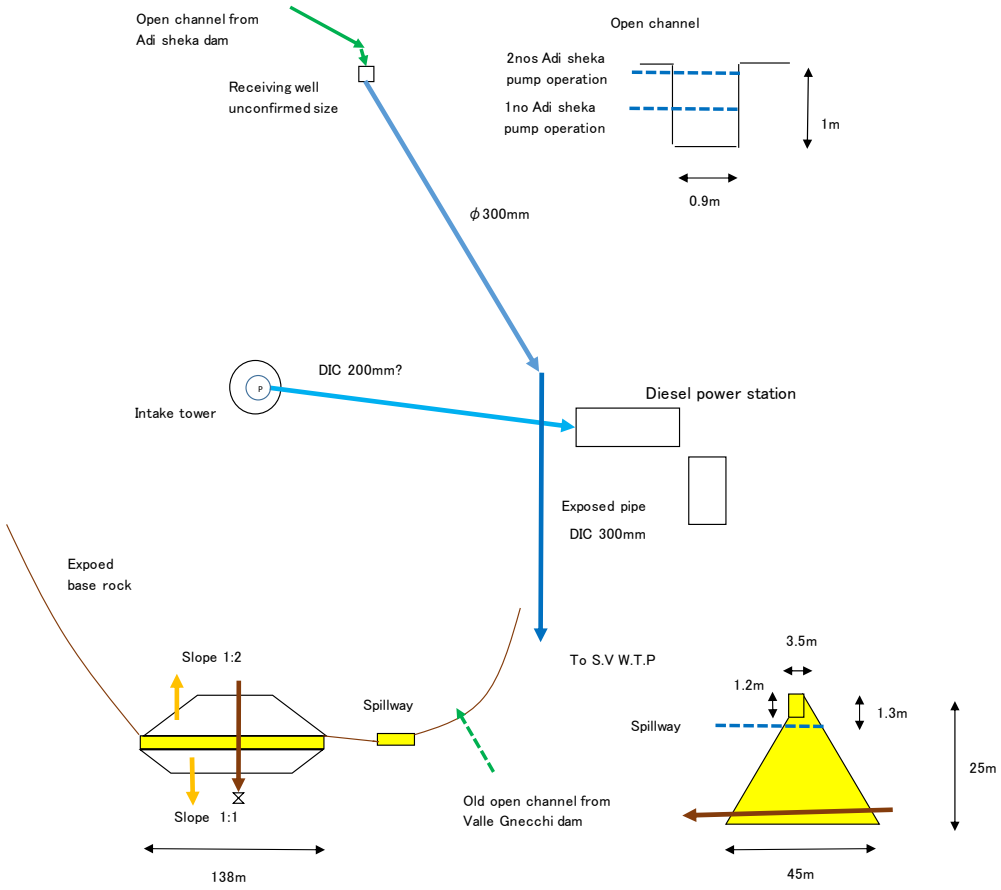
ELA NAHIB (Adi Nefas) dam



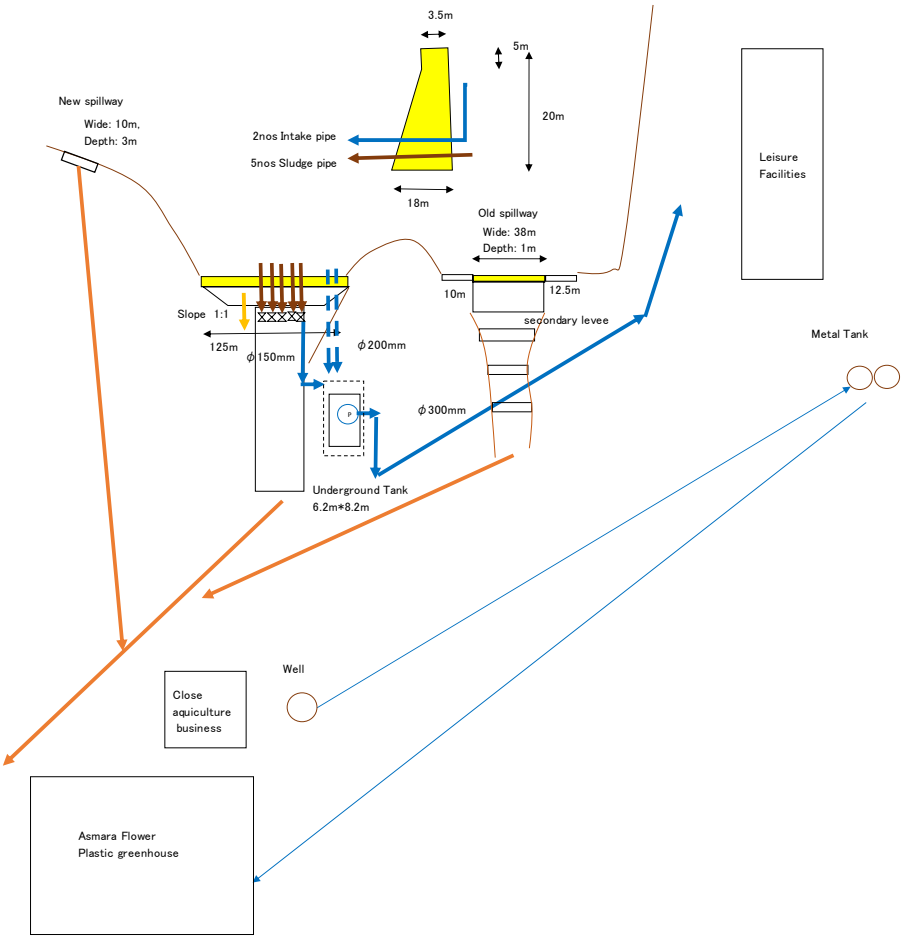
STRETTA VAUDETTO dam



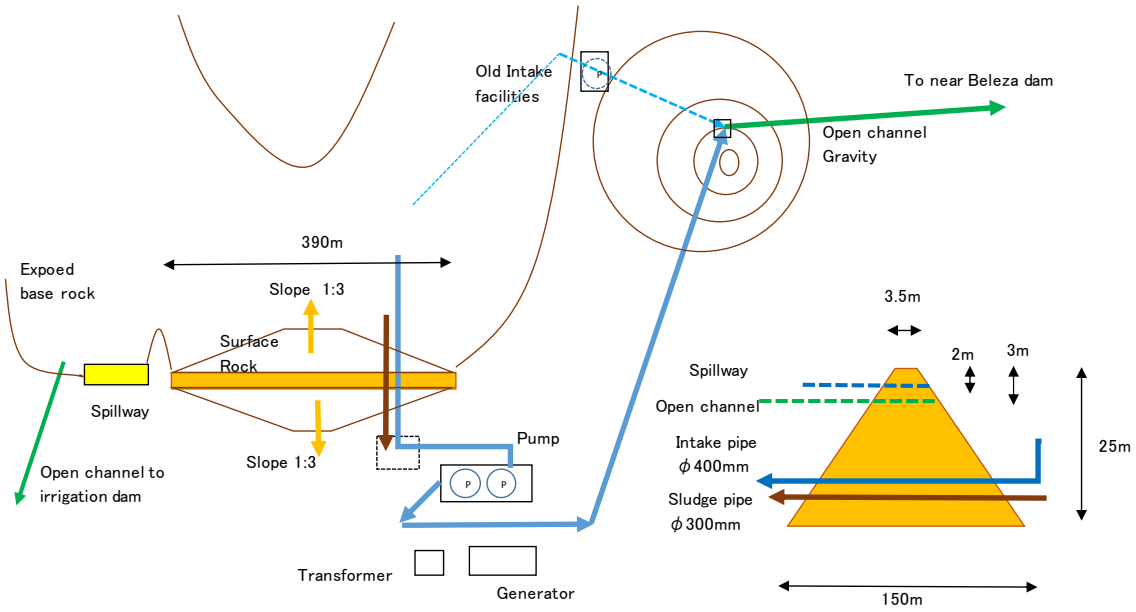
BELEZA dam



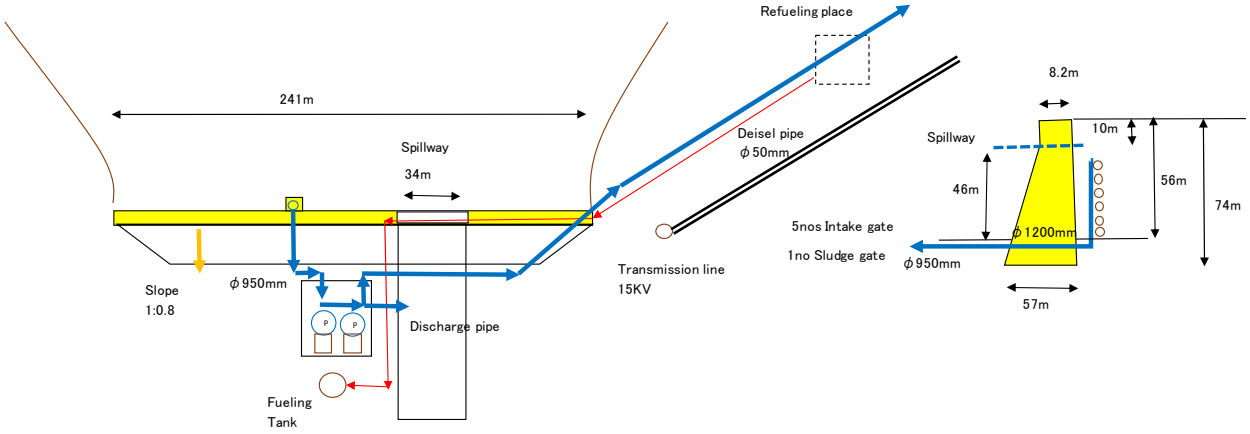
MAI SERWA dam



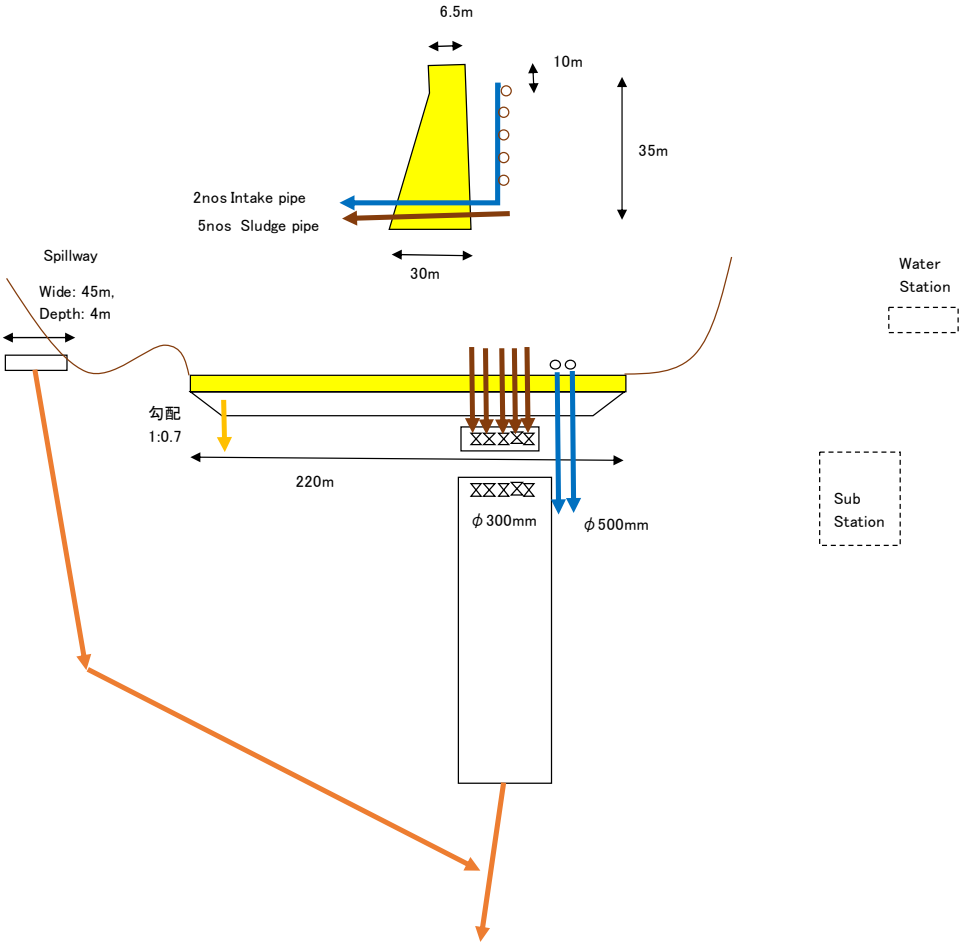
ADI SHEKA (Adi Sciana) dam



TOKER dam

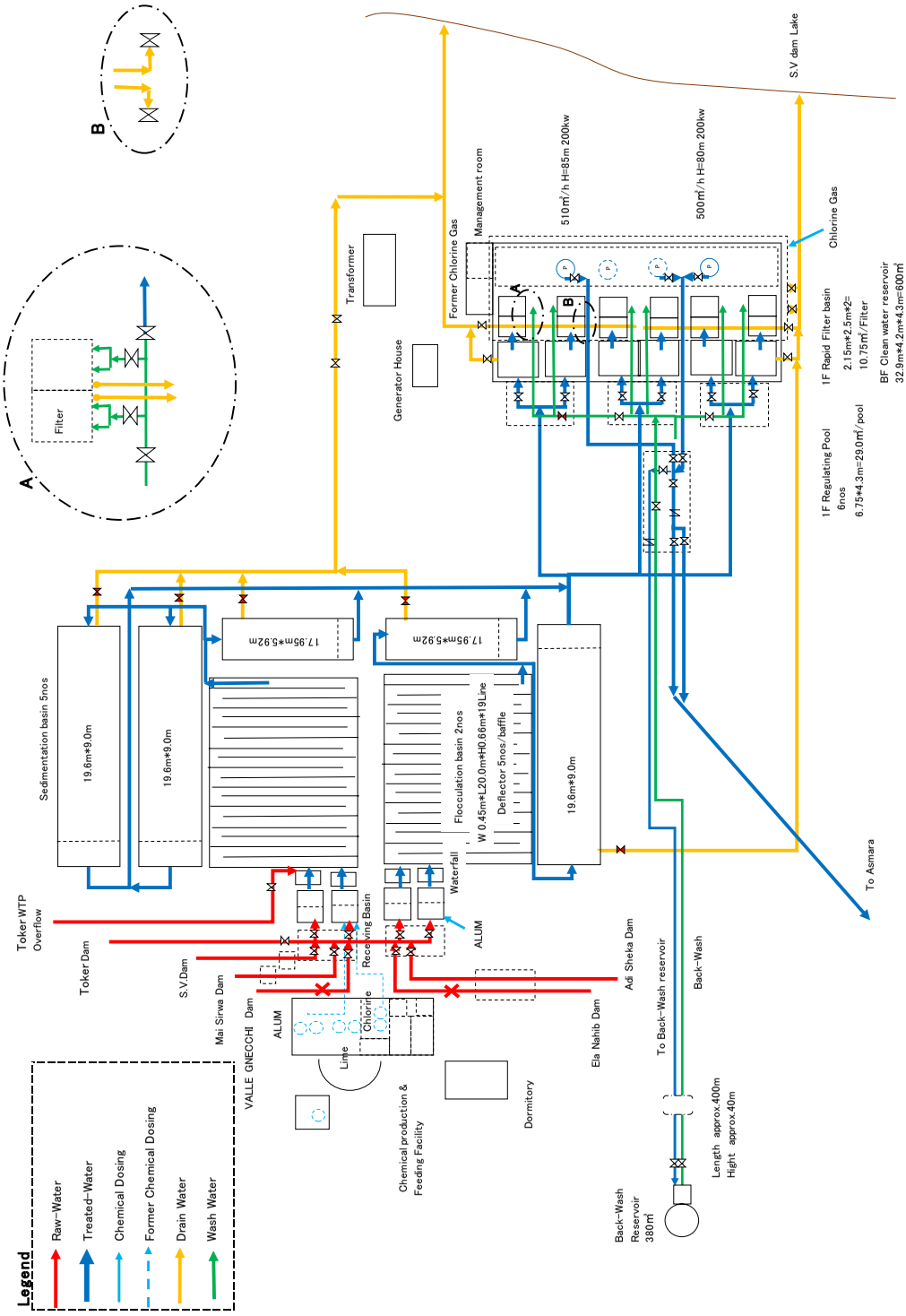


MAI NEFHI dam

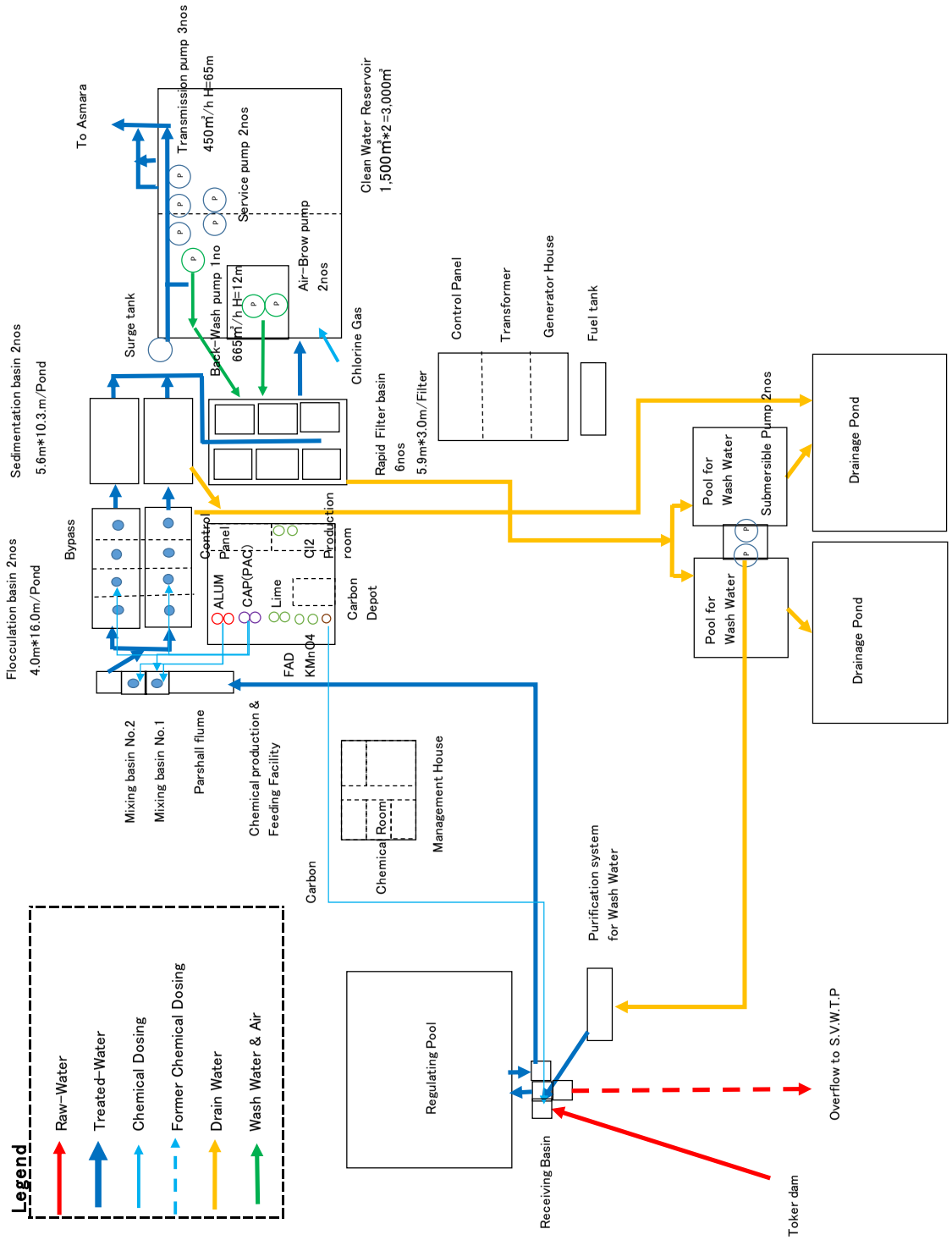


（２）Schematic Drawing of each W.T.P（Non-Scale）

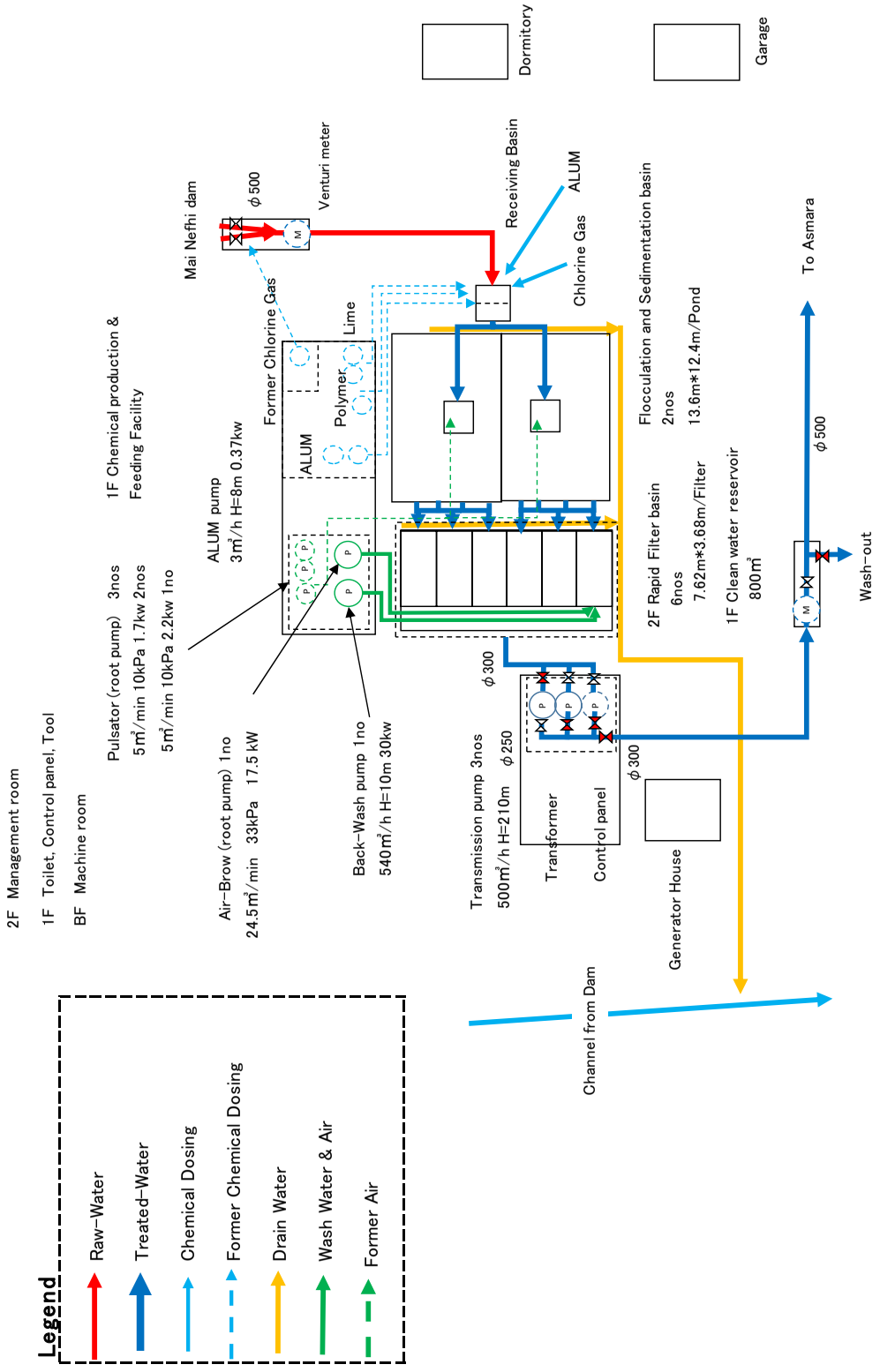
STRETTA VAUDETTO W.T.P



TOKER W.T.P


To Asmara
Transmission pump 3nos
450m³/h H=65m
Service pump 2nos
Clean Water Reservoir
1,500m³×2=3,000m³
Surge tank
Back-Wash pump 1no
665m³/h H=12m
Air-Brow pump
2nos
Chlorine Gas
Control Panel
Transformer
Generator House
Fuel tank
Sedimentation basin 2nos
5.6m*10.3.m./Pond
Rapid Filter basin
6nos
5.9m*3.0m/Filter
Flocculation basin 2nos
4.0m*16.0m/Pond
Bypass
Control Panel
ALUM
CAP(PAC)
Lime
Cl2
Production room
Carbon Depot
FAD
KMnO4
Pool for Wash Water
Submersible Pump 2nos
Drainage Pond
Pool for Wash Water
Drainage Pond
Mixing basin No.2
Mixing basin No.1
Parshall flume
Chemical production & Feeding Facility
Carbon
Chemical Room
Management House
Purification system for Wash Water
Regulating Pool
Receiving Basin
Overflow to S.V.W.T.P
Toker dam
Legend
Raw-Water
Treated-Water
Chemical Dosing
Former Chemical Dosing
Drain Water
Wash Water & Air

MAI NEFHI W.T.P



Appendix 4.

6) Water Demand Projection

2015 Potential Demand

Assumed Leakage (%) 33

ID	Area Name	Domestic (by Connection) (m3/day)	Domestic (by Truck) (m3/day)	Non-domestic (by Connection) (m3/day)	Non-domestic (by Truck) (m3/day)	Total Daily Consumption (m3/day)	Total Daily Production (m3/day)
1. Paradiso							
8	Paradiso	995		520		1,516	2,263
38	Bet Mekae TD	0		45		45	67
45	Adi Abeito village and TD	0		37		37	55
2. Maitemenai							
1	Mai Temenai	636		441		1,077	1,607
4	Mai Temenai TD	0	830	55	293	1,178	1,758
3. Edaga Hamus							
2	Haz Haz	262		35		297	443
6	Idaga Hamus and Emba Galliano	1,217		178		1,395	2,082
4. Akiria							
3	Mirham Chira and Acria	1,860		140		2,000	2,985
46	Adi Nefas village + TD	0		17		17	25
54	Mirham Chira extension	0		0		0	0
5. Abazhawl							
5	Aba Shaul	1,659		250		1,909	2,849
6. Arbate Asmara							
9	Medeber	124		15		140	208
10	Arbate Asmara	1,074		145		1,219	1,819
11	Geza Tanika	88		10		98	146
7. Tsetserat							
26	Bet Mekae	177		32		209	312
31	Space 2000 - II	68		0		68	102
34	Tsetserat + Forto Complex	81		15		97	144
36	Tsetserat D2	15		2		17	25
37	Adi Segdo TD	0		63		63	93
43	Adi Segdo village	47		16		63	94
8. Maekel Ketema							
14	Maekel Ketema North	463		55		518	772
15	Maekel Ketema West	345		83		428	639
16	Maekel Ketema South	373		44		418	623
17	Harnet	175		21		196	292
9. Tiravolo							
21	Tiravolo	623		111		734	1,095
28	Denden Housing	0		243		243	363
30	Space 2000 - I	66		23		89	132
10. Geza banda							
12	Forobia	74		8		82	122
13	Mai Chehot	546		63		609	909
18	Addis Alem	809		110		919	1,371
19	Zeban Zinkei and Halibet Complex	456		303		759	1,133
11. Sembel							
32	Sembel Village + Sembel III	403		269		672	1,002
35	Sembel high rise A	110		151		261	390
12. Godaif							
22	Barijima	150	735	22	119	1,026	1,532
24	Kahawata	544		76		620	926
25	Dembe Sembel + Godaif II	178		26		204	305
27	Godaif + Godaif I	929		305		1,234	1,842
33	Kuteba + Gegeret II	100		13		113	169
13. Gejeret							
20	Gejeret Neishto	1,070		160		1,230	1,836
20	Algin Housing	0		278		278	415
23	Gejeret Abi	642		102		745	1,111
29	Gejeret I	0		0		0	0
Daero Paulos TD		206		27		233	348
		16,566	1,566	4,511	411	23,054	34,409

Potential Daily Demand by WTPs (m3/day)	Domestic (by Connection)	Domestic (by Truck)	Non-domestic (by Connection)	Non-domestic (by Truck)	Total Daily Consumption	Total Daily Production	
Stretta Vaudetto WTP System	3,408	0	363	0	3,770	5,627	m3/day
Toker WTP System	6,258	830	2,108	293	9,488	15,495	m3/day
Mai Nefhi WTP System	6,901	735	2,040	119	9,795	13,286	m3/day
Total	**16,566**	**1,566**	**4,511**	**411**	**23,054**	**34,409**	**m3/day**

2020 Demand Projection

Assumed Leakage (%) 33

ID	Area Name	Domestic (by Connection) (m3/day)	Domestic (by Truck) (m3/day)	Non-domestic (by Connection) (m3/day)	Non-domestic (by Truck) (m3/day)	Total Daily Consumption (m3/day)	Total Daily Production (m3/day)
1. Paradiso							
8	Paradiso	1,024		545		1,569	2,342
38	Bet Mekae TD	18		47		65	97
45	Adi Abeito village and TD	4		39		43	64
2. Maitemenai							
1	Mai Temenai	654		461		1,116	1,665
4	Mai Temenai TD	13	780	57	306	1,157	1,726
3. Edaga Hamus							
2	Haz Haz	269		37		306	457
6	Idaga Hamus and Emba Galliano	1,252		186		1,438	2,147
4. Akiria							
3	Mirham Chira and Acria	1,913		147		2,060	3,074
46	Adi Nefas village + TD	11		17		29	43
54	Mirham Chira extension	1		0		1	1
5. Abazhawl							
5	Aba Shaul	1,706		262		1,968	2,937
6. Arbate Asmara							
9	Medeber	128		16		144	215
10	Arbate Asmara	1,104		152		1,256	1,875
11	Geza Tanika	91		10		101	151
7. Tsetserat							
26	Bet Mekae	182		33		216	322
31	Space 2000 - II	70		0		70	105
34	Tsetserat + Forto Complex	84		16		100	149
36	Tsetserat D2	15		2		17	26
37	Adi Segdo TD	157		65		222	332
43	Adi Segdo village	48		17		65	97
8. Maekel Ketema							
14	Maekel Ketema North	476		57		533	796
15	Maekel Ketema West	355		87		442	659
16	Maekel Ketema South	384		47		430	642
17	Harnet	180		22		202	301
9. Tiravolo							
21	Tiravolo	640		116		757	1,130
28	Denden Housing	0		255		255	380
30	Space 2000 - I	68		24		92	137
10. Geza banda							
12	Forobia	76		8		84	126
13	Mai Chehot	561		66		628	937
18	Addis Alem	832		115		947	1,414
19	Zeban Zinkei and Halibet Complex	469		317		786	1,174
11. Sembel							
32	Sembel Village + Sembel III	518		282		799	1,193
35	Sembel high rise A	114		158		272	405
12. Godaif							
22	Barijima	155	728	23	124	1,030	1,538
24	Kahawata	560		80		640	955
25	Dembe Sembel + Godaif II	183		28		211	314
27	Godaif + Godaif I	956		319		1,275	1,903
33	Kuteba + Gegeret II	103		14		117	174
13. Gejeret							
20	Gejeret Neishto	1,101		167		1,268	1,893
20	Algin Housing	0		291		291	434
23	Gejeret Abi	661		107		768	1,146
29	Gejeret I	0		0		0	0
Daero Paulos TD		212		28		240	358
		17,347	1,508	4,723	431	24,009	35,834

Projected Daily Demand by WTPs (m3/day)	Domestic (by Connection)	Domestic (by Truck)	Non-domestic (by Connection)	Non-domestic (by Truck)	Total Daily Consumption	Total Daily Production	
Stretta Vaudetto WTP System	3,517	0	380	0	3,897	5,816	m3/day
Toker WTP System	6,628	780	2,207	306	9,921	16,189	m3/day
Mai Nefhi WTP System	7,202	728	2,136	124	10,190	13,829	m3/day
Total	**17,347**	**1,508**	**4,723**	**431**	**24,009**	**35,834**	**m3/day**

2025 Demand Projection

Assumed Leakage (%) 32

ID	Area Name	Domestic (by Connection) (m3/day)	Domestic (by Truck) (m3/day)	Non-domestic (by Connection) (m3/day)	Non-domestic (by Truck) (m3/day)	Total Daily Consumption (m3/day)	Total Daily Production (m3/day)
1. Paradiso							
8	Paradiso	1,053		577		1,630	2,397
38	Bet Mekae TD	37		50		87	128
45	Adi Abeito village and TD	8		41		49	72
2. Maitemenai							
1	Mai Temenai	673		488		1,161	1,708
4	Mai Temenai TD	26	682	61	324	1,094	1,609
3. Edaga Hamus							
2	Haz Haz	291		39		331	486
6	Idaga Hamus and Emba Galliano	1,288		197		1,485	2,184
4. Akiria							
3	Mirham Chira and Acria	2,071		156		2,227	3,274
46	Adi Nefas village + TD	38		18		56	83
54	Mirham Chira extension	3		0		3	5
5. Abazhawl							
5	Aba Shaul	1,755		277		2,032	2,988
6. Arbate Asmara							
9	Medeber	138		17		155	229
10	Arbate Asmara	1,336		161		1,497	2,202
11	Geza Tanika	110		11		121	177
7. Tsetserat							
26	Bet Mekae	187		35		223	327
31	Space 2000 - II	72		0		72	106
34	Tsetserat + Forto Complex	86		17		103	151
36	Tsetserat D2	16		2		18	26
37	Adi Segdo TD	161		69		231	339
43	Adi Segdo village	50		18		67	99
8. Maekel Ketema							
14	Maekel Ketema North	489		61		550	809
15	Maekel Ketema West	365		92		457	672
16	Maekel Ketema South	395		49		444	653
17	Harnet	185		23		208	306
9. Tiravolo							
21	Tiravolo	659		123		782	1,150
28	Denden Housing	0		269		269	396
30	Space 2000 - I	70		25		95	140
10. Geza banda							
12	Forobia	79		8		87	128
13	Mai Chehot	577		70		648	952
18	Addis Alem	856		122		978	1,438
19	Zeban Zinkei and Halibet Complex	482		336		818	1,203
11. Sembel							
32	Sembel Village + Sembel III	639		298		937	1,378
35	Sembel high rise A	117		167		284	418
12. Godaif							
22	Barijima	159	720	25	132	1,035	1,522
24	Kahawata	576		85		660	971
25	Dembe Sembel + Godaif II	188		29		217	320
27	Godaif + Godaif I	983		338		1,321	1,943
33	Kuteba + Gegeret II	106		15		120	177
13. Gejeret							
20	Gejeret Neishto	1,133		177		1,310	1,926
20	Algin Housing	0		308		308	453
23	Gejeret Abi	680		113		793	1,166
29	Gejeret I	0		0		0	0
Daero Paulos TD		218		30		248	364
		18,356	1,402	4,998	456	25,212	37,076

Projected Daily Demand by WTPs (m3/day)	Domestic (by Connection)	Domestic (by Truck)	Non-domestic (by Connection)	Non-domestic (by Truck)	Total Daily Consumption	Total Daily Production	
Stretta Vaudetto WTP System	3,988	0	402	0	4,390	6,456	m3/day
Toker WTP System	6,854	682	2,335	324	10,195	16,409	m3/day
Mai Nefhi WTP System	7,514	720	2,261	132	10,626	14,211	m3/day
Total	**18,356**	**1,402**	**4,998**	**456**	**25,212**	**37,076**	**m3/day**

Non-domestic demand

ID	Area Name	FS Forcast for 2010 (Low hyposesis)		2014 Actual Billed volume		2015 Potential Demand		2020 Demand Projection		2025 Demand Projection	
		by connection	by truck	by connection	by truck	by connection	by truck	by connection	by truck	by connection	by truck
		(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)	(m3/day)
1. Paradiso						0.73		1.05		1.06	
8	Paradiso	712	0			520	0	545	0	577	0
38	Bet Mekae TD	62	33			45	24	47	25	50	27
45	Adi Abeito village and TD	50	10			37	7	39	7	41	8
2. Maitemenai											
1	Mai Temenai	602	28			441	20	461	21	488	22
4	Mai Temenai TD	75	13			55	9	57	10	61	10
3. Edaga Hamus											
2	Haz Haz	48	10			35	7	37	8	39	8
6	Idaga Hamus and Emba Galliano	243	30			178	22	186	23	197	25
4. Akiria											
3	Mirham Chira and Acria	192	41			140	30	147	32	156	33
46	Adi Nefas village + TD	23	17			17	13	17	13	18	14
54	Mirham Chira extension	0	3			0	2	0	2	0	2
5. Abazhawl											
5	Aba Shaul	342	102			250	75	262	78	277	83
6. Arbate Asmara											
9	Medeber	21	2			15	2	16	2	17	2
10	Arbate Asmara	199	39			145	29	152	30	161	32
11	Geza Tanika	13	5			10	3	10	3	11	4
7. Tsetserat											
26	Bet Mekae	44	3			32	2	33	2	35	3
31	Space 2000 - II	0	0			0	0	0	0	0	0
34	Tsetserat + Forto Complex	21	4			15	3	16	3	17	3
36	Tsetserat D2	3	1			2	1	2	1	2	1
37	Adi Segdo TD	86	35			63	25	65	27	69	28
43	Adi Segdo village	22	25			16	18	17	19	18	20
8. Maekel Ketema											
14	Maekel Ketema North	75	0			55	0	57	0	61	0
15	Maekel Ketema West	113	0			83	0	87	0	92	0
16	Maekel Ketema South	61	0			44	0	47	0	49	0
17	Harnet	29	0			21	0	22	0	23	0
9. Tiravolo											
21	Tiravolo	152	0			111	0	116	0	123	0
28	Denden Housing	333	0			243	0	255	0	269	0
30	Space 2000 - I	31	0			23	0	24	0	25	0
10. Geza banda											
12	Forobia	10	4			8	3	8	3	8	3
13	Mai Chehot	86	10			63	7	66	7	70	8
18	Addis Alem	150	0			110	0	115	0	122	0
19	Zeban Zinkei and Halibet Complex	414	2			303	1	317	2	336	2
11. Sembel											
32	Sembel Village + Sembel III	368	15			269	11	282	11	298	12
35	Sembel high rise A	206	4			151	3	158	3	167	3
12. Godaif											
22	Barijima	30	2			22	2	23	2	25	2
24	Kahawata	105	18			76	13	80	14	85	15
25	Dembe Sembel + Godaif II	36	0			26	0	28	0	29	0
27	Godaif + Godaif I	417	43			305	32	319	33	338	35
33	Kuteba + Gegeret II	18	7			13	5	14	5	15	6
13. Gejeret											
20	Gejeret Neishto	219	7			160	5	167	5	177	5
20	Algin Housing	380	0			278	0	291	0	308	0
23	Gejeret Abi	140	10			102	7	107	8	113	8
29	Gejeret I	0	0			0	0	0	0	0	0
Daero Paulos TD		37	42			27	30	28	32	30	34
	Total	**6,166**	**562**	**1,422**	**370**	**4,511**	**411**	**4,723**	**431**	**4,998**	**456**
					Toker Station	**(4. Mai Temanai)**	**293**		**306**		**324**
					Expo Station	**(22. Barijima)**	**119**		**124**		**132**

2015 Potential Domestic Demand

Pipe Supply Area (13 sub-Zoba and Daero Paulos)

No.	Area Name	FS Forcast for 2010	2008 Census	2015							2014 Potential Demand (HC)		2014 Potential Demand (WT)	
				Population (Census)	House connection		Tanker supply		Potential served population	%	Per Capita	Demand	Per Capita	Demand
					%	Population	%	Population			l/c/d	(m3/day)	l/c/d	(m3/day)
1. Paradiso		**34,062**	**29,442**	**32,457**										
8	Paradiso	18,721		17,839	90	16,055	10	1,784	17,839	100	62	995	15	27
38	Bet Mekae TD	12,150		11,577	0	0	70	8,104	8,104	70	50	0	15	122
45	Adi Abeito village and TD	3,191		3,041	0	0	60	1,824	1,824	60	43	0	15	27
2. Maitemenai		**30,419**	**24,482**	**24,257**										0
1	Mai Temenai	20,799		16,586	90	14,927	10	1,659	16,586	100	43	636	15	25
4	Mai Temenai TD	9,620		7,671	0	0	70	5,370	5,370	70	54	0	15	81
3. Edaga Hamus		**41,356**	**32,179**	**34,016**										0
2	Haz Haz	7,854		6,460	95	6,137	5	323	6,460	100	43	262	15	5
6	Idaga Hamus and Emba Galliano	33,502		27,556	95	26,178	5	1,378	27,556	100	47	1,217	15	21
4. Akiria		**37,547**	**51,182**	**55,057**										0
3	Mirham Chira and Acria	31,320		45,926	95	43,630	5	2,296	45,926	100	43	1,860	15	34
46	Adi Nefas village + TD	5,743		8,421	0	0	90	7,579	7,579	90	43	0	15	114
54	Mirham Chira extension	484		710	0	0	90	639	639	90	43	0	15	10
5. Abazhawl		**60,652**	**40,342**	**40,957**										0
5	Aba Shaul	60,652		40,957	95	38,909	5	2,048	40,957	100	43	1,659	15	31
6. Arbate Asmara		**34,666**	**35,197**	**34,484**										0
9	Medeber	2,425		2,412	95	2,292	5	121	2,412	100	54	124	15	2
10	Arbate Asmara	29,791		29,635	85	25,189	15	4,445	29,635	100	43	1,074	15	67
11	Geza Tanika	2,450		2,437	85	2,072	15	366	2,437	100	43	88	15	5
7. Tsetserat		**28,741**	**19,851**	**22,532**										0
26	Bet Mekae	5,273		4,134	85	3,514	15	620	4,134	100	50	177	15	9
31	Space 2000 - II	1,250		980	100	980			980	100	70	68		0
34	Tsetserat + Forto Complex	1,969		1,544	85	1,312	15	232	1,544	100	62	81	15	3
36	Tsetserat D2	359		281	85	239	15	42	281	100	62	15	15	1
37	Adi Segdo TD	12,870		10,090	0	0	100	10,090	10,090	100	50	0	15	151
43	Adi Segdo village	7,020		5,503	20	1,101	80	4,403	5,503	100	43	47	15	66
8. Maekel Ketema		**9,703**	**21,312**	**21,868**										0
14	Maekel Ketema North	3,311		7,462	100	7,462			7,462	100	62	463		0
15	Maekel Ketema West	2,470		5,567	100	5,567			5,567	100	62	345		0
16	Maekel Ketema South	2,671		6,020	100	6,020			6,020	100	62	373		0
17	Harnet	1,251		2,819	100	2,819			2,819	100	62	175		0
9. Tiravolo		**28,156**	**20,955**	**21,260**										0
21	Tiravolo	11,199		8,456	100	8,456			8,456	100	74	623		0
28	Denden Housing	15,707		11,860	Non Domestic	11,860			11,860		Non Domestic	0		0
30	Space 2000 - I	1,250		944	100	944			944	100	70	66		0
10. Geza banda		**36,528**	**36,306**	**36,092**										
12	Forobia	1,960		1,937	90	1,743	10	194	1,937	100	43	74	15	3
13	Mai Chehot	10,966		10,835	100	10,835		0	10,835	100	50	546	15	0
18	Addis Alem	15,094		14,914	100	14,914			14,914	100	54	809		0
19	Zeban Zinkei and Halibet Complex	8,508		8,406	100	8,406		0	8,406	100	54	456	15	0
11. Sembel		**22,533**	**16,861**	**20,076**										
32	Sembel Village + Sembel III	20,533		18,294	40	7,318	60	10,976	18,294	100	55	403	15	165
35	Sembel high rise A	2,000		1,782	100	1,782	0	0	1,782	100	62	110	15	0
12. Godaif		**49,576**	**43,280**	**44,645**										
22	Barijima	3,680		3,314	90	2,983	10	331	3,314	100	50	150	15	5
24	Kahawata	15,284		13,764	85	11,699	15	2,065	13,764	100	47	544	15	31
25	Dembe Sembel + Godaif II	3,921		3,531	100	3,531			3,531	100	50	178		0
27	Godaif + Godaif I	24,097		21,700	85	18,445	15	3,255	21,700	100	50	929	15	49
33	Kuteba + Gegeret II	2,594		2,336	85	1,986	15	350	2,336	100	50	100	15	5
13. Gejeret		**41,716**	**39,487**	**39,728**										
20	Gejeret Neishto	21,487		20,463	90	18,417	10	2,046	20,463	100	58	1,070	15	31
20	Algin Housing	3,491		3,325	Non Domestic	3,325			3,325		Non Domestic	0		0
23	Gejeret Abi	16,738		15,940	80	12,752	20	3,188	15,940	100	50	642	15	48
29	Gejeret I	0		0	50	0	50	0	0	100	47	0	15	0
Daero Paulos TD		**11,944**	**6,650**	**6,900**	70	4,830	30	2,070	6,900	100	43	206	15	31
		467,599	**417,526**	**434,329**		**348,628**		**77,797**	**426,425**		**50**	**17,325**	**15**	**1,167**
				1.0057		**80%**		**18%**	**98%**			**16,566**	**Toker Station**	**800** (4. Mai Temanai)
				96,001	SV系統	79,319	77,336	15,769					**Expo Station**	**367** (22. Barijima)
				185,768	TK系統	141,031	137,505	37,747						
				152,560	MN系統	128,277	125,071	24,282						
						348,628		77,797						

Tanker Supply Area (Outer villages)

No.	Village name	2004 Census	2008 Census	2015							2014 Potential Demand (HC)		2014 Potential Demand (WT)	
				Estimated Population	House connection		Tanker supply		Potential served population	%	Per Capita	Demand	Per Capita	Demand
					%	Population	%	Population			l/c/d	(m3/day)	l/c/d	(m3/day)
i	Adi Guadad	8,098	11,289	11,700			60	7,020	7,020	60			15	105
ii	Adi Ke	1,634	4,732	4,900			60	2,940	2,940	60			15	44
iii	Merhano	1,611		2,300			60	1,380	1,380	60			15	21
iv	Tselot	2,106	3,231	3,400			60	2,040	2,040	60			15	31
v	Kushet	5,893		8,500			60	5,100	5,100	60			15	77
vi	Tsaeda Emba	1,162		1,700			60	1,020	1,020	60			15	15
vii	Tsaedacristian	5,701		8,200			60	4,920	4,920	60			15	74
viii	Unagudo	170		200			60	120	120	60			15	2
ix	Wekiduba	2,366		3,400			60	2,040	2,040	60			15	31
				44,300		**0**		**26,580**	**26,580**					**399**
									60%				**Toker Station**	**31** (4. Mai Temanai)
													Expo Station	**368** (22. Barijima)

2020 Domestic Demand Projection
Pipe Supply Area (13 sub-Zoba and Daero Paulos)

No.	Area Name	2008 Census	2015 Census	2020 Projected Population	House connection %	House connection Population	Tanker supply %	Tanker supply Population	Expected served population	%	2020 Demand (HC) Per Capita l/c/d	2020 Demand (HC) Demand (m3/day)	2020 Demand (WT) Per Capita l/c/d	2020 Demand (WT) Demand (m3/day)
1. Paradiso		**29,442**	**32,457**	**33,385**										
8	Paradiso		17,839	18,349	90	16,514	10	1,835	18,349	100	62	1,024	15	
38	Bet Mekae TD		11,577	11,908	3	357	70	8,336	8,693	73	50	18	15	125
45	Adi Abeito village and TD		3,041	3,128	3	94	60	1,877	1,970	63	43	4	15	28
2. Maitemenai		**24,482**	**24,257**	**24,950**										
1	Mai Temenai		16,586	17,060	90	15,354	10	1,706	17,060	100	43	654	15	26
4	Mai Temenai TD		7,671	7,891	3	237	70	5,523	5,760	73	54	13	15	83
3. Edaga Hamus		**32,179**	**34,016**	**34,988**										
2	Haz Haz		6,460	6,645	95	6,312	5	332	6,645	100	43	269	15	5
6	Idaga Hamus and Emba Galliano		27,556	28,344	95	26,926	5	1,417	28,344	100	47	1,252	15	21
4. Akiria		**51,182**	**55,057**	**56,631**										
3	Mirham Chira and Acria		45,926	47,239	95	44,877	5	2,362	47,239	100	43	1,913	15	35
46	Adi Nefas village + TD		8,421	8,662	3	260	90	7,796	8,056	93	43	11	15	117
54	Mirham Chira extension		710	730	3	22	90	657	679	93	43	1	15	10
5. Abazhawl		**40,342**	**40,957**	**42,128**										
5	Aba Shaul		41,000	42,128	95	40,021	5	2,106	42,128	100	43	1,706	15	32
6. Arbate Asmara		**35,197**	**34,484**	**35,470**										
9	Medeber		2,412	2,481	95	2,357	5	124	2,481	100	54	128	15	2
10	Arbate Asmara		29,635	30,482	85	25,909	15	4,572	30,482	100	43	1,104	15	69
11	Geza Tanika		2,437	2,507	85	2,131	15	376	2,507	100	43	91	15	6
7. Tsetserat		**19,851**	**22,532**	**23,176**										
26	Bet Mekae		4,134	4,252	85	3,614	15	638	4,252	100	50	182	15	10
31	Space 2000 - II		980	1,008	100	1,008			1,008	100	70	70		0
34	Tsetserat + Forto Complex		1,544	1,588	85	1,350	15	238	1,588	100	62	84	15	4
36	Tsetserat D2		281	289	85	246	15	43	289	100	62	15	15	1
37	Adi Segdo TD		10,090	10,378	30	3,113	70	7,265	10,378	100	50	157	15	109
43	Adi Segdo village		5,503	5,661	20	1,132	80	4,529	5,661	100	43	48	15	68
8. Maekel Ketema		**21,312**	**21,868**	**22,493**										
14	Maekel Ketema North		7,462	7,675	100	7,675			7,675	100	62	476		0
15	Maekel Ketema West		5,567	5,726	100	5,726			5,726	100	62	355		0
16	Maekel Ketema South		6,020	6,192	100	6,192			6,192	100	62	384		0
17	Harnet		2,819	2,900	100	2,900			2,900	100	62	180		0
9. Tiravolo		**20,955**	**21,260**	**21,868**										
21	Tiravolo		8,456	8,698	100	8,698			8,698	100	74	640		0
28	Denden Housing		11,860	12,199	Non Domestic	12,199			12,199		Non Domestic	0		0
30	Space 2000 - I		944	971	100	971			971	100	70	68		0
10. Geza banda		**36,306**	**36,092**	**37,124**										
12	Forobia		1,937	1,992	90	1,793	10	199	1,992	100	43	76	15	3
13	Mai Chehot		10,835	11,145	100	11,145		0	11,145	100	50	561	15	0
18	Addis Alem		14,914	15,340	100	15,340			15,340	100	54	832		0
19	Zeban Zinkei and Halibet Complex		8,406	8,647	100	8,647		0	8,647	100	54	469	15	0
11. Sembel		**16,861**	**20,076**	**20,650**										
32	Sembel Village + Sembel III		18,294	18,817	50	9,408	50	9,408	18,817	100	55	518	15	141
35	Sembel high rise A		1,782	1,833	100	1,833	0	0	1,833	100	62	114	15	0
12. Godaif		**43,280**	**44,645**	**45,921**										
22	Barijima		3,314	3,409	90	3,068	10	341	3,409	100	50	155	15	5
24	Kahawata		13,764	14,157	85	12,034	15	2,124	14,157	100	47	560	15	32
25	Dembe Sembel + Godaif II		3,531	3,632	100	3,632			3,632	100	50	183		0
27	Godaif + Godaif I		21,700	22,320	85	18,972	15	3,348	22,320	100	50	956	15	50
33	Kuteba + Gegeret II		2,336	2,403	85	2,042	15	360	2,403	100	50	103	15	5
13. Gejeret		**39,487**	**39,728**	**40,864**										
20	Gejeret Neishto		20,463	21,048	90	18,943	10	2,105	21,048	100	58	1,101	15	32
20	Algin Housing		3,325	3,420	Non Domestic	3,420					Non Domestic	0		0
23	Gejeret Abi		15,940	16,396	80	13,117	20	3,279	16,396	100	50	661	15	49
29	Gejeret I		0	0	50	0	50	0	0	100	47	0	15	0
Daero Paulos TD		**6,650**	**6,900**	**7,097**	70	4,968	30	2,129	7,097	100	43	212	15	32
		417,526	**434,329**	**446,744**		**364,557**		**75,026**	**439,583**		**50**	**18,128**		**1,098**
			1.0057			**82%**		**17%**	**98%**			**17,347**	**Toker Station**	**748** (4. Mai Temanai)
				98,745	SV系統	81,868		16,219					**Expo Station**	**349** (22. Barijima)
				191,078	TK系統	148,863		35,712						
				156,920	MN系統	133,826		23,095						
						364,557		75,026						

Tanker Supply Area (Outer villages)

No.	Village name	2008 Census	2015 Census	2020 Projected Population	House connection %	House connection Population	Tanker supply %	Tanker supply Population	Expected served population	%	2020 Demand (HC) Per Capita l/c/d	2020 Demand (HC) Demand (m3/day)	2020 Demand (WT) Per Capita l/c/d	2020 Demand (WT) Demand (m3/day)
i	Adi Guadad	11,289	11,700	12,034			60	7,221	7,221	60			15	108
ii	Adi Ke	4,732	4,900	5,040			60	3,024	3,024	60			15	45
iii	Merhano		2,300	2,366			60	1,419	1,419	60			15	21
iv	Tselot	3,231	3,400	3,497			60	2,098	2,098	60			15	31
v	Kushet		8,500	8,743			60	5,246	5,246	60			15	79
vi	Tsaeda Emba		1,700	1,749			60	1,049	1,049	60			15	16
vii	Tsaedacristian		8,200	8,434			60	5,061	5,061	60			15	76
viii	Unagudo		200	206			60	123	123	60			15	2
ix	Wekiduba		3,400	3,497			60	2,098	2,098	60			15	31
			44,300	**45,566**		**0**		**27,340**	**27,340**					**410**
				1.0057					**60%**				**Toker Station**	**31** (4. Mai Temanai)
													Expo Station	**379** (22. Barijima)

2025 Domestic Demand Projection
Pipe Supply Area (13 sub-Zoba and Daero Paulos)

No.	Area Name	2015 Census	2020 Projection	2025							2025 Demand (HC)		2025 Demand (WT)	
				Projected Population	House connection		Tanker supply		Expected served population	%	Per Capita	Demand	Per Capita	Demand
					%	Population	%	Population			l/c/d	(m3/day)	l/c/d	(m3/day)
1. Paradiso		**32,457**	**33,385**	**34,339**										
8	Paradiso	17,839	18,349	18,873	90	16,986	10		16,986	100	62	1,053		
38	Bet Mekae TD	11,577	11,908	12,249	6	735	70	8,574	9,309	76	50	37	15	129
45	Adi Abeito village and TD	3,041	3,128	3,217	6	193	60	1,930	2,123	66	43	8	15	29
2. Maitemenai		**24,257**	**24,950**	**25,664**										
1	Mai Temenai	16,586	17,060	17,547	90	15,793	10	1,755	17,547	100	43	673	15	26
4	Mai Temenai TD	7,671	7,891	8,116	6	487	70	5,681	6,168	76	54	26	15	85
3. Edaga Hamus		**34,016**	**34,988**	**35,988**										
2	Haz Haz	6,460	6,645	6,835	100	6,835	0	0	6,835	100	43	291	15	0
6	Idaga Hamus and Emba Galliano	27,556	28,344	29,154	95	27,696	5	1,458	29,154	100	47	1,288	15	22
4. Akiria		**55,057**	**56,631**	**58,249**										
3	Mirham Chira and Acria	45,926	47,239	48,589	100	48,589	0	0	48,589	100	43	2,071	15	0
46	Adi Nefas village + TD	8,421	8,662	8,910	10	891	90	8,019	8,910	100	43	38	15	120
54	Mirham Chira extension	710	730	751	10	75	90	676	751	100	43	3	15	10
5. Abazhawl		**40,957**	**42,128**	**43,332**										
5	Aba Shaul	41,000	42,128	43,332	95	41,165	5	2,167	43,332	100	43	1,755	15	32
6. Arbate Asmara		**34,484**	**35,470**	**36,484**										
9	Medeber	2,412	2,481	2,552	100	2,552	0	0	2,552	100	54	138	15	0
10	Arbate Asmara	29,635	30,482	31,353	100	31,353	0	0	31,353	100	43	1,336	15	0
11	Geza Tanika	2,437	2,507	2,578	100	2,578	0	0	2,578	100	43	110	15	0
7. Tsetserat		**22,532**	**23,176**	**23,838**										
26	Bet Mekae	4,134	4,252	4,374	85	3,718	15	656	4,374	100	50	187	15	10
31	Space 2000 - II	980	1,008	1,037	100	1,037			1,037	100	70	72		0
34	Tsetserat + Forto Complex	1,544	1,588	1,633	85	1,388	15	245	1,633	100	62	86	15	4
36	Tsetserat D2	281	289	298	85	253	15	45	298	100	62	16	15	1
37	Adi Segdo TD	10,090	10,378	10,675	30	3,202	70	7,472	10,675	100	50	161	15	112
43	Adi Segdo village	5,503	5,661	5,823	20	1,165	80	4,658	5,823	100	43	50	15	70
8. Maekel Ketema		**21,868**	**22,493**	**23,136**										
14	Maekel Ketema North	7,462	7,675	7,895	100	7,895			7,895	100	62	489		0
15	Maekel Ketema West	5,567	5,726	5,890	100	5,890			5,890	100	62	365		0
16	Maekel Ketema South	6,020	6,192	6,369	100	6,369			6,369	100	62	395		0
17	Harnet	2,819	2,900	2,983	100	2,983			2,983	100	62	185		0
9. Tiravolo		**21,260**	**21,868**	**22,493**										
21	Tiravolo	8,456	8,698	8,946	100	8,946			8,946	100	74	659		0
28	Denden Housing	11,860	12,199	12,548	Non Domestic	12,548			12,548		Non Domestic	0		0
30	Space 2000 - I	944	971	999	100	999			999	100	70	70		0
10. Geza banda		**36,092**	**37,124**	**38,185**										
12	Forobia	1,937	1,992	2,049	90	1,844	10	205	2,049	100	43	79	15	3
13	Mai Chehot	10,835	11,145	11,463	100	11,463			11,463	100	50	577		0
18	Addis Alem	14,914	15,340	15,779	100	15,779			15,779	100	54	856		0
19	Zeban Zinkei and Halibet Complex	8,406	8,647	8,894	100	8,894			8,894	100	54	482		0
11. Sembel		**20,076**	**20,650**	**21,240**										
32	Sembel Village + Sembel III	18,294	18,817	19,355	60	11,613	40	7,742	19,355	100	55	639	15	116
35	Sembel high rise A	1,782	1,833	1,885	100	1,885	0	0	1,885	100	62	117	15	0
12. Godaif		**44,645**	**45,921**	**47,234**										
22	Barijima	3,314	3,409	3,506	90	3,156	10	351	3,506	100	50	159	15	5
24	Kahawata	13,764	14,157	14,562	85	12,378	15	2,184	14,562	100	47	576	15	33
25	Dembe Sembel + Godaif II	3,531	3,632	3,736	100	3,736			3,736	100	50	188		0
27	Godaif + Godaif I	21,700	22,320	22,958	85	19,515	15	3,444	22,958	100	50	983	15	52
33	Kuteba + Gegeret II	2,336	2,403	2,471	85	2,101	15	371	2,471	100	50	106	15	6
13. Gejeret		**39,728**	**40,864**	**42,032**										
20	Gejeret Neishto	20,463	21,048	21,650	90	19,485	10	2,165	21,650	100	58	1,133	15	32
20	Algin Housing	3,325	3,420	3,517	Non Domestic	3,517					Non Domestic	0		0
23	Gejeret Abi	15,940	16,396	16,865	80	13,492	20	3,373	16,865	100	50	680	15	51
29	Gejeret I	0	0	0	50	0	50	0	0	100	47	0	15	0
Daero Paulos TD		**6,900**	**7,097**	**7,300**	70	5110.061598	30	2,190	7,300	100	43	218	15	33
		434,329	**446,744**	**459,513**		**386,285**		**65,359**	**451,644**		**50**	**19,159**		**980**
			1.0057			**84%**		**14%**	**98%**			**18,356**	**Toker Station**	**650** (4. Mai Temanai)
				101,568	SV系統	92,873		8,694					**Expo Station**	**330** (22. Barijima)
				196,540	TK系統	153,826		34,845						
				161,406	MN系統	139,586		21,819						
						386,285		65,359						

Tanker Supply Area (Outer villages)

No.	Village name	2015 Estimate	2020 Projection	2025							2025 Demand (HC)		2025 Demand (WT)	
				Population	House connection		Tanker supply		Expected served population	%	Per Capita	Demand	Per Capita	Demand
					%	Population	%	Population			l/c/d	(m3/day)	l/c/d	(m3/day)
i	Adi Guadad	11,700	12,034	12,378			60	7,427	7,427	60			15	111
ii	Adi Ke	4,900	5,040	5,184			60	3,110	3,110	60			15	47
iii	Merhano	2,300	2,366	2,433			60	1,460	1,460	60			15	22
iv	Tselot	3,400	3,497	3,597			60	2,158	2,158	60			15	32
v	Kushet	8,500	8,743	8,993			60	5,396	5,396	60			15	81
vi	Tsaeda Emba	1,700	1,749	1,799			60	1,079	1,079	60			15	16
vii	Tsaedacristian	8,200	8,434	8,675			60	5,205	5,205	60			15	78
viii	Unagudo	200	206	212			60	127	127	60			15	2
ix	Wekiduba	3,400	3,497	3,597			60	2,158	2,158	60			15	32
		44,300	**45,566**	**46,869**		**0**		**28,121**	**28,121**					**422**
			1.0057						**60%**				**Toker Station**	**32** (4. Mai Temanai)
													Expo Station	**389** (22. Barijima)

Present Condition of AWSD

Population in Service Area	**Number**	**434,329**	=434,329+6,900
Estiated Served population			
1) By connection	Number	339,472	=409,329-69,857
2) By water tanker (Asmara city) (estimated by billed volume)	Number	69,857	=339,971x (3/4) x1000/ 365/10
1) + 2)		409,329	=434,329 - 25,000 (Estimated)
3) By water tanker (Outer village) (estimated by billed volume)	Number	23,286	=339,971 x (1/4) x 1000/ 365/10
Number of connection	**Number**	**35,483**	
Domestic	Number	29,722	
Non domestic	Number	5,761	
Billed volume	**m3/year**	**2,611,509**	
	m3/day	**7,155**	
By connection (Domestic)	m3/year	1,552,317	
	m3/day	4,253	
By conncection (Non domestic)	m3/year	519,144	
	m3/day	1,422	
By water tanker (Domestic)	m3/year	339,971	
	m3/day	931	
By water tanker (Non domestic)	m3/year	200,077	
	m3/day	548	
Production Volume	**m3/year**	**6,659,541**	
	m3/day	**18,245**	
Stretta Vaudetto WTP	m3/year	756,575	
	m3/day	2,073	
Toker WTP	m3/year	2,740,396	
	m3/day	7,508	
Mai Nefhi WTP	m3/year	3,162,570	
	m3/day	8,665	

Population of AWSD Piped Service Area

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
Daero Paulos TD	6,650	6,900	1.0053
	417,526	**434,329**	**1.0057**

2025 Demand Projection Demand Distribution to EPANET nodes

ID	Area	Average demand per area		74.7 189.9 164.5																	7.6 1.9							
		m3/day	l/s		3	4	5	7	9	10	11	12	13	14	15	16	17	19	20	22	23	24	25	29	30	31	32	33	34
	Total	**37,076**	**429.1**		**18.6**	**27.7**	**6.3**	**6.3**	**2.3**	**19.8**	**1.7**	**0.7**	**7.6**	**7.6**	**1.7**	**24.2**	**6.3**	**0.0**	**6.3**	**1.9**	**2.8**	**9.5**	**3.8**	**2.4**	**0.9**	**0.9**	**2.8**	**4.6**	**0.4**
1	Mai Temenai	1,708	19.8	100% N10	0.0	0.0	0.0	0.0	0.0	19.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Haz Haz	486	5.6	40% N9 + 30% N11 + 30% N15	0.0	0.0	0.0	0.0	2.3	0.0	1.7	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Mirham Chira and Acria	3,274	37.9	20% N13 + 20% N14 + 10% N25 + 50% N141	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0
4	Mai Temenai D (I and II) + Mai Hutsa B	1,609	18.6	100% N3	18.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	Aba Shaul	2,988	34.6	70% N16 + 30% N143	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	Idaga Hamus and Emba Galliano	2,184	25.3	25% N5 + 25% N7 + 25% N17 + 25% N20	0.0	0.0	6.3	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	LC1 Paradiso extension		0.0	100% N3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Paradiso	2,397	27.7	100% N4	0.0	27.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	Medeber	229	2.6	100% N143	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	Arbate Asmara	2,202	25.5	30% N24 + 20% N48 + 30% N65 + 20% N142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	Geza Tanika	177	2.1	50% N48 + 50% N65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	Forobia	128	1.5	70% N65 + 30% N133	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	Mai Chehot	952	11.0	25% N77 + 75% N78	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	Maekel Ketema North	809	9.4	20% N22 + 30% N23 + 20% N24 + 30% N32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	2.8	1.9	0.0	0.0	0.0	0.0	2.8	0.0	0.0
15	Maekel Ketema West	672	7.8	30% N33 + 30% N40 + 40% N89	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0
16	Maekel Ketema South	653	7.6	20% N29 + 30% N36 + 30% N39 + 20% N40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0
17	Harnet	306	3.5	25% N29 + 25% N30 + 25% N31 + 25% N101	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9	0.9	0.0	0.0	0.0
18	Addis Alem	1,438	16.6	50% N52 + 50% N77	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	Zeban Zinkei and Halibet Complex	1,203	13.9	100% N51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	Gejeret Neishto	1,926	22.3	30% N39 +20% N40 + 30% N41 + 20% N79	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	Algin Housing	453	5.2	100% N150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	Tiravolo	1,150	13.3	40% N42 + 60% N43	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	Barijima	1,522	17.6	100% N81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	Gejeret Abi	1,166	13.5	25% N80 + 25% N81 + 25% N83 + 25% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	Kahawata	971	11.2	50% N73 + 50% N85	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	Dembe Sembel + Godaif II	320	3.7	100% N71	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	Bet Mekae	327	3.8	60% N33 + 40% N89	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0
27	Godaif + Godaif I	1,943	22.5	30% N82 + 30% N88 + 40% N105	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	Denden Housing	396	4.6	100% N150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	Gejeret I	0	0.0	100% N73	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	Space 2000 - I	140	1.6	50% N92 + 50% N94	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	Space 2000 - II	106	1.2	20% N92 + 80% N94	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	Sembel Village + Sembel III	1,378	15.9	40% N115 + 20% N116 + 40% N117	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	Kuteba + Gegeret II	177	2.1	100% N88	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	Tsetserat + Forto Complex	151	1.8	20% N34 + 10% N45 + 50% N101 + 20% N120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
35	Sembel high rise A (MD)	418	4.8	100% N44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	Tsetserat D2	26	0.3	100% N120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	Adi Segdo TD	339	3.9	30% N109 + 40% N110 + 30% N111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	Bet Mekae TD	128	1.5	50% N12 + 50% N147	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	Merhano Village + TD + extensions		0.0	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	Adi Guada, Adi Ke village + TD + ext.		0.0	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	Tsaeda Cristian Village + TD		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	Tsaeda Emba		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	Adi Segdo Village	99	1.1	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	Woki Diba Village + TD		0.0	100% N19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	Adi Abeito Village + TD	72	0.8	100% N146	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	Adi Nfas Village + TD	83	1.0	100% N127	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	Tselot +TD		0.0	100% N149	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	Kushet Village + TD + extension		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	Daero Paulos + TD	364	4.2	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	Arbaete Asmara I		0.0	100% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	Arbaete Asmara II and III		0.0	100% N47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	Arbaete Asmara IV		0.0	100% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53	Haz Haz extension		0.0	100% N11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
54	Mihram Chira Extension	5	0.1	100% N14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	LC2 Acria extension		0.0	100% N25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
56	Sembel IV		0.0	100% N56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
57	Paradiso extension		0.0	100% N3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

2025 Demand Projection Demand Distribution to EPANET nodes

ID	Area	Average demand per area		74.7													8.7											
				189.9													1.0											
		m3/day	l/s	164.5	36	39	40	41	42	43	44	45	47	48	51	52	56	65	71	72	73	77	78	79	80	81	82	83	84
	Total	**37,076**	**429.1**		**2.3**	**9.0**	**8.3**	**6.7**	**5.3**	**8.0**	**4.8**	**0.2**	**0.0**	**6.1**	**13.9**	**8.3**	**0.0**	**9.7**	**3.7**	**4.2**	**5.6**	**11.1**	**8.3**	**4.5**	**3.4**	**21.0**	**6.7**	**3.4**	**3.4**
1	Mai Temenai	1,708	19.8	100% N10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Haz Haz	486	5.6	40% N9 + 30% N11 + 30% N15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Mirham Chira and Acria	3,274	37.9	20% N13 + 20% N14 + 10% N25 + 50% N141	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	Mai Temenai D (I and II) + Mai Hutsa B	1,609	18.6	100% N3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	Aba Shaul	2,988	34.6	70% N16 + 30% N143	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	Idaga Hamus and Emba Galliano	2,184	25.3	25% N5 + 25% N7 + 25% N17 + 25% N20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	LC1 Paradiso extension		0.0	100% N3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Paradiso	2,397	27.7	100% N4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	Medeber	229	2.6	100% N143	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	Arbate Asmara	2,202	25.5	30% N24 + 20% N48 + 30% N65 + 20% N142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	0.0	0.0	0.0	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	Geza Tanika	177	2.1	50% N48 + 50% N65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	Forobia	128	1.5	70% N65 + 30% N133	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	Mai Chehot	952	11.0	25% N77 + 75% N78	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	8.3	0.0	0.0	0.0	0.0	0.0	0.0
14	Maekel Ketema North	809	9.4	20% N22 + 30% N23 + 20% N24 + 30% N32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	Maekel Ketema West	672	7.8	30% N33 + 30% N40 + 40% N89	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	Maekel Ketema South	653	7.6	20% N29 + 30% N36 + 30% N39 + 20% N40	2.3	2.3	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	Harnet	306	3.5	25% N29 + 25% N30 + 25% N31 + 25% N101	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	Addis Alem	1,438	16.6	50% N52 + 50% N77	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	Zeban Zinkei and Halibet Complex	1,203	13.9	100% N51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	Gejeret Neishto	1,926	22.3	30% N39 +20% N40 + 30% N41 + 20% N79	0.0	6.7	4.5	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0
20	Algin Housing	453	5.2	100% N150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	Tiravolo	1,150	13.3	40% N42 + 60% N43	0.0	0.0	0.0	0.0	5.3	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	Barijima	1,522	17.6	100% N81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.6	0.0	0.0	0.0
23	Gejeret Abi	1,166	13.5	25% N80 + 25% N81 + 25% N83 + 25% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	3.4	0.0	3.4	3.4
24	Kahawata	971	11.2	50% N73 + 50% N85	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	Dembe Sembel + Godaif II	320	3.7	100% N71	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	Bet Mekae	327	3.8	60% N33 + 40% N89	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	Godaif + Godaif I	1,943	22.5	30% N82 + 30% N88 + 40% N105	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0
28	Denden Housing	396	4.6	100% N150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	Gejeret I	0	0.0	100% N73	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	Space 2000 - I	140	1.6	50% N92 + 50% N94	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	Space 2000 - II	106	1.2	20% N92 + 80% N94	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	Sembel Village + Sembel III	1,378	15.9	40% N115 + 20% N116 + 40% N117	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	Kuteba + Gegeret II	177	2.1	100% N88	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	Tsetserat + Forto Complex	151	1.8	20% N34 + 10% N45 + 50% N101 + 20% N120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	Sembel high rise A (MD)	418	4.8	100% N44	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	Tsetserat D2	26	0.3	100% N120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	Adi Segdo TD	339	3.9	30% N109 + 40% N110 + 30% N111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	Bet Mekae TD	128	1.5	50% N12 + 50% N147	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	Merhano Village + TD + extensions		0.0	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	Adi Guada, Adi Ke village + TD + ext.		0.0	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	Tsaeda Cristian Village + TD		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	Tsaeda Emba		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	Adi Segdo Village	99	1.1	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	Woki Diba Village + TD		0.0	100% N19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	Adi Abeito Village + TD	72	0.8	100% N146	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	Adi Nfas Village + TD	83	1.0	100% N127	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	Tselot +TD		0.0	100% N149	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	Kushet Village + TD + extension		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	Daero Paulos + TD	364	4.2	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	Arbaete Asmara I		0.0	100% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	Arbaete Asmara II and III		0.0	100% N47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	Arbaete Asmara IV		0.0	100% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53	Haz Haz extension		0.0	100% N11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
54	Mihram Chira Extension	5	0.1	100% N14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	LC2 Acria extension		0.0	100% N25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
56	Sembel IV		0.0	100% N56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
57	Paradiso extension		0.0	100% N3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

2025 Demand Projection Demand Distribution to EPANET nodes

ID	Area	Average demand per area		74.7 / 189.9 / 164.5																		2.6 / 10.4						
		m3/day	l/s		85	88	89	92	94	101	105	109	110	111	115	116	117	120	127	133	141	142	143	146	147	148	149	150	Total
	Total	**37,076**	**429.1**		**5.6**	**8.8**	**4.6**	**1.1**	**1.8**	**1.8**	**9.0**	**1.2**	**1.6**	**1.2**	**6.4**	**3.2**	**6.4**	**0.7**	**1.0**	**0.4**	**18.9**	**5.1**	**13.0**	**0.8**	**0.7**	**1.1**	**0.0**	**9.8**	**429.1**
1	Mai Temenai	1,708	19.8	100% N10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.8
2	Haz Haz	486	5.6	40% N9 + 30% N11 + 30% N15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6
3	Mirham Chira and Acria	3,274	37.9	20% N13 + 20% N14 + 10% N25 + 50% N141	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.9
4	Mai Temenai D (I and II) + Mai Hutsa B	1,609	18.6	100% N3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.6
5	Aba Shaul	2,988	34.6	70% N16 + 30% N143	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.4	0.0	0.0	0.0	0.0	0.0	34.6
6	Idaga Hamus and Emba Galliano	2,184	25.3	25% N5 + 25% N7 + 25% N17 + 25% N20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.3
7	LC1 Paradiso extension		0.0	100% N3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Paradiso	2,397	27.7	100% N4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.7
9	Medeber	229	2.6	100% N143	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	2.6
10	Arbate Asmara	2,202	25.5	30% N24 + 20% N48 + 30% N65 + 20% N142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	25.5
11	Geza Tanika	177	2.1	50% N48 + 50% N65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1
12	Forobia	128	1.5	70% N65 + 30% N133	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
13	Mai Chehot	952	11.0	25% N77 + 75% N78	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0
14	Maekel Ketema North	809	9.4	20% N22 + 30% N23 + 20% N24 + 30% N32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.4
15	Maekel Ketema West	672	7.8	30% N33 + 30% N40 + 40% N89	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8
16	Maekel Ketema South	653	7.6	20% N29 + 30% N36 + 30% N39 + 20% N40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6
17	Harnet	306	3.5	25% N29 + 25% N30 + 25% N31 + 25% N101	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5
18	Addis Alem	1,438	16.6	50% N52 + 50% N77	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.6
19	Zeban Zinkei and Halibet Complex	1,203	13.9	100% N51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.9
20	Gejeret Neishto	1,926	22.3	30% N39 +20% N40 + 30% N41 + 20% N79	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.3
20	Algin Housing	453	5.2	100% N150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	5.2
21	Tiravolo	1,150	13.3	40% N42 + 60% N43	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.3
22	Barijima	1,522	17.6	100% N81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.6
23	Gejeret Abi	1,166	13.5	25% N80 + 25% N81 + 25% N83 + 25% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.5
24	Kahawata	971	11.2	50% N73 + 50% N85	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.2
25	Dembe Sembel + Godaif II	320	3.7	100% N71	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7
26	Bet Mekae	327	3.8	60% N33 + 40% N89	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8
27	Godaif + Godaif I	1,943	22.5	30% N82 + 30% N88 + 40% N105	0.0	6.7	0.0	0.0	0.0	0.0	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.5
28	Denden Housing	396	4.6	100% N150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	4.6
29	Gejeret I	0	0.0	100% N73	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	Space 2000 - I	140	1.6	50% N92 + 50% N94	0.0	0.0	0.0	0.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
31	Space 2000 - II	106	1.2	20% N92 + 80% N94	0.0	0.0	0.0	0.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
32	Sembel Village + Sembel III	1,378	15.9	40% N115 + 20% N116 + 40% N117	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	3.2	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.9
33	Kuteba + Gegeret II	177	2.1	100% N88	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1
34	Tsetserat + Forto Complex	151	1.8	20% N34 + 10% N45 + 50% N101 + 20% N120	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8
35	Sembel high rise A (MD)	418	4.8	100% N44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8
36	Tsetserat D2	26	0.3	100% N120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
37	Adi Segdo TD	339	3.9	30% N109 + 40% N110 + 30% N111	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.6	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9
38	Bet Mekae TD	128	1.5	50% N12 + 50% N147	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	1.5
39	Merhano Village + TD + extensions		0.0	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	Adi Guada, Adi Ke village + TD + ext.		0.0	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	Tsaeda Cristian Village + TD		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	Tsaeda Emba		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	Adi Segdo Village	99	1.1	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	1.1
44	Woki Diba Village + TD		0.0	100% N19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	Adi Abeito Village + TD	72	0.8	100% N146	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.8
46	Adi Nfas Village + TD	83	1.0	100% N127	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
47	Tselot +TD		0.0	100% N149	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	Kushet Village + TD + extension		0.0	100% N148	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	Daero Paulos + TD	364	4.2	100% N72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
50	Arbaete Asmara I		0.0	100% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	Arbaete Asmara II and III		0.0	100% N47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	Arbaete Asmara IV		0.0	100% N84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53	Haz Haz extension		0.0	100% N11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
54	Mihram Chira Extension	5	0.1	100% N14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
55	LC2 Acria extension		0.0	100% N25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
56	Sembel IV		0.0	100% N56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
57	Paradiso extension		0.0	100% N3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix 4.

7) Pipeline Network Analysis

2025 Demand

Network Table – Nodes at 8:00 Hrs

Node ID	Elevation m	Base Demand LPS	Demand LPS	Head m	Pressure m
Junc 3	2340	18.6	33.48	2365.49	25.49
Junc 4	2330	27.7	36.01	2360.89	30.89
Junc 5	2323	6.3	8.19	2360.07	37.07
Junc 6	2335	0	0.00	2360.75	25.75
Junc 7	2335	6.3	8.19	2360.73	25.73
Junc 8	2341	0	0.00	2419.09	78.09
Junc 9	2362	2.3	2.99	2412.88	50.88
Junc 10	2342	19.8	25.74	2361.48	19.48
Junc 11	2365	1.7	2.21	2408.24	43.24
Junc 13	2358	7.6	9.88	2402.70	44.70
Junc 14	2350	7.6	9.88	2400.11	50.11
Junc 15	2335	1.7	2.21	2400.06	65.06
Junc 16b	2330	0	0.00	2356.59	26.59
Junc 17	2334	6.3	8.19	2360.00	26.00
Junc 18	2335	0	0.00	2360.23	25.23
Junc 20	2326	6.3	8.19	2359.90	33.90
Junc 21	2326	0	0.00	2359.83	33.83
Junc 22	2326	1.9	2.47	2359.78	33.78
Junc 23	2333	2.8	3.64	2358.04	25.04
Junc 24	2345	1.9	2.47	2358.00	13.00
Junc 25	2356	3.8	4.94	2398.37	42.37
Junc 26	2395	0	0.00	2398.43	3.43
Junc 29	2336	2.4	3.12	2359.61	23.61
Junc 30	2335	0.9	1.17	2359.58	24.58
Junc 31	2338	0.9	1.17	2341.67	3.66
Junc 32	2332	2.8	3.64	2359.59	27.59
Junc 33	2328	4.6	5.98	2359.42	31.42
Junc 34	2338	0.4	0.52	2359.02	21.02
Junc 36	2342	2.3	2.99	2360.89	18.89
Junc 38	2350	0	0.00	2361.17	11.17
Junc 39	2345	9.0	11.70	2360.81	15.81
Junc 40	2338	8.3	10.79	2360.68	22.68
Junc 41	2339	6.7	8.71	2379.90	40.90
Junc 42	2338	5.3	6.89	2379.92	41.92

2025 Demand

Node ID	Elevation m	Base Demand LPS	Demand LPS	Head m	Pressure m
Junc 43	2328	8.0	10.40	2380.22	52.22
Junc 44	2322	4.8	6.24	2381.44	59.44
Junc 46	2324	0	0.00	2380.08	56.08
Junc 49	2337	0	0.00	2371.13	34.13
Junc 51	2350	13.9	18.07	2369.94	19.94
Junc 52	2353	8.3	10.79	2369.94	16.94
Junc 53	2324	0	0.00	2380.12	56.12
Junc 54	2319	0	0.00	2382.36	63.36
Junc 56	2320	0	0.00	2394.00	74.00
Junc 57	2320	0	0.00	2427.34	107.34
Junc 58	2320	0	0.00	2322.59	2.59
Junc 60	2375	0	0.00	2375.97	0.97
Junc 61	2375	0	0.00	2375.94	0.94
Junc 63	2350	0	0.00	2350.35	0.35
Junc 64	2350	0	0.00	2445.52	95.52
Junc 45	2352	0.2	0.26	2362.35	10.35
Junc 71	2319	3.7	4.81	2382.36	63.36
Junc 75	2359	0	0.00	2363.83	4.83
Junc 79	2330	4.5	5.85	2372.32	42.32
Junc 80	2337	3.4	4.42	2371.14	34.14
Junc 81	2330	21.0	37.80	2371.93	41.93
Junc 82	2336	6.7	8.71	2374.55	38.55
Junc 83	2335	3.4	4.42	2371.14	36.14
Junc 84	2342	3.4	4.42	2371.81	29.81
Junc 85+149	2338	5.6	7.28	2374.52	36.52
Junc 73	2338	5.6	7.28	2374.81	36.81
Junc 77	2350	11.1	14.43	2369.73	19.73
Junc 78	2350	8.3	10.79	2369.40	19.40
Junc 88	2330	8.8	11.44	2376.59	46.59
Junc 89	2340	4.6	5.98	2356.60	16.60
Junc 90	2348	0	0.00	2352.96	4.96
Junc 92	2330	1.1	1.43	2379.56	49.56
Junc 94	2320	1.8	2.34	2379.57	59.57
Junc 103	2335	0	0.00	2358.92	23.92
Junc 105	2334	9.0	11.70	2375.07	41.07

2025 Demand

Node ID	Elevation m	Base Demand LPS	Demand LPS	Head m	Pressure m
Junc 96	2325	0	0.00	2359.65	34.65
Junc 97	2317	0	0.00	2358.15	41.15
Junc 101	2319	1.8	2.34	2355.96	36.96
Junc 109	2315	1.2	1.56	2354.16	39.16
Junc 110	2315	1.6	2.08	2353.66	38.66
Junc 111	2315	1.2	1.56	2353.13	38.13
Junc 112	2310	0	0.00	2332.24	22.24
Junc 113	2320	0	0.00	2379.59	59.59
Junc 114	2318	0	0.00	2331.48	13.48
Junc 115	2318	6.4	8.32	2331.47	13.47
Junc 116	2308	3.2	4.16	2331.90	23.90
Junc 117	2309	6.4	8.32	2331.49	22.49
Junc 118	2319	0	0.00	2331.48	12.48
Junc 120	2345	0.7	0.91	2352.99	7.99
Junc 121	2325	0	0.00	2353.08	28.08
Junc 122	2318	0	0.00	2353.13	35.13
Junc 127	2355	1.0	1.30	2424.03	69.03
Junc 130	2340	0	0.00	2339.98	-0.02
Junc 132	2336	0	0.00	2426.22	90.22
Junc 133	2380	1.5	1.95	2425.69	45.69
Junc 141	2353	18.9	24.57	2398.37	45.37
Junc 142	2356	7.7	10.01	2395.64	39.64
Junc 143	2337	10.4	13.52	2357.41	20.41
Junc 144	2340	0	0.00	2340.03	0.03
Junc 145	2346	0	0.00	2366.23	20.23
Junc 146	2330	0.8	1.04	2366.19	36.19
Junc 147+12+19	2320	1.4	1.82	2360.88	40.88
Junc 148	2315	1.1	1.43	2353.65	38.65
Junc 150	2346	9.8	12.74	2351.70	5.69
Junc 48	2358	13.7	17.81	2379.13	21.13
Junc 65	2363	8.6	11.18	2377.52	14.52
Junc 70	2150	0	0.00	2378.06	228.06
Junc 72	2300	4.2	5.46	2332.48	32.48
Junc IN-MNF	2150	-164.5	-164.50	2152.79	2.79
Junc IN-STR	2350	-74.7	-74.70	2350.45	0.45

2025 Demand

Node ID	Elevation m	Base Demand LPS	Demand LPS	Head m	Pressure m
Junc IN-TOK	2375	-189.9	-189.90	2376.02	1.02
Junc 2	2150	0	0.00	2152.74	2.74
Junc 35	2336	0	0.00	2339.94	3.94
Junc 16	2330	24.2	31.46	2356.53	26.53
Tank T-HAZ	2359	#N/A	-19.88	2363.84	4.84
Tank T-ARB	2395	#N/A	-8.26	2398.43	3.43
Tank T-TSE	2360	#N/A	-107.86	2364.24	4.24
Tank T-MON	2359	#N/A	-48.52	2361.46	2.46
Tank T-DEN	2348	#N/A	129.12	2351.93	3.93
Tank T-MCH	2336	#N/A	24.80	2339.94	3.94
Tank T-MNF	2150	#N/A	-92.71	2152.78	2.78
Tank T-SEM1	2320	#N/A	47.69	2322.66	2.66
Tank T-STR	2350	#N/A	-14.02	2350.41	0.41
Tank T-TOK	2375	#N/A	-44.06	2376.00	1.00
Tank T-SEM2	2330	#N/A	-14.96	2332.36	2.36

2025 Demand

Network Table - Links at 8:00 Hrs

Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Status
Pipe 2	2100	400	120	109.98	0.88	Open
Pipe 3	820	400	120	72.15	0.57	Open
Pipe 4	1280	300	120	-24.02	0.34	Open
Pipe 5	10	300	120	39.70	0.56	Open
Pipe 7	810	300	120	0.00	0.00	Closed
Pipe 8	1400	350	120	89.46	0.93	Open
Pipe 9	480	350	120	63.72	0.66	Open
Pipe 10	440	250	120	87.42	1.78	Open
Pipe 11	350	250	120	84.43	1.72	Open
Pipe 13	260	250	120	72.34	1.47	Open
Pipe 14	1100	200	120	2.21	0.07	Open
Pipe 16	540	200	120	-31.46	1.00	Open
Pipe 17	110	300	120	-51.39	0.73	Open
Pipe 18	570	300	120	-31.51	0.45	Open
Pipe 22	480	250	140	-8.26	0.17	Open
Pipe 25	670	300	120	11.74	0.17	Open
Pipe 26	70	300	120	34.91	0.49	Open
Pipe 27	60	300	120	28.74	0.41	Open
Pipe 28	660	200	120	19.63	0.62	Open
Pipe 31	690	200	120	6.17	0.20	Open
Pipe 32	530	200	120	6.64	0.21	Open
Pipe 33	220	200	120	3.00	0.10	Open
Pipe 34	440	200	120	3.05	0.10	Open
Pipe 37	480	300	120	30.60	0.43	Open
Pipe 40	290	300	120	8.71	0.12	Open
Pipe 41	700	300	120	0.00	0.00	Closed
Pipe 42	450	250	120	-10.79	0.22	Open
Pipe 43	320	250	120	-22.49	0.46	Open
Pipe 44	60	250	120	-48.52	0.99	Open
Pipe 45	370	200	120	-23.04	0.73	Open
Pipe 47	800	350	120	63.52	0.66	Open
Pipe 48	1260	300	120	15.60	0.22	Open
Pipe 52	1450	250	120	18.75	0.38	Open
Pipe 53	10	300	140	36.01	0.51	Open

2025 Demand

Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Status
Pipe 59	1950	250	120	54.92	1.12	Open
Pipe 66	10	250	120	42.61	0.87	Open
Pipe 1	390	300	120	-107.60	1.52	Open
Pipe 6	220	300	120	-107.86	1.53	Open
Pipe 56	510	350	120	-69.76	0.73	Open
Pipe 82	190	250	120	26.03	0.53	Open
Pipe 20	280	250	120	-19.88	0.40	Open
Pipe 84	10	250	120	-19.88	0.40	Open
Pipe 92	1100	200	120	33.75	1.07	Open
Pipe 93	920	200	140	15.57	0.50	Open
Pipe 94	470	200	140	12.33	0.39	Open
Pipe 96	500	150	120	-0.32	0.02	Open
Pipe 97	870	150	120	-4.74	0.27	Open
Pipe 98	450	200	140	-3.22	0.10	Open
Pipe 46	500	150	120	-4.06	0.23	Open
Pipe 69	1150	150	120	9.16	0.52	Open
Pipe 87	470	300	140	-25.22	0.36	Open
Pipe 88	500	200	140	-10.79	0.34	Open
Pipe 101	1520	300	140	81.04	1.15	Open
Pipe 39	370	300	120	0.00	0.00	Closed
Pipe 99	180	300	120	-137.68	1.95	Open
Pipe 102	390	300	140	131.70	1.86	Open
Pipe 105	750	200	140	-1.43	0.05	Open
Pipe 119	130	200	120	27.92	0.89	Open
Pipe 120	230	200	120	27.92	0.89	Open
Pipe 121	530	300	140	69.60	0.98	Open
Pipe 122	980	200	140	25.47	0.81	Open
Pipe 123	660	200	140	11.93	0.38	Open
Pipe 35	160	300	120	56.62	0.80	Open
Pipe 36	200	300	120	36.58	0.52	Open
Pipe 51	240	200	140	-3.77	0.12	Open
Pipe 95	1100	250	140	1.39	0.03	Open
Pipe 100	1480	200	140	-6.93	0.22	Open
Pipe 103	420	300	140	1.39	0.02	Open
Pipe 106	640	300	140	0.00	0.00	Closed

2025 Demand

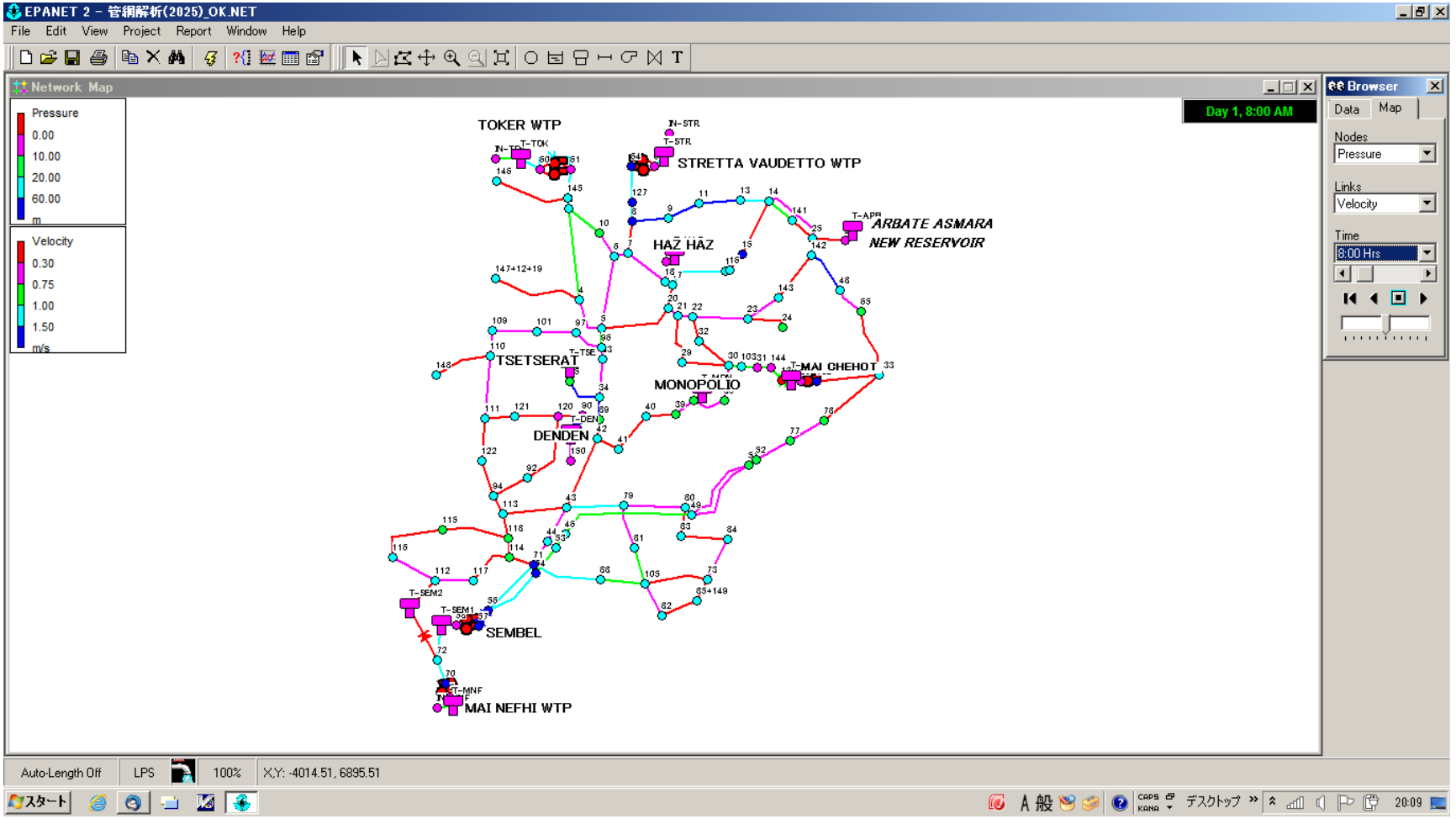
Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Status
Pipe 107	630	200	140	1.39	0.04	Open
Pipe 129	610	200	140	-12.63	0.40	Open
Pipe 130	360	200	140	-16.14	0.51	Open
Pipe 133	800	200	120	-20.04	0.64	Open
Pipe 134	550	200	120	-20.04	0.64	Open
Pipe 137	960	300	140	-11.07	0.16	Open
Pipe 138	560	300	140	-11.07	0.16	Open
Pipe 139	610	200	140	0.00	0.00	Closed
Pipe 140	660	200	140	0.00	0.00	Open
Pipe 144	1400	200	140	9.71	0.31	Open
Pipe 145	500	200	140	11.09	0.35	Open
Pipe 112	10	250	140	8.26	0.17	Open
Pipe 23	3600	300	120	88.72	1.26	Open
Pipe 73	850	300	120	87.42	1.24	Open
Pipe 151	10	200	120	26.75	0.85	Open
Pipe 154	350	200	120	-0.09	0.00	Open
Pipe 160	480	200	120	13.52	0.43	Open
Pipe 162	770	200	120	0.00	0.00	Closed
Pipe 168	290	200	120	-39.00	1.24	Open
Pipe 24	350	200	120	26.75	0.85	Open
Pipe 135	10	200	120	26.75	0.85	Open
Pipe 127	250	500	120	232.92	1.19	Open
Pipe 169	4200	200	140	-1.04	0.03	Open
Pipe 170	2800	300	140	-1.82	0.03	Open
Pipe 171	1100	200	140	17.70	0.56	Open
Pipe 172	1200	200	140	1.43	0.05	Open
Pipe 173	1380	200	140	0.00	0.00	Closed
Pipe 174	1250	150	120	-3.77	0.21	Open
Pipe 176	880	300	140	20.50	0.29	Open
Pipe 178	600	250	120	42.61	0.87	Open
Pipe 179	2400	250	120	42.61	0.87	Open
Pipe 180	200	200	120	12.74	0.41	Open
Pipe 181	350	300	140	-10.16	0.14	Open
Pipe 183	780	400	120	31.36	0.25	Open
Pipe 184	800	200	120	2.47	0.08	Open

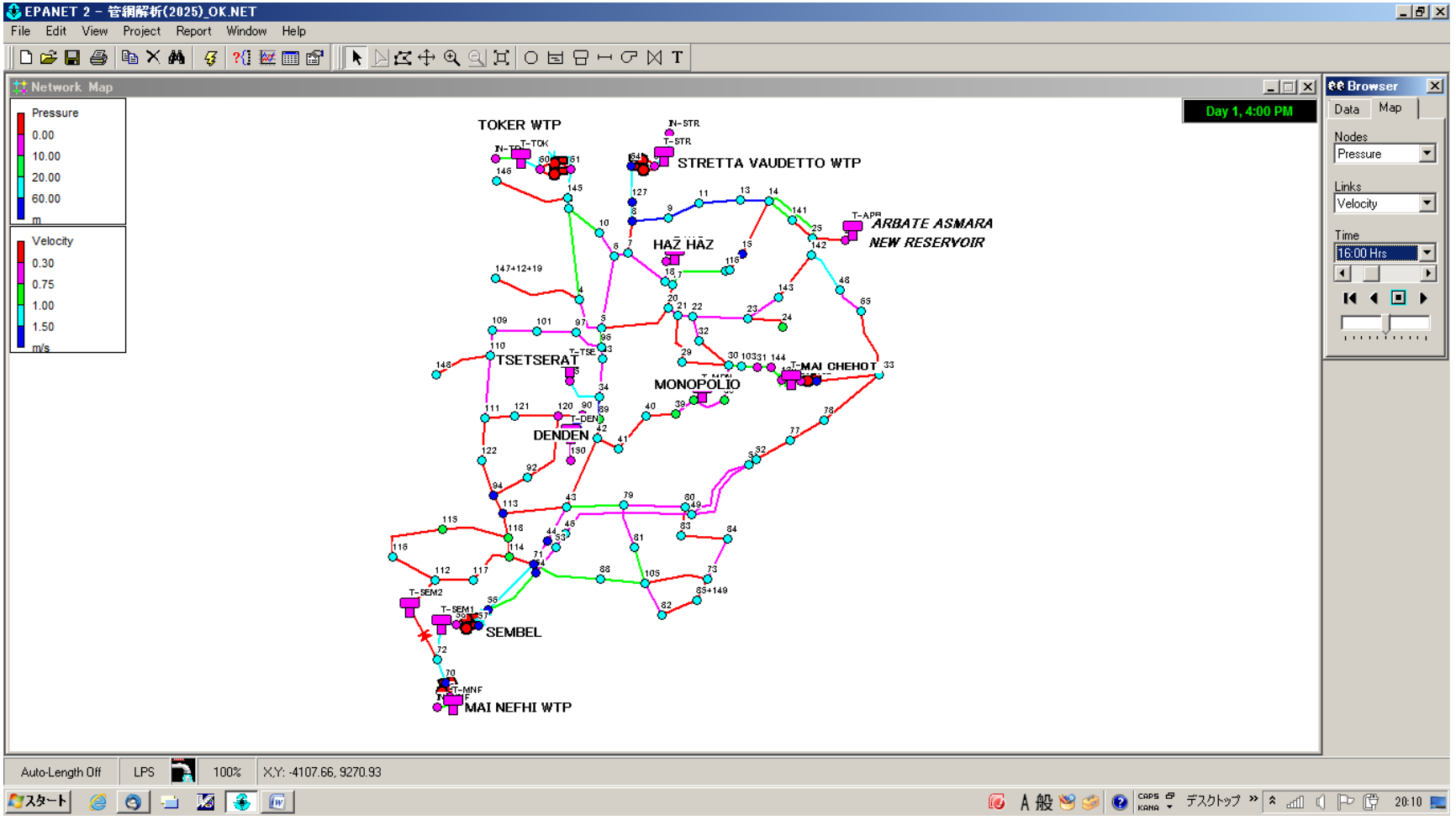
2025 Demand

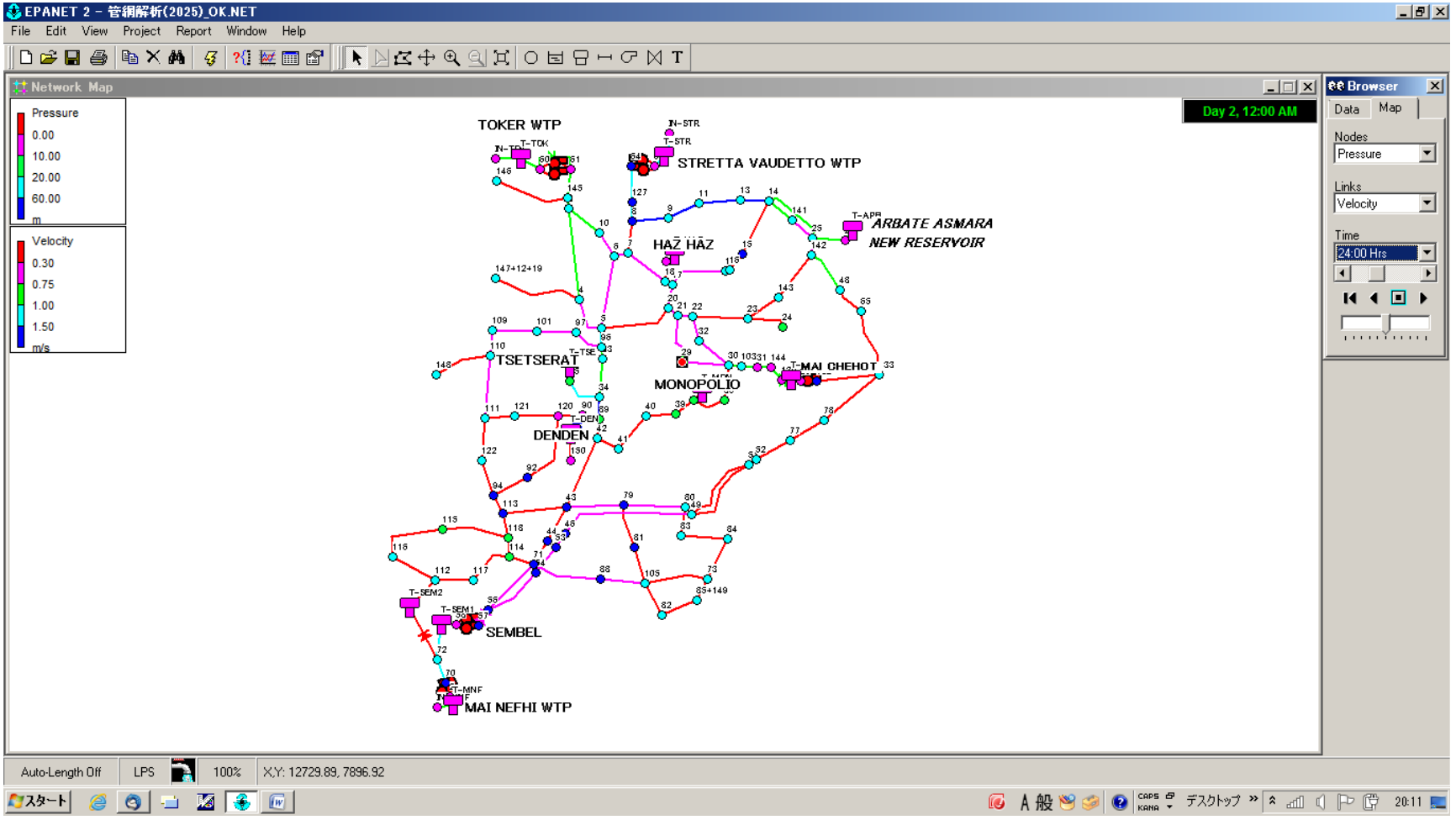
Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Status
Pipe 185	440	200	120	24.48	0.78	Open
Pipe 186	440	250	120	82.22	1.67	Open
Pipe 21	750	150	120	28.99	1.64	Open
Pipe 49	570	150	140	-11.18	0.63	Open
Pipe 58	12800	500	120	257.21	1.31	Open
Pipe 61	3000	500	120	245.91	1.25	Open
Pipe 63	10	400	120	198.22	1.58	Open
Pipe 75	10	500	120	164.50	0.84	Open
Pipe 76	10	300	120	74.70	1.06	Open
Pipe 78	10	300	120	88.72	1.26	Open
Pipe 79	10	500	120	189.90	0.97	Open
Pipe 70	10	500	120	233.96	1.19	Open
Pipe 71	3250	500	120	233.96	1.19	Open
Pipe 80	10	500	120	257.21	1.31	Open
Pipe 38	10	200	120	1.95	0.06	Open
Pipe 60	470	300	140	0.00	0.00	Closed
Pipe 12	1700	350	120	143.30	1.49	Open
Pipe 55	860	250	140	35.77	0.73	Open
Pipe 57	1080	250	140	0.00	0.00	Closed
Pipe 65	10	200	140	11.47	0.37	Open
Pipe 67	10	250	140	-12.30	0.25	Open
Pipe 72	10	500	120	233.96	1.19	Open
Pipe 104	1450	300	140	35.33	0.50	Open
Pipe 15	360	200	120	0.00	0.00	Closed
Pipe 29	10	200	120	31.46	1.00	Open
Pipe 19	500	100	120	1.95	0.25	Open
Pipe 30	500	200	120	0.00	0.00	Closed
Pipe 50	4500	300	140	5.84	0.08	Open
Pipe 54	400	300	140	20.80	0.29	Open
Pipe 62	10	200	120	141.86	4.52	Open
Pump P-SEM1	#N/A	#N/A	#N/A	99.11	0.00	Open
Pump P-TOK1	#N/A	#N/A	#N/A	0.00	0.00	Closed
Pump P-STR1	#N/A	#N/A	#N/A	44.36	0.00	Open
Pump P-MNF1	#N/A	#N/A	#N/A	128.60	0.00	Open
Pump P-MCH	#N/A	#N/A	#N/A	1.95	0.00	Open

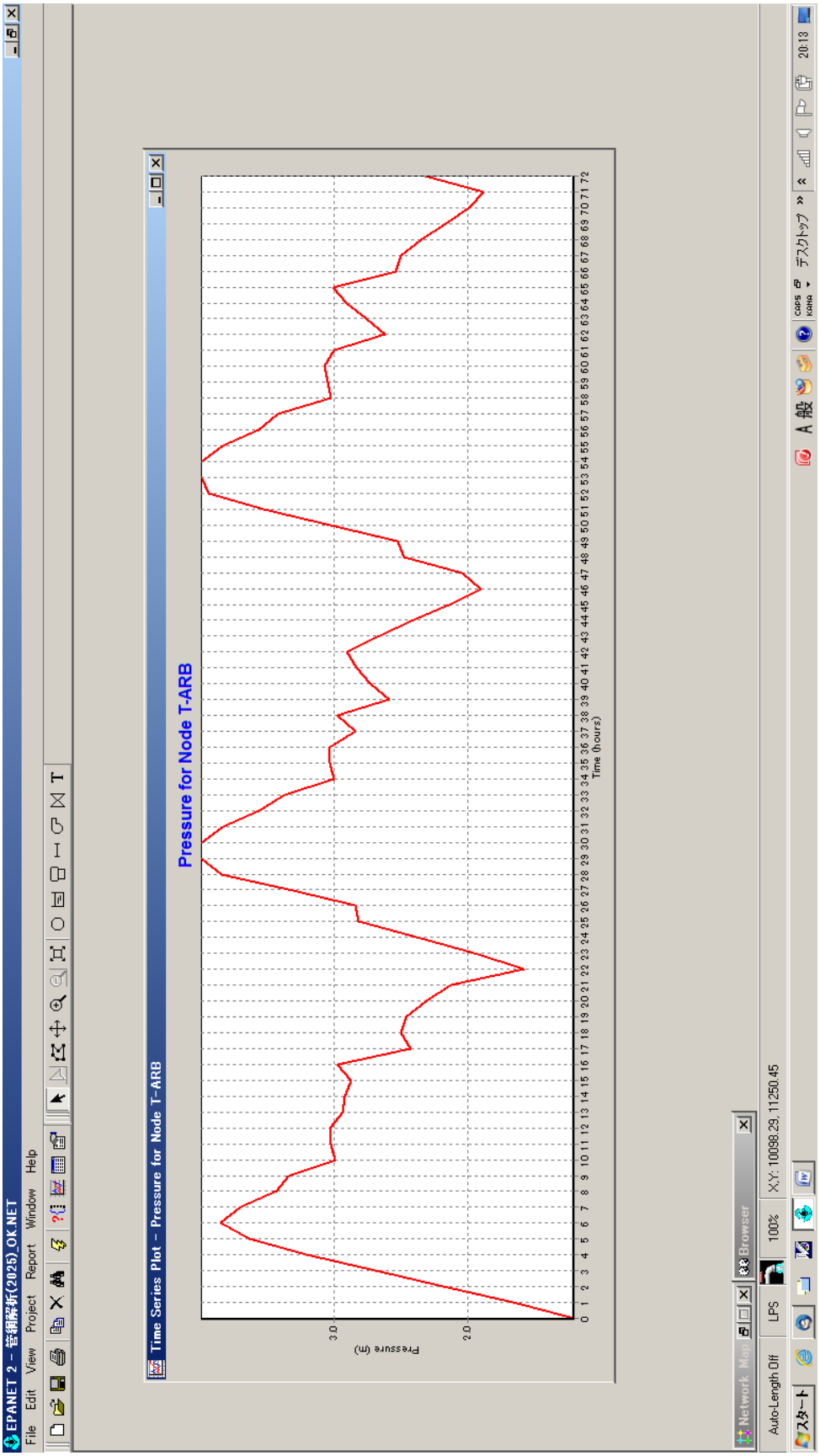
2025 Demand

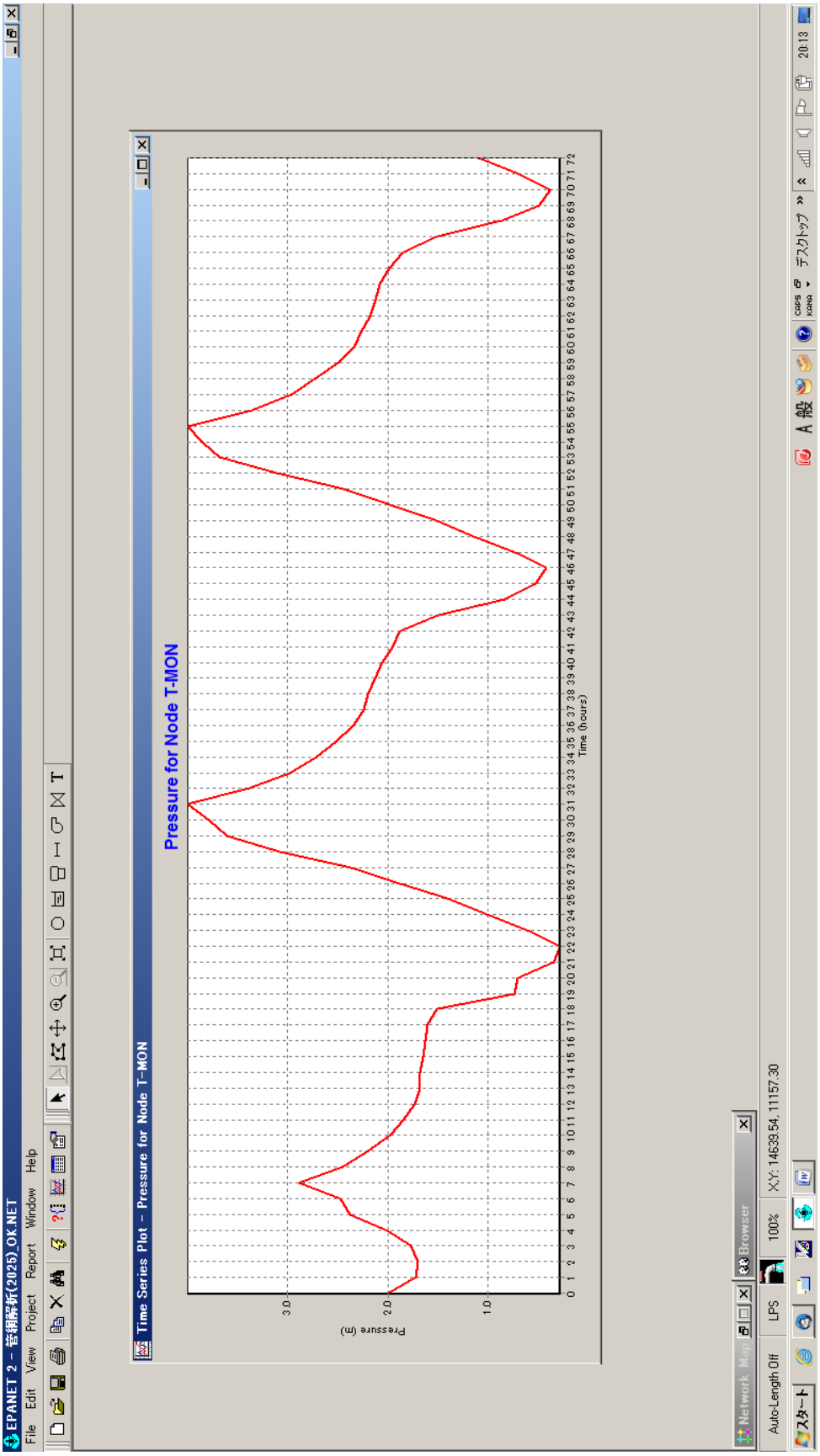
Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Status
Pump P-MNF2	#N/A	#N/A	#N/A	128.60	0.00	Open
Pump P-SEM2	#N/A	#N/A	#N/A	99.11	0.00	Open
Pump P-STR2	#N/A	#N/A	#N/A	44.36	0.00	Open
Pump P-TOK2	#N/A	#N/A	#N/A	0.00	0.00	Closed
Valve V-SEM	#N/A	400	#N/A	198.22	1.58	Active

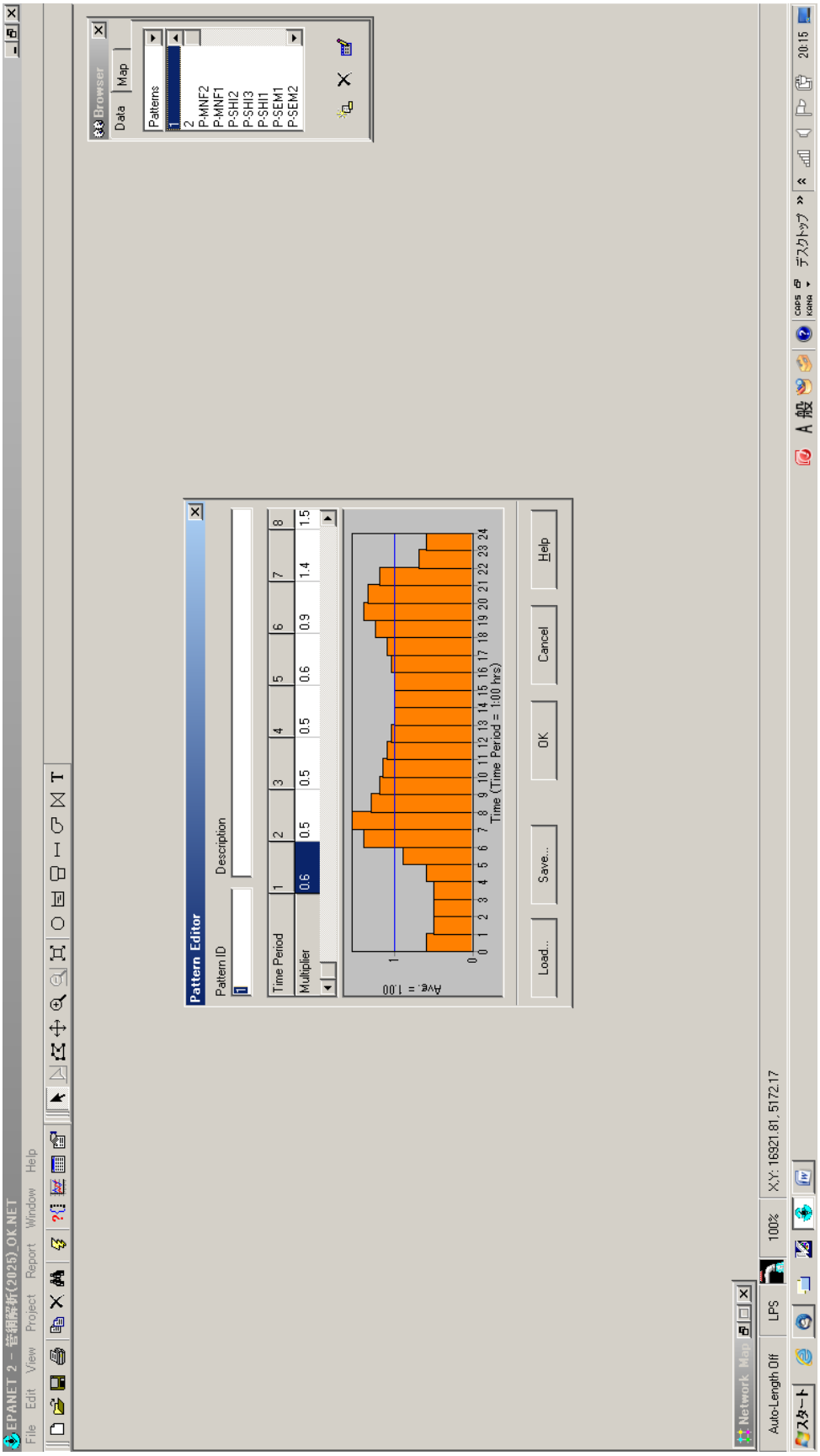

EPANET 2 - 管網解析(2025)_OK.NET
File Edit View Project Report Window Help
Network Map
Day 1, 8:00 AM
Pressure
0.00
10.00
20.00
60.00
m
Velocity
0.30
0.75
1.00
1.50
m/s
TOKER WTP
STRETTA VAUDETTO WTP
ARBATE ASMARA
NEW RESERVOIR
HAZ HAZ
TSETSERAT
MONOPOLIO
DENDEN
SEMBEL
MAI NEFHI WTP
Browser
Data
Map
Nodes
Pressure
Links
Velocity
Time
8:00 Hrs
Auto-Length Off
LPS
100%
X,Y: -4014.51, 6895.51


EPANET 2 - 管網解析(2025)_OK.NET
File Edit View Project Report Window Help
Network Map
Pressure
0.00
10.00
20.00
60.00
m
Velocity
0.30
0.75
1.00
1.50
m/s
Day 1, 4:00 PM
TOKER WTP
STRETTA VAUDETTO WTP
HAZ HAZ
ARBATE ASMARA
NEW RESERVOIR
TSETSERAT
MONOPOLIO
DENDEN
SEMBEL
MAI NEFHI WTP
Browser
Data
Map
Nodes
Pressure
Links
Velocity
Time
16:00 Hrs
Auto-Length Off
LPS
100%
X,Y: -4107.66, 9270.93


EPANET 2 - 管網解析(2025)_OK.NET
File Edit View Project Report Window Help
Network Map
Pressure
0.00
10.00
20.00
60.00
m
Velocity
0.30
0.75
1.00
1.50
m/s
Day 2, 12:00 AM
TOKER WTP
STRETTA VAUDETTO WTP
HAZ HAZ
ARBATE ASMARA
NEW RESERVOIR
TSETSERAT
MONOPOLIO
DENDEN
SEMBEL
MAI NEFHI WTP
Browser
Data
Map
Nodes
Pressure
Links
Velocity
Time
24:00 Hrs
Auto-Length Off
LPS
100%
X,Y: 12729.89, 7896.92


EPANET 2 – 管網解析(2025)_OK.NET
File Edit View Project Report Window Help
Time Series Plot – Pressure for Node T-ARB
Pressure for Node T-ARB
Pressure (m)
3.0
2.0
Time (hours)
Network Map
Browser
Auto-Length Off
LPS
100%
X,Y: 10098.29, 11250.45
スタート
デスクトップ
20:13


EPANET 2 – 管網解析(2025)_OK.NET
File Edit View Project Report Window Help
Time Series Plot – Pressure for Node T-MON
Pressure for Node T-MON
Pressure (m)
Time (hours)
Network Map
Browser
Auto-Length Off
LPS
100%
X,Y: 14639.54, 11157.30


EPANET 2 – 管網解析(2025)_OK.NET
File Edit View Project Report Window Help
Browser
Data Map
Patterns
1
2
P-MNF2
P-MNF1
P-SHI2
P-SHI3
P-SHI1
P-SEM1
P-SEM2
Pattern Editor
Pattern ID
Description
Time Period
Multiplier
Ave. = 1.00
Time (Time Period = 1:00 hrs)
Load...
Save...
OK
Cancel
Help
Network Map
Auto-Length Off
LPS
100%
X,Y: 16921.81, 5172.17
スタート
デスクトップ
20:15

Appendix 4.

8) Water Quality Standards in Eritrea

4. Reference

4.8. Water Quality Standards in Eritrea

（1） Drinking Water Quality Standards in Eritrea

1. The Bacteriological Quality of Drinking Water –Organisms Guideline

a. All water intended for drinking

E. coli or faecal coliform bacteria	Must not be detected in any 100-mlsample

b. Treated water entering the distribution system

E. Coli or faecal coliform bacteria	Must not be detected in any 100-ml sample
Total coliform bacteria	Must not be detected in any 100-ml sample

c. Treated water in the distribution system

E. Coli or faecal coliform bacteria	Must not be detected in any 100-ml sample.
Total coliform bacteria	Must not be detected in any 100-ml sample. In the case of large supplies, where sufficient samples are examined, must not be present in 95% of samples taken throughout any 12-month period

d. Un-piped water supplies

coliform organisms no/100ml 3	(not in consecutive samples)
faecal coliforms	should be absent from 100-ml sample

e. Untreated water entering the distribution system

coliform organisms no/100ml 10	(not in consecutive samples)
faecal coliforms	should be absent from 100-ml sample

The above criteria are valid for groups A, B, and C

Source: World Health Organisation Guidelines for Drinking Water Quality, Nov. 1992

2. Physio-Chemical Quality of Drinking Water

Though the basis for setting this physio-chemical guideline is WHO's recommendation, classification in accordance to the existing water quality of the country is done to grade and judge available water resources for fitness of potability.

		Limits For Groups			
Parameters	Units	A	B	C	D*
Color	TCU	10	20		20
Conductivity	µs/cm	1000	1500	3000	3000
pH	pH Units	6.5-8.5	5.5-9.5		5.5-9.5
Total Dissolved Solids	mg/l	650	1000	2000	2000
Turbidity	NTU	1	5	10	10
Total Hardness	mg/l, $CaCO_3$	200	350	600	600
Magnessium	mg/l	30	50	80	80
Potassium	mg/l	10	12	20	20
Chloride	mg/l, Cl	100	250	600	600
Nitrite(as Nitrite)	mg/l, NO_2	1	3	3	3
Nitrate(as Nitrate)	mg/l, NO_3	20	40	50	50
Sulphate	mg/l, SO_4	100	250	500	500
Iron (total)	mg/l, Fe	0.15	0.3	0.3	0.3
Manganese	mg/l, Mn	0.05	0.1	0.5	0.5
Zinc	mg/l, Zn	1.5	3	3	3
Copper	mg/l, Cu	0.5	1.5	2	2
Ammonia	mg/l, NH_4	0.13	0.64	1.5	1.5
Aluminium	mg/l, Al	0.1	0.2	0.2	0.2
Arsenic	mg/l, As	0.01	0.05	0.05	0.05
Cadmium	mg/l, Cd	0.003	0.005	0.005	0.005
Chromium	mg/l, Cr	0.05	0.05	0.05	0.05
Cyanide	mg/l, CN	0.07	0.07	0.07	0.07
Lead	mg/l, Pb	0.01	0.05	0.05	0.05
Mercury	mg/l, Hg	0.001	0.001	0.001	0.001
Sodium	mg/l, Na	100	200	400	400
Fluoride	15-25°c, mg/l	1	1.5	3	3
	25-33°c, mg/l	0.5	1	2.5	2.5
Barium	mg/l, Ba	0.7	0.7	1.0	1.0
Boron	mg/l, B	0.3	0.3	0.3	0.3
Molybdenum	mg/l, Mo	0.05	0.07	0.07	0.07
Nickel	mg/l, Ni	0.02	0.02	0.02	0.02
Selenium	mg/l,Se	0.01	0.01	0.01	0.01
Antimony	mg/l, Sb	0.003	0.003	0.003	0.003
Hydrogen Sulfide	mg/l, H_2S	0.05	0.05	0.1	0.1

* greater than the value indicated.

3. Organics	μg/litre (maximum permissible level)
a. *Chlorinated alkanes*	
Carbon tetrachloride	2
Dichloro methane	20
1,2-dichloroethane	30
1,1,1- trichloroethane	2000
b. Chlorinated ethanes	
Vinyl chloride	5
1,1-dichloroethene	30
1,2-dichloroethene	50
trichloroethene	70
tetrachloroethene	40
c. Aromatic Hydrocarbons	
benzene	10
toluene	700
xylenes	500
ethylbenzene	300
styrene	20
benzo(a)pyrene	0.7
d. Chlorinated benzenes	
monochlorobenzene	300
1,2-dichlorobenzene	1000
1,4-dichlorobenzene	300
trichlorobenzenes(total)	20
e. Miscellaneous organics	
di(2-ethylhexyl)adipate	80
di(2-ethylhexyl)phthalate	8
acrylamide	0.5
epichlorohydrine	0.4
hexachlorobutadiene	0.6
EDTA	200
nitrilotriaceticacid	200

Source: World Health Organization Guidelines for Drinking Water Quality, Nov. 1992.

4. Pesticides	μg/l (maximum permissible level)
alachlor	20
aldicarb	10
aldrin/dieldrine	0.03
atrazine	2
bentazone	30
carbofuran	5
chlordane	0.2
chlortoluron	30
DDT	2
1,2-dibromo-3-chloropropane	1
2,4-D	30
1,2-dichloropropane	20
1,3-dichloropropene	20
heptachlor and heptachlor epoxide	0.03
hexachlorobenzene	1
isoprotron	9
lindane	2
MCPA	2
methoxychlor	20
metolachlor	10
molinate	6
pendimethaline	20
pentachlorophenol	9
permethrin	20
propanil	20
pyridate	100
simazine	2
trifluralin	20
chlorophenoxy herbicides other than 2,4,D and MCPA	
dichlorprop	100
2,4-DB	90
2,4,5-T	9
silvex	9
mecoprop	10

Source: World Health Organization, Guidelines for Drinking Water Quality, Nov. 1992

5. Disinfectants and Disinfectant By-products	

a. Disinfectants	mg/l (maximum permissible level)
monochloroamine	3
chlorine	5

b. Disinfectant by-products	μg/l (maximum permissible level)
bromate	25
chlorite	200
2,4,6-trichlorophenol	200
formaldehyde	900
trihalomethanes	The sum of the ratio of the concentration of each to their respective guideline value should not exceed 1
bromoform	100
dibromochloromethane	100
bromodichloroethane	60
chloroform	200
chlorinated aceticacid	
dichloroacetic acid	50
trichloroacetic acid	100
trichloroacetaldehyde/chloral hydrate	10
haloacetonitriles	
dichloroacetinitrile	90
dibromoacetonitrile	100
trichloroacetonitrile	1
cyanogen chloride (as CN^-)	70

Source: World Health Organisation Guidelines for Drinking Water Quality, Nov.1992

（２） River Water Quality Standards in Eritrea

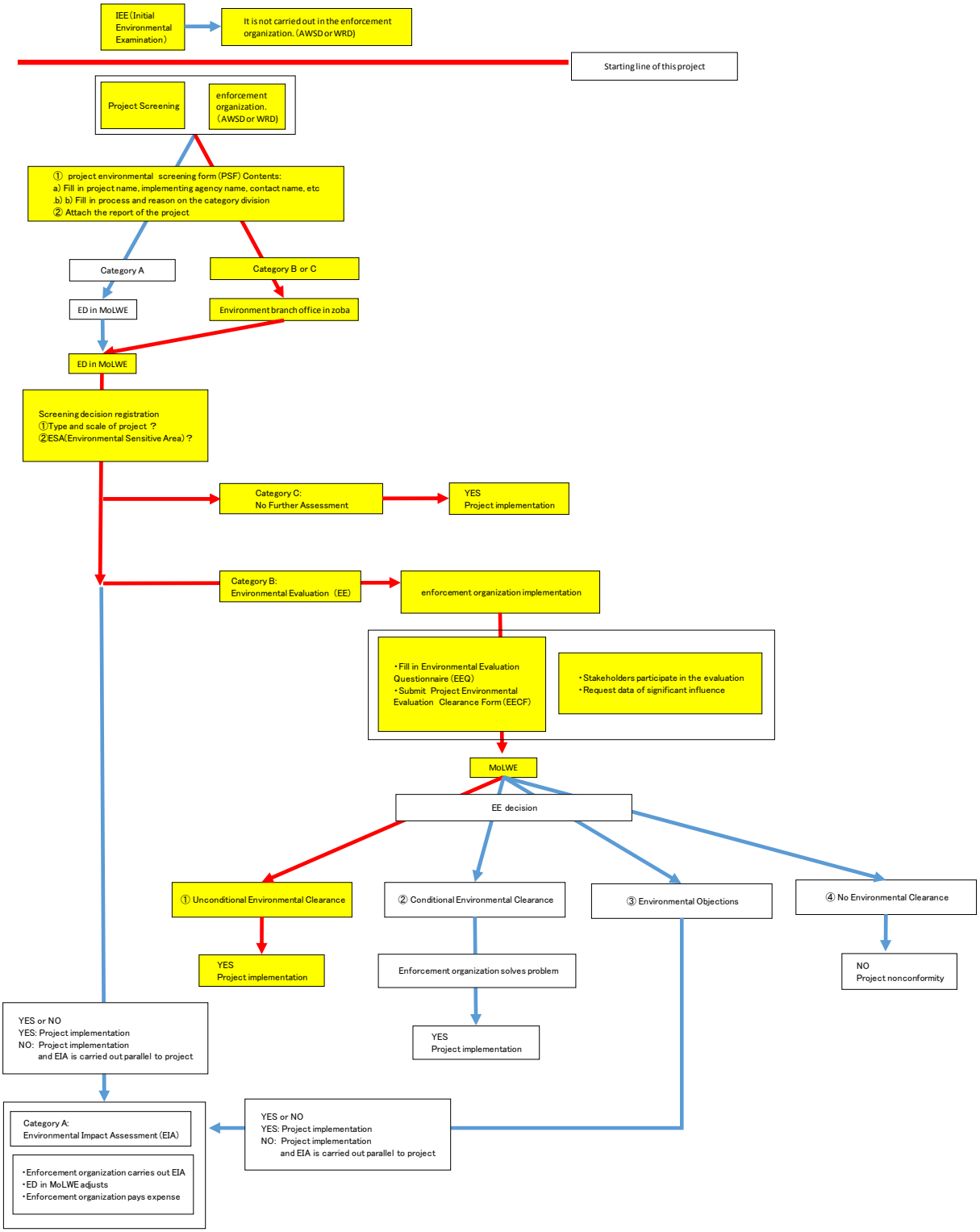
Parameter	Maximum allowable discharge into streams
Temperature(℃)	35
pH (-units)	5.5-9
Dissolved oxygen (%-sat)	75
BOD, mg/l	30
COD, mg/l	75
Ammonia (as N), mg/l	10
Color, (TCU)	50
Total coliform, nos./100ml	20000
Faecal coliform, nos./100ml	500
Arsenic (As), mg/l	0.5
Boron (B), mg/l	1
Zinc (Zn),mg/l	5
Copper (Cu), mg/l	1
Phenols	0.01
Lead (Pb), mg/l	0.05
Cyanide (CN), mg/l	0.1
Chromium (Cr), mg/l	0.5
Cadmium (Cd), mg/l	0.05
Mercury (Hg), mg/l	0.02
Selenium (Se), mg/l	0.05
Iron (Fe), mg/l	1
Manganese (Mn), mg/l	0.5
Sodium (Na), mg/l	600
Sulphate (SO4), mg/l	600
Chloride (Cl), mg/l	1000
Fluoride (F), mg/l	2.5
TDS(total dissolved solids)	2000
Oil and Scum	nil

Appendix 4.

9) Flow Chart of Environmental Assessment Procedure

4. Reference

4.9. Flow chart of environmental procedure



Appendix 4.

10) Answer to the Questionnaire

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

QUESTIONNAIRE

FOR

Preparatory Survey on the Project for Asmara Water Supply Development

Prepared by JICA Survey Team

March 2015

To AWSD:

(Asmara Water Supply and Sewerage Department, Administration of Zoba Maekel)

JICA is going to conduct "Preparatory Survey on the Project for Asmara Water Supply Development" in middle of March to middle of May, 2015.

Objectives of this survey are to collect required information of water supply sector of the Eritrea, as general condition, and Asmara city in details, and to analyze the possibility of drinking water supply improvement.

We would appreciate your cooperation in answering the following questions, and provide available data and information requested herein by March 27, 2015, for the sake of smooth implementation of the Survey.

- Form of response:
  We would like to receive the response in the form of soft data (Word/Excel/Auto CAD). We will bring our flush memory when we visit your office.
  In case the soft data is not available, please show us the hard copy of documents/drawings.
- Contact person:
  - Hidehisa Tamura (E-mail: a5361@n-koei.co.jp)
  - Koji Yoshikawa (E-mail: kingdom@heart.ocn.ne.jp)

Contents of the Questionnaire

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

I. Background and History of the Application for Japanese Grant Aid

We would like to confirm the background and history of the Application for Japanese Grant Aid.

- **To upgrade the system capacity of all the components of the water distribution system to improve service coverage and efficiency.**
- **To supply the population of Asmara with reliable, adequate and safe water which is beneficial for public health and economic activities.**

II. Current Status of Water Supply Sector in Eritrea

(1) National Development Plan

We would like to know the current overall national development plan in Eritrea.

WRD

(2) Laws/Regulation and Policy regarding Water Supply Service and Drinking Water

1) Water Resources Management

Please provide us with the Laws/Regulations and Policy on Water Resources Management in Eritrea.

See the attachment Proclamation 162/2010 and Water Resources Policy 2009

2) Water Supply Service

Please provide us with the Laws/Regulations and Policy on Water Supply Service in Eritrea.

There is no document for the whole Eritrea, but a separate draft document prepared for Massawa Water Supply is attached to this document.

3) Water Quality

Please provide us with the current regulation regarding water quality

Please see the attached Draft Document Water Quality standard of Eritrea 2004

(3) Governmental Organization related to Urban Water Supply Service in Eritrea

Please provide us with the following information.

Organization	Function

(4) Budget for Construction/Rehabilitation of Urban Water Supply Facility in Eritrea

Please provide us with past and current budget for construction/rehabilitation of urban water supply facility.

(Thousand Nakfa)

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

Zoba	2011	2012	2013	2014	2015
Maekel (AWSD)	( )	( )	( )	( )	( )

*** Data will be given from AWSD**

III. Asmara Water Supply and Sewerage Department (AWSD)

(1) Regulation on Establishment of AWSD

Please provide us with regulation/decree on establishment of AWSD.

AWSD is established during the Italian time. MEDA

(2) Organization and Staffing

Please provide us with current organization chart of AWSD. Please provide us with current staffing in the form below.

Staffing of Each Division

Division		Permanent	Contract	National Service	Total
Manager office		1			1
Water Supply Division					
Division Head		1	-	5	6
	Unit	15	26	26	67
	Unit	39	103	34	176
	Unit	-	-	9	9
Administration and Finance Division					
Division Head		1	-	2	3
	Unit	3	-	16	19
	Unit	21	24	29	74
	Unit	4	3	6	13
	Unit	2	8	6	16
	Unit	4	11	4	19
Sewerage Division					
Division Head		7	9	18	34
	Unit	-	-	-	-
	Unit	-	-	-	-
	Total	98	184	155	437

Number of Engineers/Specialist

Specialty	Manager office	Water Supply Division	Administration and Finance Division	Sewerage Division	Planning and Engineering Division
Civil engineer		1			
Assistant Engineer (Diploma)		1		1	
Junior Assistant Engineer (Technical School Diploma)		2		1	
Public Administration			1		

Accountants			**2**		

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

(3) Number of O& M Equipment

Please provide us with the information regarding the AWSD's O&M equipment

Equipment	Type/Specification	Number
Truck with hydraulic lift	Renualt (France)	1
Trench excavator	Luilong (China)	1
Damp truck	Fiat 110 (Italy)	1
4W drive cars	Toyota Helux 4WD	1

IV. Outline of Water Supply Service of AWSD

Please provide us with the annual report of AWSD as of 2012, 2013, and 2014 (tentative, if possible).

(1) Service Condition

1) Service Area, Service Population

Please provide us with the map showing service area of AWSD (both piped supply area and water tanker service area).

Please provide us with the following information as of 2014.

Item	Number
Population in the Service Area	**750,000**
Served Population	**550,000**
Number of connection	**Sirak**
Number of water tanker (Private)	**150**
Number of water tanker (AWSD)	**7**

2) Water Supply Schedule

Please provide us with the distribution area map showing the distribution pipeline and distribution zoning boundary. Please provide us with the current supply schedule as of 2014 for each distribution zone.

Zone No.	Supplied by (Name of WTP)	Supply Frequency (days/week)	On days (Sun, Mon, Tue, Wed, Thu, Fri, Sat)	Supply hours (Between)
	Mai Nefhi	**7**	**7 days**	**20 hours**
	Tokor Adi Nfas	**7**	**7 days**	**10 hours**
	Stretta Vaudetto	**7**	**7 days**	**13 hours**
	Sembel Pump Station	**7**	**7 days**	**16 hours**

***production by WTP is variable depending on the pumping hours per day based on availability of power and water conservation program (rationing regimes)**

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

(2) Operational Condition

1) Business Operation Record

Please provide us with the following information

Item	2012 (Actual)	2013 (Actual)	2014 (Tentative)
Intake volume (m3)			
Stretta Vaudetto, AdiSheka, Mai Serwa dam	No BM's	No BM's	No BM's
Toker dam	4,268,930	4,178,520	3,400,396
Mai Nefhi dam	No BM's	No BM's	No BM's
Total			
Production volume (m3)			
Stretta Vaudetto WTP	1,053,685	1,126,255	756,575
Toker WTP	3,573,650	3,929,120	2,740,396
Mai Nefhi WTP	2,833,797	3,654,972	3,162,570
Total	**7,461,132**	**8,710,347**	**6,659,541**
Billed volume (m3)			
Pipe connection	2,237038.53	2,462515.46	2,071461.37
Water tanker (AWSD)	68,761	54,126	42,528
Water tanker (Private)	490,763	640,584.4	339,971
Total	**2,796,562.53**	**3,157,225.86**	**2,453,960.37**
Number of pipe connection			
Length of distribution pipeline (km)	320	320	379
Revenue (Thousand Nakfa)			
Water sales revenue (pipe connection)	23,323,226.34	23,154,577.16	20,693,163.92
Water sales revenue Industrial	13,303,537.86	12,678,117.25	11,665,380.93
Water sales revenue (AWSD water tanker)	2,062,134.00	1,539,015.60	1,698,203.16
Water sales revenue (Private water tanker)	723,259.80	960,449.42	509,581.00
Water sales revenue (other water tanker)			
Other revenue	9,958,553.47	33,608,593.00	44,744,831.89
Other (subsidy, etc.)	43,208.78	37,029.94	4,449,651.01
Total	51,645,492.60	74,592,801.35	86,764,422.55
Expense (Thousand Nakfa)			
Personnel (Salary, Allowance, etc)	6,769,181.58	6,891,871.71	6,113,122.84
Energy (Electricity)	13,027,769.43	8,069,913.45	7,286,446.66
Energy (Fuel for Pumps)	24,940,691.36	17,287,656.25	16,977,781.07
Energy (Fuel for water tanker)	860,667.04	1,158,834.73	1,039,273.00
Chemical	266,000.00	1,244,369.50	1,252,851.65
House connection work	1,639,285,85	3,585,250.87	13,265,515.97
Maintenance/Repair	2,773,318.96	2,462,219.18	3,888,544.12
Other	1,731,196.81	2,304,170.66	3,835,099.20
Total	52,008,111.03	43,004,286.35	53,658,544.51

2) Customer Service and Tariff collection

Please provide us with:

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

- Current tariff table See attachment tariff table
- Sample customer contract. See attachment customer water contract
- List of Bulk users **Please see attachments Asmara drawings page 25 bulk users list**
- Sample of customer list **Please see attachment document number sample**
- Installation ratio of customer meter Sirak
- Method of billing **Customers read their water meter & present reading on the counter EVERY 3 MONTYHS**
- Method of tariff collection **Please see table 5**
- Installation record of water meter Sirak
- Repair record of water meter **NoT YET**
- Supplier of water meter **Bosco and Unimag schlumberger**

3) Financial Condition

Please provide us with the breakdown of revenue and expense record as of 2013 and 2014 (Tentative).

Please provide us with the capital expenditure record for last three years: 1) from Donors, 2) from own sources, 3) from Zoba, 4) from Central Government.

ESTIF

4) Procurement condition

Please provide us with the list of supplier of each equipment/material

Company Name	Address	Contact person	TEL&FAX(E-Mail)	Activity
				Pipe, valve, fittings
				Pump
				chlorine
				ALUM (aluminum sulfate) or PAC
				calcium hydroxide

Please provide us with the sample procurement documents

ESTIF

(3) Business Plan

Please provide us with the business plan of 2015 and long/medium term plan, if any. **NoT YET**

JOHN

Please provide us with output of Asmara Infrastructure Development Study including electric CAD data and pipeline network modeling data.

- Phase-1: Urban Development Plan
- Phase-2: Feasibility Study, Water Sector, Water Supply
- Phase-3: Detail Design of Priority Projects

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

Please find attachment document on Asmara Infrastructure Development

1) Water Demand Projection

Please provide us with the water demand projection (target year, service area, service population, planned per capita consumption, target ratio of water loss, etc.) applied by AWSD.

Please see table 1

Please provide us with the latest population data in the service area.

Please see table of recent population on table (Maekel Population)

2) Upper Level Plan of Water Supply Development Plan

Please provide us with:

- Water Resources Management Plan of Zoba Maekel **Misghina**
- Urban Development Plan of Asmara city **Medhanie**

3) Plan for strengthening water production and distribution capacity

Please provide us with the current plan for strengthening water production and distribution capacity, if any. **The only plan is ASMARA INFRASTRUCTURE DEVELOPMENT STUDY 2005**

4) Major Issues for future development of water supply service

Please list up the major issues for safe, sufficient, stable, and sustainable water supply service of AWSD.

1. **Construction of Ungula and Demsebai Dams as sources of water supply**
2. **Their respective WTP, Pumping stations and Transmissions mains**
3. **Construction of Ababruk dam as a backup dam for Mainefhi dam, its raw water pumping station and transmission mains.**
4. **CAPCITY BUILDING**

V. Outline of Water Supply Facility of AWSD **Please see attached drawing document**

V-1. Intake Facility (River and Dam)

Please provide us with the following information.

V-1-1. Water utilization

(1) Construction project or water-utilization plan in Anseba river and Nefhi river basins (Upper River basin of TOKAR Dam and MAI NEFHI Dam)

Items	Upper River basin of TOKAR Dam	Upper River basin of MAI NEFHI Dam
	Water demand（m3/d or %）	Water demand（m3/d or %）
Drinking water by water supplier	No BM's at Adisheka, Streta vaudetto, Maiserwa and Elanahib dams	Nothing
Drinking water from river for local people	Nothing	Nothing
Industrial water	Nothing	Nothing
Irrigation water	Asmara Flowers No water meters	Nothing

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

Water for electric power plant	No water meter Beleza Dam	Nothing
Water for fishery (aquaculture)	Not working at this time	Nothing
Others	Not quantified. Micro dams for micro-irrigation, soil and water conservation	Nothing
Total		

*** for more clarification please see hydrological map of Zoba Maekel**

(2) Customary water right or water right for drinking water, industrial water, drinking water from river, agricultural water, water for electric power plant, and water for fishery in Anseba river and Nefhi river basins **Mebrahtu Iyassu**

(3) Location and structure of existing dams in Maekel (Central) region

Please see the attached hydrological map of Zoba Maekel

Appendix 4-10)

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

V-1-2. Existing Dam (TOKAR, ADI SHEKA, MAI SERWA、STRETTA VAUDETTO, BELEZA, VALLE GNECCHI, ELA NAHIB, MAI NEFHI Dam)

Items		TOKAR	ADI SHEKA	MAI SERWA	STRETTA VAUDETTO	BELEZA	VALLE GNECCHI	ELA NAHIB	MAI NEFHI
River Name		Tokor		Mai Hutsa					Nefhi
Intended use		AWS	Hydro-electric	AWS	AWS	Thermo Electricity	Hydro-electric	Hydro-electric	AWS
Structure Type		RCC	Earth	Masonry	Concrete	Earth	Earth	Earth	Masonry
Dam Size	Length								
	Height(Max)								
	Upper Wide(Max)								
	Bottom Wide(Max)								
	Dam volume								
Catchment area		89	38	10	15	7			97
Water surface area									
Gross storage capacity		13.6	6	2.1	0.320	1.2	0.6	0.6	26
Effective storage capacity		9.2	4.2	1.47	0.22	0.84	0.42	0.42	19
Landownership		Gov	Gov	Gov	Gov	Gov	Gov	Gov	Gov
Ownership of structure		AWSD	AWSD	AWSD	AWSD	AWSD	AWSD	AWSD	AWSD
Water rights		Only given to AWSD	Only given to AWSD	Only given to AWSD	Only given to AWSD	Only given to AWSD	Only given to AWSD	Only given to AWSD	Only given to AWSD
Conservation-Management for Catchment area		MOA, zoba Maekel	MOA, zoba Maekel	MOA, zoba Maekel	MOA, zoba Maekel	MOA, zoba Maekel	MOA, zoba Maekel	MOA, zoba Maekel	MOA, zoba Maekel
Management for Structure		AWSD	AWSD	AWSD	AWSD	AWSD	MOA	AWSD	AWSD
Current Problem		No enough runoff due to climate chang	No enough runoff due to climate chang	High leakage & sedimentation, No enoug	High sedimentation accumulated, No	High sedimentation accumulated, No enough runoff due	High sedimentation accumulated, No enough	High sedimentation accumulated	No enough runoff due to climate change,

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

	e,	e,	h runoff due to climate chang e,	enoug h runoff due to climate chang e,	to climate change,	runoff due to climate change ,	, No enoug h runoff due to climat e chang e,	

V-1-3. Erosion and flood control

Please describe the detailed contents of the Disasters Report (flood, drought, overflowing of river, landslide etc.) in Anseba river and Nefhi river basins (Upper River basin of TOKAR Dam and MAI NEFHI Dam) (last decade) with the following information

Location		Date	cause	situation of damage
Upper River basin of TOKAR Dam	Between TOKAR and ADI SHEKA Dam	**WRD**		
	Upper side of ADI SHEKA Dam			
	Between TOKAR and MAI SERWA Dam			
	Between MAI SERWA and STRETTA VAUDETTO Dam			
	Between STRETTA VAUDETTO and BELEZA Dam			
	Upper side of BELEZA Dam			
	Between STRETTA VAUDETTO and VALLE GNECCHI Dam			
	Between STRETTA VAUDETTO and ELA NAHIB Dam			
	Upper side of VALLE GNECCHI Dam			
	Upper side of ELA NAHIB Dam			
Upper River basin of MAI NEFHI Dam	Upper side of MAI NEFHI Dam			

*** Generally**

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

V-2. Raw Water Conveyance Facility

Please provide us with the following information.

	Adi Sheka dam to Stretta Vaudetto WTP	Stretta Vaudetto dam to Stretta Vaudetto WTP	Mai Serwa dam to Stretta Vaudetto WTP	Toker dam to Toker WTP	Mai Nefhi dam to Mai Nfhi WTP
Raw water conveyance pump station					
Pump capacity and number	400m^3/hr each, 2 pumps	400m3/hr, 1 pump	250m3/hr, 1 pump	1200m3/hr, 2 pumps with diesel engines	Gravity
Year of construction	1997	1998	1963	2000	1970
Condition	Need replacement	Need replacement on its original location	Need replacement	Need replacement with electrical motors	Need replacement
Raw water conveyance pipeline					
Pipe material	Open channel	GI	Asbestos + Cast Iron	ductile Iron	Cast Iron
Pipe diameter		150mm	300mm	600mm	500mm
Pipe length		500m	2700m	20000m	150m
Year of construction	1942	1941	1963	2000	1970
Condition	Fair	Need replacement	Urgently need replacement	Good	Urgently need replacement

Please provide us with the location map and drawings showing pipe alignment, longitudinal and cross section, valve location, etc. of the above facility.

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

V-3. Water Treatment Facility

Please provide us with the following information.

(1) Inlet, Outlet Volume and Operation Time

WTP Name	Inlet (m3/day)	Outlet (m3/day)	Operation Time (hour/day)
STRETTA VAUDETTO (S.V.) WTP	12600	5000	13
TOKER WTP	11000	7200	10
MAI NEFHI WTP	Depends on water level of dam	12000	20

(2) Problem of each Facility

Items	STRETTA VAUDETTO (S.V.) WTP	TOKER WTP	MAI NEFHI WTP
Intake Basin			
Mixer			
ALUM(aluminum sulfate) or PAC			
Calcium hydroxide			
Flocculation Basin			
Sedimentation Basin			
Filter basin			
Air Blow			
Back Wash			
Clean water Tank			
chlorination			
Electric System			

V-4. Treated Water Transmission Facility from WTP to Service Area

Please provide us with the following information.

V-4-1. Transmission Pump Station

	Stretta Vaudetto WTP	Toker WTP	Mai Nefhi WTP
Pumps			
Pump capacity and number	500m3/hr, 2 pumps	450m3/hr, 3 pumps	500m3/hr, 3 pumps
Year of construction	1941 and 2013	2000	1971
Condition	One need replacement	Fair	Need replacement
Pump well			
Elevation	2350	2375	2150
Volume	600m3	5000m3	800m3
Year of construction	1941	2000	1971
Condition	Bad	Need maintenance	Need maintenance

Please provide us with the drawings of the above facility.

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

V-4-2. Treated Water Transmission Pipeline

	Stretta Vaudetto WTP to Service Area	Toker WTP to Service Area	Mai Nefhi WTP to Service Area (New Sembel PS)
Pipe material	PVC	Ductile Iron	Cast Iron
Pipe diameter	300mm	400mm	500mm
Pipe length	About 3.6 Km	About 3.25 Km	25 Km
Pipe bridge (type, span)	-		?
Year of construction	1999	2000	1971
Condition	Good	Good	Urgently Need replacement

Please provide us with the location map and drawings showing pipe alignment, longitudinal and cross section, valve location, etc. of the above facility.

V-5. Treated Water Transmission/Distribution Facility in the Service Area

Please provide us with the following information.

V-5-1. Transmission/Distribution Pump Station

	Sembel	Godaif	MaiChhot	Denden
Pumps				
Pump capacity and number	450m3/hr, 3 pumps	500m3/hr, 300m3/hr, 2 pumps	200m3/hr, 150m3/hr, 2 pumps	200m3/hr, 2 pumps
Year of construction	1998	2013, 1971	2013, before 1971	1956
Condition	Fair	1 need replacement	1 need replacement	Need replacement
Pump well				
Elevation	2320	2324	2336	2348
Volume	3000m3	Relay station or buster pump	480m3	3000m3
Year of construction	1971	1971	Before 1971	1956
Condition	Need maintenance	Should be abandoned	Need maintenance	Need maintenance

Please provide us with the drawings of the above facility.

V-5-2. Distribution Reservoir

	Tsetserat	Hazhaz	Mihram Chira	Arbate Asmara	Monopolio	Addis Alem
Elevation	2361	2361	2375	2394	2360	2372
Capacity	2x500	2x500	300	500	2x300	250
Year of construction						
Condition	Need maintenance	Need maintenance	Not in use	Not in use	Need maintenance	Need maintenance

Please provide us with the drawings of the above facility.

Please provide us with current reservoir operation (water level fluctuating pattern)

V-5-3. Transmission/Distribution Pipeline Network

- General network drawings showing:
  - Location, material, diameter, construction year of primary network
  - Location of secondary network
  - Location of major valves
  - Boundary of distribution zoning
- Detail network drawings showing:
  - Location, material, diameter, of primary and secondary network
  - Location of service connection on the primary pipe
- Detail drawings of the major valve chamber
- Pipe Inventory (pipe length by material, construction year, and diameter)
- Repair record of distribution pipeline
- Standard cross section drawings of pipe installation

*** Please see the attachment document on Asmara infrastructure Development Study; Water Sector: Drainage- Water Supply – Sanitation Drawings**

V-5-4. Current valve operation for scheduled water supply restriction

Please provide us with the current valve operation for scheduled water supply restriction

*** Data From John**

V-5-5. Schematic drawing and modeling data for pipe network analysis

Please provide us with the modeling data for pipe network analysis made by the Asmara Infrastructure Development Study.

Please see the attachment document on Asmara infrastructure Development Study; Water Sector: Drainage- Water Supply – Sanitation Drawings

V-6. Water Service Facility

Please provide us with the following information.

- Location of water tanker filling station and bulk user.
- Supply hour and average daily supply volume of each filling station
- Average daily consumption of the bulk users
- Standard drawings of customer connection
  - i) Direct connection to tap
  - ii) Connection to receiving tank
- Approximate ratio of the number of i) and ii) (if data is available)
- **Please see the attachment document on Asmara infrastructure Development Study;**

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

Water Sector: Drainage- Water Supply – Sanitation Drawings

VI. Operation and Maintenance by AWSD

Please provide us with the following information.

VI-1. Current Problem in Operation and Maintenance of each water supply facility.

Facility	Problem of Operation and Maintenance
Dam and Intake Facilities	
VALLE GNECCHI Dam	High sedimentation (mud) inside the dam, pipeline connecting to the S.V. WTP is destroyed, no BM's meters to WTP
ELA NAHIB Dam	High sedimentation (mud) inside the dam no BM's to WTP
STRETTA VAUDETTO (S.V.) Dam	High sedimentation (mud) inside the dam, primary and secondary Intake structure not working, Leakage from dam, no BM's to WTP
BELEZA Dam	High sedimentation (mud) inside the dam
MAI SERWA Dam	High sedimentation (mud) inside the dam, high leakage from dam , no BM's meters to WTP, We are not using the hydraulic pressure from the dam elevation since we first put in the pumping station reservoir.
ADI SHEKA Dam	High sedimentation (mud) inside the dam, in pumping station one motor is working, no BM's meters to WTP
TOKER Dam	High running cost due to Diesel engine and should be replaced by electric motors
MAI NEFHI Dam	Moderate sedimentation problem. no BM's meters to WTP
Raw Water Pipe and Open Channel (Inc. Pump Station)	
ADI SHEKA Dam - S.V.WTP	500m asbestos pipe line, contamination on Open channel
MAI SERWA Dam - S.V.WTP	Replacement of 2.5Km asbestos pipeline
S.V Dam - S.V.WTP	No BM's meters
TOKER Dam - TOKER WTP	
MAI NEFHI Dam - MAI NEFHI WTP	no BM's meters
Water Treatment Plant	
STRETTA VAUDETTO (S.V.) WTP	Requires high maintenance, need to be replaced by new WTP
TOKER WTP	Automatic equipment are not functioning, liquid chlorine producing plant is not working, chlorine hypochlride mixer is not working, electric motors for mixing and string need replacement, need backup generator
MAI NEFHI WTP	Generally requires full maintenance on main structure, Gas chlorine should be stopped and need to be replaced as in Tokor WTP, mixers of aluminum sulphate together with injectors need maintenance and/or replacement, need backup generator, no BM's to WTP and BM's

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

	from WTP to Sembel pumping station need to be replaced.
Clean Water Pipe (Inc. Pump Station)	
S.V.WTP - P.S or Reservoir in City	No BM's meters
TOKER WTP - P.S or reservoir in City	Backup pumps are required
MAI NEFHI WTP - NEW SEMBEL P.S.	pumps are old and need to be replaced, pipe line is old and need to be replaced, BM's meter is not working and need to be replaced
NEW SEMBEL P.S. - P.S or reservoir in City	The reservoir itself require maintenance, backup generator required. Pumps need to be replaced with better head and efficiency so as to supply with Godaif pumping station
Pump Station in city	
MAI CHEHOT P.S.	
DENDEN P.S.	
NEW SEMBEL P.S.	
GODAIF P.S.	Not required if the Sembel is replaced
Reservoir	
MIHRAM CHIRA E.T.	Not use
ARBATO ASMARA E.T.	Not use
ADDIS ALEM Reservoir	Not use
HAZHAZ Reservoir	Requires maintenance
TSETSERAT Reservoir	Requires maintenance
MONOPOLIO Reservoir	Requires maintenance
Distribution Pipe	
North East (From S.V.WTP mainly)	
North West and Central (From TOKAR WTP mainly)	
South (From MAI NEFHI WTP mainly)	
Service Pipe	
Public Water Tap	
Private	
Large Consumer (Industry)	They are suffering from shortage of water supply. Therefore, they have to assess their own groundwater sources.
Truck Hydrant (LC1 P.E, Haz Haz, Sembel)	

VI-2. Non-Revenue Water (NRW) Reduction

(1) Action plan for NRW reduction

(2) Activity for leak Detection and pipe repair work

(a) Record of number of leakage repaired in 2014

Items	No
Major leak and pipe burst	
Minor leak and service connection leakage	
Meter leak	

Broken meter	

(b) Number of pipe repair team and staff composition

・Number of pipe repair team

・Number of staff

・List of equipment and vehicle

(3) If you have established a computerized mapping system (CAD or GIS), please describe the contents of the mapping system (e.g. kind of software, kind of data compiled, coverage of network, linkage to water tariff collection system and number of computer installed).

(4) What is the most critical problem which you encounter in NRW reduction at present?

VI-3. Water quality management

(1) Water sampling point, frequency of test and parameter of water quality test, and the latest water quality test records of raw water and treated water.

(2) List of laboratory and its staff composition (number, level and specialty).

(3) List of available laboratory equipment for water quality analysis.

(4) Current issues and problems on drinking water quality which you encounter at present.

*** We are using Water Resources Department Water Quality laboratory. All information can be provided from Mr Efrem Teferi**

VI-4. Staff training

(1) Records of staff training in the year 2014

(a) Number of trainees (managers, engineers and operators/office clerks/workers) by each training course.

(b) Budget for staff training.

(2) Do you have trainers for staff training in your office? If you have, please describe their name and training course they teach, and records of staff training in your office.

(3) Your plan for staff training in the year 2015.

(4) Do you have job description or qualification system for each post?

(5) Do you have any incentive system for trainers and trainees such as promotion and salary rise?

(6) If you have any problem in staff training, please describe it in detail.

VI-5. Assistance for O&M

Please list up required assistance for O&M

VII . Environment and Social Consideration

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

Please provide us with the following information

VII -1. Environmental Impact Assessment (EIA)

(1) Please provide us with the legal system, competent authorities and procedure of following information.

1) Initial Environmental Examination(IEE)

2) Project Environmental Screening

3) Project Environmental Evaluation (EE)

4) Environmental Impact Assessment (EIA)

*** The Department of Environment has National Environmental Impact Assesment Guideline. All the IEE, PSF, EE AND EIA are included in it.**

(2) Have you surveyed the IEE for the project which you requested to Japan?

*** No.**

(3) Have you submitted the project environmental screening form (PSF) for the requested project to the environment department?

*** Department of Environment was part of the study and already PSF is done. The whole study of Asmara infrastructure development study.**

(4) How do you think that the requested project is necessary to do EIA ?

*** Yes it is good to review EIA due to that the fact the last study was carried before 10 years back.**

VII -2. Environment (esp. Maekel (Central) region)

Please provide us with the following information and map.

(1) Reserve, national park *** No National Park**

(2) Habitat of Vegetation flora *** Yes, but information we could not find in map form other than the land cover map.**

(3) Habitat of water creatures, rare animals and plants *** No information**

(4) Migratory fish *** No migratory fish in the project area.**

(5) Breeding place, feeding area for wild animals *** The breeding and feeding place is the Semenawi Bahri and Eastern Escarpment protected area which is out of the project development site.**

VII -3. Culture (esp. Maekel (Central) region)

Please provide us with information and maps of (cultural, natural, religious, archaeological) heritages and historic spot, Nationally-designated important cultural property

For a time being it is not yet mapped. It can be mapped during the EIA process.

VII -4. Ethnic group (esp. Maekel (Central) region)

Please provide us with the following information and map.

(1) Residence area of ethnic group and segment *** there is no residence by ethnic groups**

(2) Ethnic group conflict *** no ethnic conflict in the project area even within the country**

(3) Culture and life pattern of minority or indigenous group *** there is no such things in Eritrea. All ethnic, culture, language and religion have equal rights and live together with respecting each other.**

VII -5. Region (esp. Maekel (Central) region)

Please provide us with the following information

(1) Average earnings and family structure per household *** At this time we could not find census data.**

(2) Regional industry *** refer to maps provided as a potential point source pollutant industries.**

(3) Data of water disease (diarrhea, typhoid (fever), cholera, schistosomiasis) *** we do not have at hand in this time.**

VIII . Electric Power Supply

Please provide us with the following information.

(1) Electricity supply time per day (Average) in Maekel (Central) region *** it is completely variable**

(2) Current tariff applied by EEC * **Please look the bill attached**

IX. Others

Please provide us with the following information.

IX-1. Condition of Access Road

Access Road	Problem
STRETTA VAUDETTO (S.V.) Dam	Need minor maintenance and increase width
MAI SERWA Dam	No problem
ADI SHEKA Dam	No problem
TOKER Dam	Require maintenance especially with in the Tokor valley
MAI NEFHI Dam	No problem
STRETTA VAUDETTO (S.V.) WTP	Need minor maintenance and increase width
TOKER WTP	Need minor maintenance and increase width
MAI NEFHI WTP	Road with in the valley need to be change to asphalt

IX-2. Construction Companies and Suppliers

(1) List of construction companies (civil, building, pipe installation and electricity) having experiences of water supply works

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

Company Name	Address	Contact person	TEL&FAX(E-Mail)	Activity
				Civil
				Building
				Pipe installation
				Electricity

(2) List of suppliers (Pump, pipe, valve and fittings)

Company Name	Address	Contact person	TEL&FAX(E-Mail)	Activity
				Pipe, valve, fittings
				Pump
				chlorine
				ALUM (aluminum sulfate) or PAC
				calcium hydroxide

IX-3. Procedure and permission

(1) Competent authorities and Procedure of permission for Water supply facilities

(2) Competent authorities and procedure for land acquisition for water supply facilities

*** land is Government owned,. The responsibility department is Department of Land under the ministry of land, water and environment. There is no problem to own land for water supply.**

X. Related Document and Data

Please provide us with following document and data.

X-1. Law and regulation

River	River Law
	Law of customary water right or water right (Drinking, industry, drawing water from river, agriculture, fishery)
Water	Water Law (River and Drinking water quality standard, daily maximum water-consumption etc.) *** pls look the attached Water Law 162/2010**
	Water supply facility standard (intake, filtration, distribution) *** we use ISO standard.**
Hygiene	Hygiene Law (drinking water quality standard) *** pls see Draft Eritrea Water Quality Standard 2004**
Sewerage	Sewerage Act (Effluent standard; SS、BOD、COD、pH etc.) *** in draft form from DOE**
Waste Disposal	Waste Disposal Law *** in draft form from DOE**
Environment	Environmental Law (regulation of nature and wild animal reserve) *** in draft**

	form from DOE
	Environment Protection Law *** in draft form from DOE**
	Environmental Standards Law (Air pollution, noise, vibration) *** in draft form from DOE**
	Law of EIA for dam and Water supply **?????**
Land	Land Law (landownership) *** Land Law 1994**
	Land Law (land transfer) *** Land Law 1994**
	Regulation of Land Acquisition *** Land Law 1994**
	Regulation of compensation for resettlement ???????????
	Regulation of land utilization *** Land Law 1994**
Tax	Regulation of collect [levy] tax (real estate tax, consumption tax, customs duty etc.) *** Office of inland revenue and Municipality of Asmara and administrative regions.**
Labor	Labor Standards Act (Minimum wage etc.) *** Yes there is but we could not find copy at this time.**
	Industrial Safety and Health Law (safety statutes) *** Yes there is but we could not find copy at this time.**

X-2. Map

Basic	Topographical map in Maekel (Central) region (approx. scale 1:5000) *** We have 1:50,000 scale**
	Geological Map in Maekel (Central) region *** We have 1:50,000 scale for the project area**
	Hydrogeological Map in Maekel (Central) region *** We have 1:50,000 scale for the project area**
	Soil map in Maekel (Central) region *** We have 1:50,000 scale for the project area**
River	Location map of water flow observation station in Anseba river and Nefhi river basins *** We have 1:50,000 scale for the project area**
Meteorological	Location map of a precipitation station in Maekel (Central) region *** We have 1:50,000 scale for the project area**
Ecosystem	Natural vegetation map in Maekel (Central) region *** We do not have this**
	Inhabitation map of wildlife in Maekel (Central) region *** We do not have this**
	Nature reserve and protection area *** Pls see land cover map of project area**
Land	Land use map in Maekel (Central) region *** We have 1:50,000 scale for the project area**
	Land-block map in Maekel (Central) region **???????**
	Map of state-owned land municipal land *** All Land is owned by Government**
Water-utilization	Water-utilization distribution map in Anseba river and Nefhi river basins (Drinking, industry, drawing water from river, agriculture, fishery) *** pls refer to hydrological map**
Erosion and flood control	Erosion and flood control plan map in Anseba river and Nefhi river basins *** We could not find at this time**

X-3. Monitoring Data

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To AWSD

Meteorological	Hourly rainfall, monthly rainfall, sunny day, rainy day, wind direction, wind velocity, evapotranspiration, temperature, humidity, atmospheric pressure, hourly sunlight, intensity of solar radiation (last decade) at precipitation station in Maekel (Central) region
River	Water level, water quality, discharge rate (last decade) at water flow observation station in Anseba river and Nefhi river basins
Dam	Water Level of each dam (TOKAR, ADI SHEKA, STRETTA VAUDETTO, BELEZA, VALLE GNECCHI, ELA NAHIB, MAI NEFHI Dam) *** pls refere to attached table**
Water quality	Water quality of Raw, Clean and Drinking water (3 years) at each WTP(TOKAR, STRETTA VAUDETTO, MAI NEFHI WTP)
Hygiene	Water disease in Maekel (Central) region (diarrhea, typhoid (fever), cholera, schistosomiasis**)** *** We could not find now, but is negligible at this time**.

X-4. Document

(1) Design Report (Inc. Drawings) for each existing dam (TOKAR, ADI SHEKA, STRETTA VAUDETTO, BELEZA, VALLE GNECCHI, ELA NAHIB, MAI NEFHI Dam)

(2) Design Report (Inc. Drawings) for each Water treatment Plant (TOKAR, STRETTA VAUDETTO, MAI NEFHI)

Table 1 Population Projection and Water Demand Analysis

WATER DEMAND FORECAST

			2005		LOW HYPOTHESIS				REFERENCE HYPOTHESIS			
			shortage	demand	2010	2015	2020	2025	2010	2015	2020	2025
GREAT ASMARA POPULATION		**Number**	**450 000**	**450 000**	**579 817**	**745 311**	**765 653**	**822 796**	**579 817**	**745 311**	**765 653**	**822 796**
		Growth rate			*5.2%*	*5.2%*	*0.5%*	*1.5%*	*5.2%*	*5.2%*	*0.5%*	*1.5%*
Households		Number	100 000	100 000	128 848	165 625	170 145	182 844	128 848	165 625	170 145	182 844
People per household		Number	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
NON SERVED POPULATION		**Number**	**40 000**	**40 000**	**40 587**	**44 719**	**38 283**	**41 140**	**40 587**	**40 992**	**30 626**	**32 912**
		%			**7.0%**	**6.0%**	**5.0%**	**5.0%**	**7.0%**	**5.5%**	**4.0%**	**4.0%**
SERVED POPULATION		**Number**	**410 000**	**410 000**	**539 230**	**700 592**	**727 370**	**781 656**	**539 230**	**704 319**	**735 027**	**789 884**
By connection		Number	266 500	266 500	377 461	525 444	581 896	664 408	377 461	549 369	602 722	695 098
		%	65%	65%	70%	75%	80%	85%	70%	78%	82%	88%
By water tank trucks or public taps		Number	143 500	143 500	161 769	175 148	145 474	117 248	161 769	154 950	132 305	94 786
		%	35%	35%	30%	25%	20%	15%	30%	22%	18%	12%
CONSUMPTION		**m3/day**	**19 000**	**24 134**	**32 586**	**43 515**	**46 402**	**51 272**	**34 767**	**52 244**	**60 982**	**68 560**
By connections		m3/day	16 100	20 690	28 704	39 311	42 911	48 458	30 884	48 112	57 454	66 033
Domestic		m3/day	13 100	15 990	22 648	31 527	34 914	39 864	24 535	39 555	48 218	55 608
Non domestic		m3/day	3 000	4 700	6 056	7 784	7 997	8 594	6 349	8 557	9 236	10 425
	Non domestic growth rate				*5.2%*	*5.2%*	*0.5%*	*1.5%*	*6.2%*	*6.2%*	*1.5%*	*2.5%*
By water tank trucks		m3/day	2 900	3 444	3 882	4 204	3 491	2 814	3 882	4 132	3 528	2 528
Domestic	75%	m3/day	2 175	2 583	2 912	3 153	2 619	2 110	2 912	3 099	2 646	1 896
Non domestic	25%	m3/day	725	861	971	1 051	873	703	971	1 033	882	632
Per capita domestic consumption		lpc/day	37	45	47	50	52	54	51	61	69	73
By connection		lpc/day	49	60	60	60	60	60	65	72	80	80
By water tank trucks or public taps		lpc/day	15	18	18	18	18	18	18	20	20	20
LOSSES		**m3/day**	**5 051**	**11 887**	**12 052**	**14 505**	**15 467**	**17 091**	**12 859**	**17 415**	**20 327**	**22 853**
		%	**21%**	**33%**	**27%**	**25%**	**25%**	**25%**	**27%**	**25%**	**25%**	**25%**
TOTAL DEMAND			**24 051**	**36 021**	**44 638**	**58 019**	**61 869**	**68 363**	**47 626**	**69 658**	**81 310**	**91 414**

End

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To WRD

QUESTIONNAIRE

FOR

Preparatory Survey on the Project for Asmara Water Supply Development

Prepared by JICA Survey Team

March 2015

To WRD

(Water Resources Department, Ministry of Land, Water and Environment)

JICA is going to conduct "Preparatory Survey on the Project for Asmara Water Supply Development" in middle of March to middle of May, 2015.

Objectives of this survey are to collect required information of water supply sector of the Eritrea, as general condition, and Asmara city in details, and to analyze the possibility of drinking water supply improvement.

We would appreciate your cooperation in answering the following questions, and provide available data and information requested herein by March 27, 2015, for the sake of smooth implementation of the Survey.

- Form of response:
  We would like to receive the response in the form of soft data (Word/Excel/Auto CAD). We will bring our flush memory when we visit your office.
  In case the soft data is not available, please show us the hard copy of documents/drawings.
- Contact person:
  - Hidehisa Tamura (E-mail: a5361@n-koei.co.jp)
  - Koji Yoshikawa (E-mail: kingdom@heart.ocn.ne.jp)

Contents of the Questionnaire

I. Background and History of the Application for Japanese Grant Aid

We would like to confirm the background and history of the Application for Japanese Grant Aid.

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To WRD

II. Current Status of Water Supply Sector in Eritrea

(1) National Development Plan

We would like to know the current overall national development plan in Eritrea.

- To upgrade the system capacity of all the components of the water distribution system to improve service coverage and efficiency.
- To supply the population of Asmara with reliable, adequate and safe water which is beneficial for public health and economic activities.

(2) Laws/Regulation and Policy regarding Water Supply Service and Drinking Water

1) Water Resources Management

Please provide us with the Laws/Regulations and Policy on Water Resources Management in Eritrea.

See IWRM action plan

2) Water Supply Service

Please provide us with the Laws/Regulations and Policy on Water Supply Service in Eritrea.

There is no document for the whole Eritrea, but a separate draft document prepared for Massawa Water Supply is attached to this document.

3) Water Quality

Please provide us with the current regulation regarding water quality

Please see the attached Draft Document Water Quality standard of Eritrea 2004

(3) Governmental Organization related to Urban Water Supply Service in Eritrea

Please provide us with the following information.

Organization	Function
All urban settlements in Eritrea are autonomous.	They carry out urban water supply under the municipality of each urban center. They will cover their O&M from their income.

(4) Budget for Construction/Rehabilitation of Urban Water Supply Facility in Eritrea

Please provide us with past and current budget for construction/rehabilitation of urban water supply facility.

(Thousand Nakfa)

Zoba	2011	2012	2013	2014	2015
Maekel (AWSD)	( )	( )	( )	( )	( )
Debubu					
Gash-Barka					

Anseba					
Northern Red Sea					
Southern Red Sea					

*** Data will be given from AWSD**

*** other data could be provided from Michael Yosief, Mr Misghina and DJ Mebrahtu**

(5) Current Assistance by Foreign Donors in Water Supply Sector in Eritrea

Please provide us with the following information.

Donor	Project Name	Project Area	Period	Amount (Million Nakfa)
UNICEF				
AfDB				
World Bank				
EU				
Other ( )				
Other ( )				

*** Data will be given from AWSD**

*** other data could be provided from Michael Yosief, Mr Misghina and DJ Mebrahtu**

III. Integrated Water Resources Management Plan (IWRM)

Do you have any plan of Integrated Water Resources Management regarding Anseba river and Nefhi river basins or around Asmara city ? *** Pls look the IWRM action plane;**

If you have, please show us the plan.

IV. Water quality management

(1) Water sampling point, frequency of test and parameter of water quality test, and the latest water quality test records of raw water and treated water.

(2) List of laboratory and its staff composition (number, level and specialty).

(3) List of available laboratory equipment for water quality analysis.

(4) Current issues and problems on drinking water quality which you encounter at present.

*** We are using Water Resources Department Water Quality laboratory. All information can be provided from Mr Efrem Teferi**

V. Environment and Social Consideration

Please provide us with the following information

V-1. Environmental Impact Assessment (EIA)

(1) Please provide us with the legal system, competent authorities and procedure of following information.

1) Initial Environmental Examination(IEE)

2) Project Environmental Screening

3) Project Environmental Evaluation (EE)

4) Environmental Impact Assessment (EIA)

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To WRD

*** The Department of Environment has National Environmental Impact Assesment Guideline. All the IEE, PSF, EE AND EIA are included in it.**

(2) Have you surveyed the IEE for the project which you requested to Japan?

*** No.**

(3) Have you submitted the project environmental screening form (PSF) for the requested project to the environment department?

*** Department of Environment was part of the study and already PSF is done. The whole study of Asmara infrastructure development study.**

(4) How do you think that the requested project is necessary to do EIA ?

*** Yes it is good to review EIA due to that the fact the last study was carried before 10 years back.**

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To WRD

V-2. Environment (esp. Maekel (Central) region)

Please provide us with the following information and map.

(1) Reserve, national park *** No National Park**

(2) Habitat of Vegetation flora *** Yes, but information we could not find in map form other than the land cover map.**

(3) Habitat of water creatures, rare animals and plants *** No information**

(4) Migratory fish *** No migratory fish in the project area.**

(5) Breeding place, feeding area for wild animals *** The breeding and feeding place is the Semenawi Bahri and Eastern Escarpment protected area which is out of the project development site.**

V-3. Culture (esp. Maekel (Central) region)

Please provide us with information and maps of (cultural, natural, religious, archaeological) heritages and historic spot, Nationally-designated important cultural property

For a time being it is not yet mapped. It can be mapped during the EIA process.

V-4. Ethnic group (esp. Maekel (Central) region)

Please provide us with the following information and map.

(1) Residence area of ethnic group and segment *** there is no residence by ethnic groups**

(2) Ethnic group conflict *** no ethnic conflict in the project area even within the country**

(3) Culture and life pattern of minority or indigenous group *** there is no such things in Eritrea. All ethnic, culture, language and religion have equal rights and live together with respecting each other.**

V-5. Region (esp. Maekel (Central) region)

Please provide us with the following information

(1) Average earnings and family structure per household *** we do not have census data**

(2) Regional industry *** refer to maps provided as a potential point source pollutant industries.**

(3) Data of water disease (diarrhea, typhoid (fever), cholera, schistosomiasis) *** we do not have at hand in this time.**

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To WRD

VI. Related Document and Data

Please provide us with following document and data.

V-1. Law and regulation

River	River Law
	Law of customary water right or water right (Drinking, industry, drawing water from river, agriculture, fishery)
Water	Water Law (River and Drinking water quality standard, daily maximum water-consumption etc.) * pls look the attached Water Law 162/2010
	Water supply facility standard (intake, filtration, distribution) * we use ISO standard.
Hygiene	Hygiene Law (drinking water quality standard) * pls see Draft Eritrea Water Quality Standard 2004
Sewerage	Sewerage Act (Effluent standard; SS、BOD、COD、pH etc.) * in draft form from DOE
Waste Disposal	Waste Disposal Law * in draft form from DOE
Environment	Environmental Law (regulation of nature and wild animal reserve) * in draft form from DOE
	Environment Protection Law * in draft form from DOE
	Environmental Standards Law (Air pollution, noise, vibration) * in draft form from DOE
	Law of EIA for dam and Water supply ?????
Land	Land Law (landownership) * Land Law 1994
	Land Law (land transfer) * Land Law 1994
	Regulation of Land Acquisition * Land Law 1994
	Regulation of compensation for resettlement ???????????
	Regulation of land utilization * Land Law 1994
Tax	Regulation of collect [levy] tax (real estate tax, consumption tax, customs duty etc.) * Office of inland revenue and Municipality of Asmara and administrative regions.
Labor	Labor Standards Act (Minimum wage etc.) * Yes there is but we could not find copy at this time.
	Industrial Safety and Health Law (safety statutes) * Yes there is but we could not find copy at this time.

X-2. Map

Basic	Topographical map in Maekel (Central) region (approx. scale 1:5000) * We have 1:50,000 scale
	Geological Map in Maekel (Central) region * We have 1:50,000 scale for the project area
	Hydrogeological Map in Maekel (Central) region * We have 1:50,000 scale for the project area
	Soil map in Maekel (Central) region * We have 1:50,000 scale for the project area
River	Location map of water flow observation station in Anseba river and Nefhi river basins * We have 1:50,000 scale for the project area

Questionnaire for
Preparatory Survey on the Project for Asmara Water Supply Development

To WRD

Meteorological	Location map of a precipitation station in Maekel (Central) region *** We have 1:50,000 scale for the project area**
Ecosystem	Natural vegetation map in Maekel (Central) region *** We do not have this**
	Inhabitation map of wildlife in Maekel (Central) region *** We do not have this**
	Nature reserve and protection area *** Pls see land cover map of project area**
Land	Land use map in Maekel (Central) region *** We have 1:50,000 scale for the project area**
	Land-block map in Maekel (Central) region **???????**
	Map of state-owned land municipal land *** All Land is owned by Government**
Water-utilization	Water-utilization distribution map in Anseba river and Nefhi river basins (Drinking, industry, drawing water from river, agriculture, fishery) *** pls refer to hydrological map**
Erosion and flood control	Erosion and flood control plan map in Anseba river and Nefhi river basins *** We could not find at this time**

X-3. Monitoring Data

Meteorological	Hourly rainfall, monthly rainfall, sunny day, rainy day, wind direction, wind velocity, evapotranspiration, temperature, humidity, atmospheric pressure, hourly sunlight, intensity of solar radiation (last decade) at precipitation station in Maekel (Central) region *** Information can be found from Water Assessment and Information Division of WRD**
River	Water level, water quality, discharge rate (last decade) at water flow observation station in Anseba river and Nefhi river basins region *** Information can be found from Water Assessment and Information Division of WRD**
Dam	Water Level of each dam (TOKAR, ADI SHEKA, STRETTA VAUDETTO, BELEZA, VALLE GNECCHI, ELA NAHIB, MAI NEFHI Dam) *** pls refere to attached table**
Water quality	Water quality of Raw, Clean and Drinking water (3 years) at each WTP(TOKAR, STRETTA VAUDETTO, MAI NEFHI WTP) *** Data can be found from WRD water quality lab**
Hygiene	Water disease in Maekel (Central) region (diarrhea, typhoid (fever), cholera, schistosomiasis**)** *** We could not find now, but is negligible at this time.**

X-4. Document

(1) Design Report (Inc. Drawings) for each existing dam (TOKAR, ADI SHEKA, STRETTA VAUDETTO, BELEZA, VALLE GNECCHI, ELA NAHIB, MAI NEFHI Dam)

*** all these information can be found from AWSD or Municipality of Asmara**

End

Appendix 4.

11) Photos

Water sources and Dams （1/9）

Valle Gnecchi dam Earthfill dam
Water level is low as of April, 2015. There is a lot of sedimentary soil in dam lake.

Valle Gnecchi dam Upstream slope of dam
Surface lock is protected slope of dam.

Valle Gnecchi dam Downstream slope of dam

Valle Gnecchi dam Spillway
Spillway size is small.

Valle Gnecchi dam downstream slope of dam
There are intake facility, but is unused now.

Ela Nahib (Adi Nefas) dam Concrete gravity dam
It's seen as there is enough quantity of water as of April, 2015 but the water level is low.

Water sources and Dams （2/9）

Ela Nahib (Adi Nefas) dam Spillway
Spillway and old cannel to Valle Gnecchi dam

Ela Nahib (Adi Nefas) dam Downstream side of dam
Intake facility in middle

Ela Nahib (Adi Nefas) dam Downstream side of dam
Field spreads using permeated water.

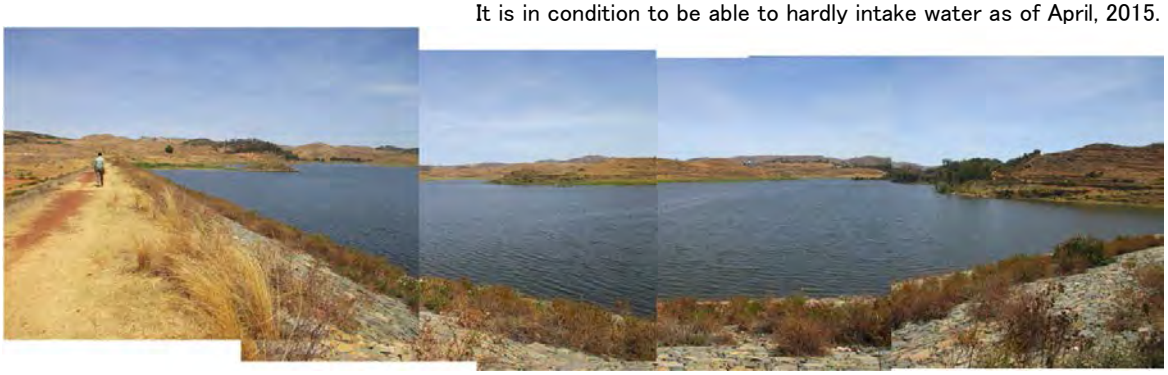
Beleza dam Concrete gravity dam
There seems to be water as of April, 2015, but is only the part near dam body.

Beleza dam Dam lake
Intake tower and a thermal power plant that EEC is using. There is a lot of sedimentary soil in dam lake.

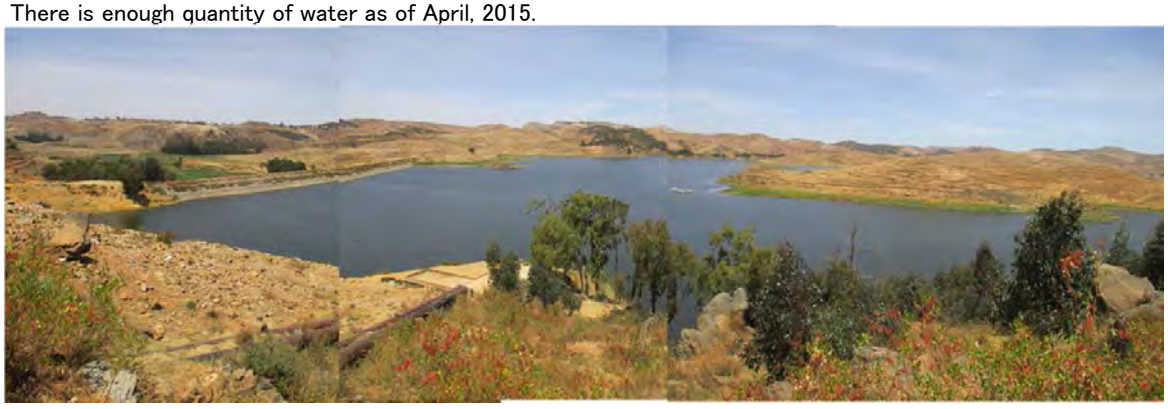
Water sources and Dams （3/9）

Beleza dam Spillway

Beleza dam Intake tower used EEC
It is in condition to be able to hardly intake water as of April, 2015.



Adi Sheka dam Earthfill dam
There is enough quantity of water as of April, 2015.



Adi Sheka dam Earthfill dam

Adi Sheka dam Spillway

Adi Sheka dam Slope of dam of Upstream side
Surface lock is protected slope of dam.

Water sources and Dams （4/9）

Adi Sheka dam In dam lake
There is a lot of sedimentary soil in dam lake.

Adi Sheka dam Downstream side of dam
Field spreads using permeated water.

S.V dam Concrete gravity dam
There seems to be enough quantity of water as of April, 2015,
but there is not the water level because there is much sedimentary soil.

S.V dam Spillway in dam body

S.V dam Intake pipe

S.V dam Old intake tower

S.V dam Old intake pumping station
Water was taken from sludge pipe in the past.

Water sources and Dams （5/9）

S.V dam Intake pump
Intake pump on top of dam body is working.

S.V dam Sludge pipe
5 Valve of sludge pipe are not working for mud clogging.

S.V dam Water leakage from joint at left side of dam.
Water leakageof approx.0.1ℓ/s

S.V dam Sedimentary soil in dam lake
Sedimentary soil in dam lake is remarkable.

Mai Serwa dam Concrete gravity dam
Pumping station is to the left side.

Mai Serwa dam Dam lake
There is enough water as of April, 2015.

Mai Serwa dam Downstream side of dam
Four valves are unusable for mud clogging
among five valves of sludge pipe.

Water sources and Dams （6/9）

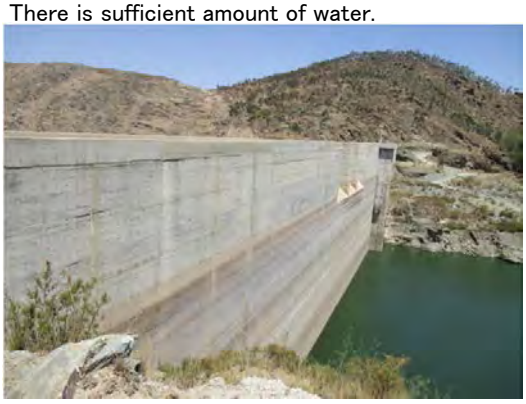
Mai Serwa dam Intake gate
It has not been used in valve failure of the intake pipe.

Mai Serwa dam Intake valve at dowmstream

Mai Serwa dam Old spillway
After downstream side collapse, spillway is unused.

Mai Serwa dam Spillway
Temporary spillway is currently also used.

Toker dam Concrete gravity dam
There is sufficient amount of water.



Toker dam Upstream side of dam

Toker dam Downstream side of dam
Spillwayn on dam

Water sources and Dams （7/9）

Toker dam Intake gate on dam body

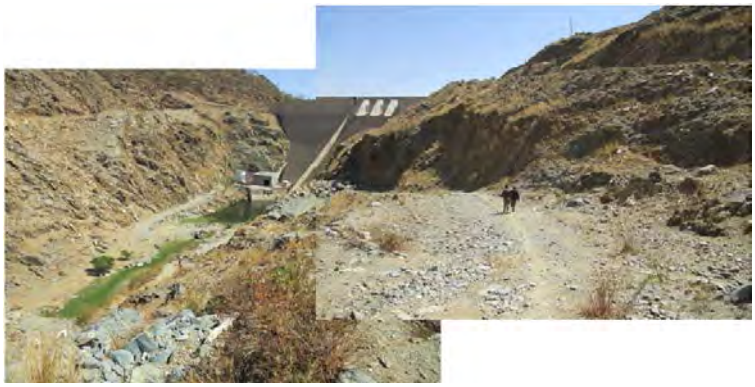
Toker dam Intake gate on dam body

Toker dam

Toker dam Pump station and Discharge pipe

Toker dam Discharge valve

Toker dam Power transmission line of 15KVA



Toker dam Access road
Road access difficult in the steep slope of rock.

Water sources and Dams （8/9）

Mai Nefhi dam dam lake

Mai Nefhi dam Concrete gravity dam

Mai Nefhi dam Downstream side of dam

Mai Nefhi dam Downstream side of dam

Mai Nefhi dam Intake gate

Mai Nefhi dam Intake gate

Water sources and Dams （9/9）

Mai Nefhi dam Spillway

Mai Nefhi dam Sludge pipe
Unconfirmed to use

Mai Nefhi dam Valve of Sludge pipe
Unconfirmed to use

Mai Nefhi dam Channel for sludge discharge

S.V W.T.P　(1/7)

S.V W.T.P　Overview

S.V W.T.P　Inlet pipe
Inlet pipe from overflow of Toker W.T.P

S.V W.T.P　Inlet pipe

S.V W.T.P　Inlet pipe

S.V W.T.P　Receiving well

S.V W.T.P　Receiving well

S.V W.T.P　Waterfalls

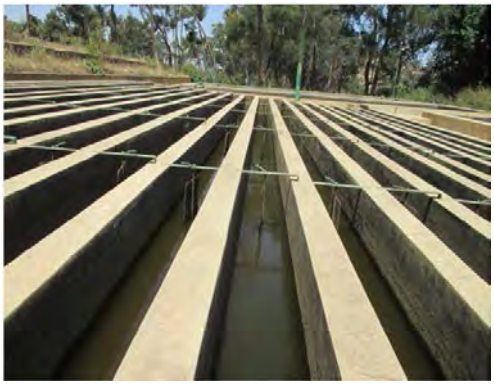
S.V W.T.P　Waterfalls

S.V W.T.P　(2/7)

S.V W.T.P　Waterfalls

S.V W.T.P　Flocculation basin

S.V W.T.P　Flocculation basin



S.V W.T.P　Deflector of flocculation basin

S.V W.T.P　Deflector of flocculation basin
It is non-operation by corrosion.

S.V W.T.P　Link channel between
flocculation and sedimentation basins.

S.V W.T.P　Sedimentation

S.V W.T.P　Outlet of sedimentation

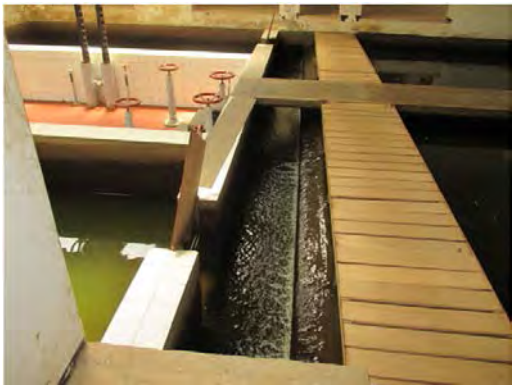
S.V W.T.P　(3/7)

S.V W.T.P　Sludge pipe of sedimentation
Sludge discharge valves are out of order

S.V W.T.P　Pipe between
sedimentation and adjustment pond

S.V W.T.P　Back-wash pipe

S.V W.T.P　Adjustment pond



S.V W.T.P　Outlet of adjustment pond

S.V W.T.P　Filteration basin
Mud is deposited on surface filter bed.

S.V W.T.P　Filteration basin
Hole is open on surface filter bed.

S.V W.T.P　Filteration basin

S.V W.T.P （4/7）

S.V W.T.P Filteration basin
Valve operatio of back-wash

S.V W.T.P Filteration basin
Bottom of filteration basin

S.V W.T.P Back-wash tank

S.V W.T.P Bottom of back-wash tank

S.V W.T.P Clear water transmission pump

S.V W.T.P Clear water transmission pump

S.V W.T.P Clear water transmission pump
Intake pipe from clear water reservoir

S.V W.T.P Clear water transmission pump
Intake pipe from clear water reservoir

S.V W.T.P　(5/7)

S.V W.T.P　Clear water transmission pipe
Water leakage from the pipeconnection

S.V W.T.P　Clear water transmission pipe

S.V W.T.P　Clear water transmission pipe and back-wash pipe

S.V W.T.P　Sludge valve of back-wash

S.V W.T.P　Sludge valve of back-wash etc.

S.V W.T.P　Sludge valve of
back-wash and adjustment pond

S.V W.T.P　Generator house

S.V W.T.P　Generator is unused
for the generation capacity which pump cannot work.

S.V W.T.P　(6/7)

S.V W.T.P　management house

S.V W.T.P　Transformer

S.V W.T.P　wastwater
Discharge untreated wastewater to S.V dam lake.

S.V W.T.P　Water color in rainy season

S.V W.T.P　Old chemical liquid production sysytem

S.V W.T.P　Old chemical liquid production facility and chemical storage house

S.V W.T.P　ALUM storage

S.V W.T.P　Former chlorine gas room

S.V W.T.P　(7/7)

S.V W.T.P　Former chlorine gas room

S.V W.T.P　Chlorine gas is injected directly into clear water reservoir.

S.V W.T.P　Structure of filteration basin and clear water reservoir

Deterioration of structure

S.V W.T.P　Structure of filteration basin and clear water reservoir Subsidence about 5 cm.

Crack and detachment of the building

S.V W.T.P　Structure of filteration basin and clear water reservoir Crack and detachment of the building

Crack and detachment of the building

Toker W.T.P （1/6）

Toker W.T.P Water recycling facility

Toker W.T.P Adjustment pond

Toker W.T.P Adjustment pond

Toker W.T.P Receiving well

Toker W.T.P Outlet from adjustment pond to mixing basin

Toker W.T.P Inlet from adjustment pond
Parshall flume

Toker W.T.P Mixing basin No.1& No.2

Toker W.T.P Mixing basin No.1
ALUM dosing point

Toker W.T.P　(2/6)

Toker W.T.P　Flocculation basin

Toker W.T.P　Flocculation basin

Toker W.T.P　Sedimentation (Inclined plate) basin

Toker W.T.P　Sedimentation (Inclined plate) basin

Toker W.T.P　Filteration basin

Toker W.T.P　Filteration basin

Toker W.T.P　Filteration basin
State of filter bed.

Toker W.T.P　Filteration basin
Filtr media

Toker W.T.P　(3/6)

Toker W.T.P　Filteration basin
Bottom of the basin

Toker W.T.P　Filteration basin
Bottom of the basin

Toker W.T.P　Clear water reservoir

Toker W.T.P　Clear water reservoir

Toker W.T.P　Chlorine gas
Chlorine gas is injected directly into clear water reservoir. Steel lid is corroded by chlorine gas.

Toker W.T.P　Chlorine gas

Toker W.T.P　Top of Clear water reservoir
Transmission pump and Back-wash pump

Toker W.T.P　Top of Clear water reservoir
Transmission pump and Back-wash pump

Toker W.T.P　(4/6)

Toker W.T.P　clear water transmission pipe

Toker W.T.P　clear water transmission pipe

Toker W.T.P　Air-blow pump

Toker W.T.P　Air-blow pump

Toker W.T.P　Generator, Transformer and Fuel tank

Toker W.T.P　Generator

Toker W.T.P　Wastewater pond

Toker W.T.P　Submersible pump of wastewater pond

Toker W.T.P　(5/6)

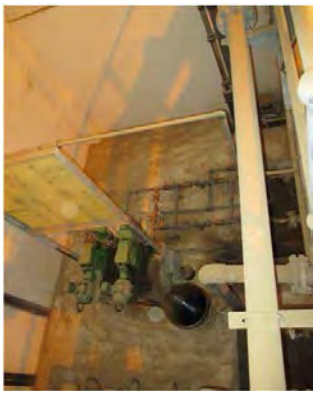
Toker W.T.P　Channel
between Wastewater pond and Wastewater disposal pond

Toker W.T.P　Wastewater disposal pond

Toker W.T.P　Chemical house

Toker W.T.P　ALUM storage

Toker W.T.P　Chemical liquid production



Toker W.T.P　Chemical pump of ALUM

Toker W.T.P　Chemical pump of ALUM

Toker W.T.P　Sodium hypochlorite generation apparatus

Toker W.T.P　(6/6)

Toker W.T.P　Chlorine liquid tank from
Sodium hypochlorite generation apparatus

Toker W.T.P　Chlorine liquid tank from
hypochlorous acid powder

Toker W.T.P　Chemical pump of chlorine liquid

Toker W.T.P　Chemical pipe of chlorine liquid

Toker W.T.P　Jar tester
Currently unused.

Toker W.T.P　pH and turbidity
and residual chlorine equipment
There is no reagent of residual chlorine equipment.

Mai Nefhi W.T.P　(1/7)

Mai Nefhi W.T.P Overview

Mai Nefhi W.T.P Inlet pipe

Mai Nefhi W.T.P Inlet pipe

Mai Nefhi W.T.P Inlet pipe
Broken Venturi equipment

Mai Nefhi W.T.P Receiving well

Mai Nefhi W.T.P Chlorinegas
Chlorine gas is injected directly.

Mai Nefhi W.T.P Receiving well

Mai Nefhi W.T.P
Inlet pipe from receiving well
to pulsator type flocculating sedimentation basin

Mai Nefhi W.T.P　(2/7)

Mai Nefhi W.T.P　Pulsator type flocculating sedimentation basin

Equipment of Vacuum tower

Mai Nefhi W.T.P Equipment of Vacuum tower
Broken Vacuum release valve

Mai Nefhi W.T.P　Equipment of Vacuum tower
Corroded manhole lid

Mai Nefhi W.T.P Equipment of Vacuum tower

Mai Nefhi W.T.P Equipment of Vacuum tower
Broken water level relay switch.

Mai Nefhi W.T.P　Pulsator type flocculating sedimentation basin
The opening and shutting of each valve does not function enough.

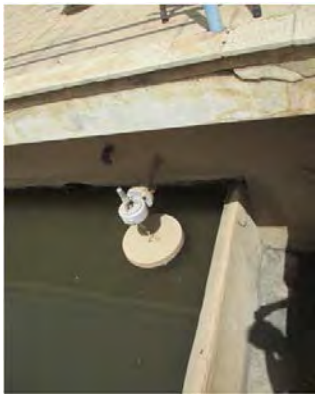
Mai Nefhi W.T.P　(3/7)

Mai Nefhi W.T.P　Link channel
Water leakage

Mai Nefhi W.T.P　Filtration basin of Aquazur type

Mai Nefhi W.T.P　Filtration basin of Aquazur type

Mai Nefhi W.T.P　Filtration basin of Aquazur type
Broken clogging indicator



Mai Nefhi W.T.P　Filtration basin of Aquazur type

Broken partialization box

Mai Nefhi W.T.P　Filtration basin of Aquazur type
Backwash method, water and air at the same time are 7 minutes, water only is 8 minutes.

Mai Nefhi W.T.P　Filtration basin of Aquazur type
Filter media

Mai Nefhi W.T.P　Filtration basin of Aquazur type
Broken Crack valve

Mai Nefhi W.T.P　(4/7)

Mai Nefhi W.T.P　Filtration basin of Aquazur type
State of fulter bed after back-wash

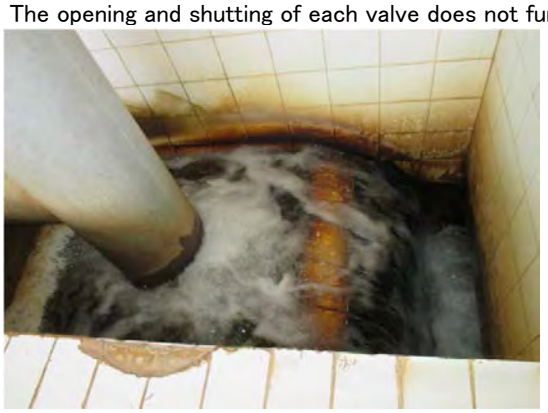
Mai Nefhi W.T.P　Filtration basin of Aquazur type
State of sludge water at the time of back-wash

Mai Nefhi W.T.P　Back-wash and air-blow pumps
The opening and shutting of each valve does not function enough.

Mai Nefhi W.T.P　Air-blow pump

Mai Nefhi W.T.P　Filtration basin of Aquazur
The opening and shutting of each valve does not function enough.

Bottom of the basin
Broken siphon



Mai Nefhi W.T.P　Filtration basin of Aquazur
Bottom of the basin

Clear water
Mai Nefhi W.T.P　Clear water transmission pump hpuse

Mai Nefhi W.T.P　(5/7)

Mai Nefhi W.T.P　Clear water transmission pump
Water leakage

Mai Nefhi W.T.P　Clear water transmission pipe
Broken meter

Mai Nefhi W.T.P　Transformer

Mai Nefhi W.T.P　Sludge discharge
Discharge sludge in cahnnel of Mai Nefhi dam

Mai Nefhi W.T.P　Generator house
Removal generator for a breakdown.

Mai Nefhi W.T.P　management,pump and chemical house

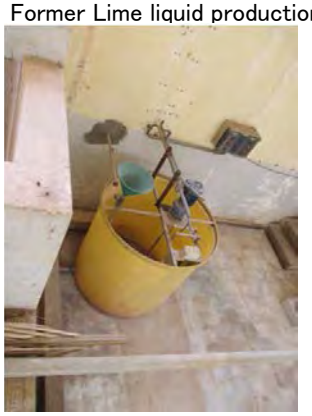
Mai Nefhi W.T.P　Old chemical dosing equipment
Former ALUM liquid production

Mai Nefhi W.T.P　(6/7)

Mai Nefhi W.T.P　Old chemical dosing equipment
Former ALUM liquid production

Mai Nefhi W.T.P　Old chemical dosing equipment
Former Lime liquid production

Mai Nefhi W.T.P　Old chemical dosing equipment
Former Lime liquid production



Mai Nefhi W.T.P　Old chemical dosing equipment
Former Polymer liquid production

Mai Nefhi W.T.P　Pulsator pump

Mai Nefhi W.T.P　Back-wash pump

Mai Nefhi W.T.P　Former chlorine gas house

Mai Nefhi W.T.P　Former chlorine gas house
Old chlorine gase injector

Mai Nefhi W.T.P　(7/7)

Mai Nefhi W.T.P　Jar tester

Mai Nefhi W.T.P　pH and turbidity equipment
Broken both equipment

O&M (1/7)

Ela Nahib (Adi Nefas) dam
Water is used for agriculture by using pump.

Beleza dam
Water supply by donkey

Adi Sheka dam
Livestock are drinking water directly.

Open channel at Adi Sheka dam–Beleza dam
There are a lot of falling rocks in channel.

Open channel at Adi Sheka dam–Beleza dam
There are a lot of falling rocks in channel.

Adi Sheka raw water pump
It's leaking, but it isn't repaired.

Mai Serwa raw water pump
Out of order

Toker dam
Scale of level indicator isn't seen.

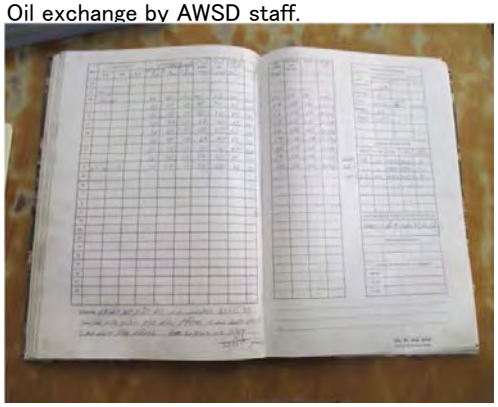
O&M (2/7)

Toker raw water engin pump
Mentenance by CAT.

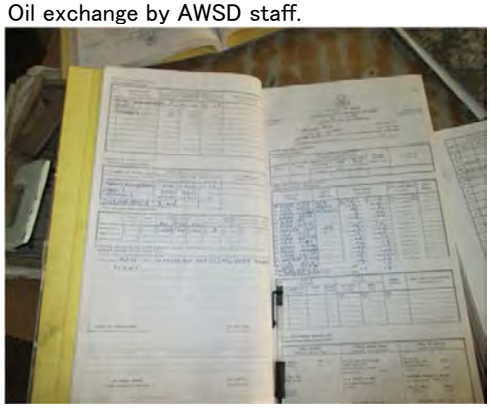
Toker raw water engin pump
Mentenance schedule

Toker raw water engin pump
Oil exchange by AWSD staff.

Toker raw water engin pump
Oil exchange by AWSD staff.

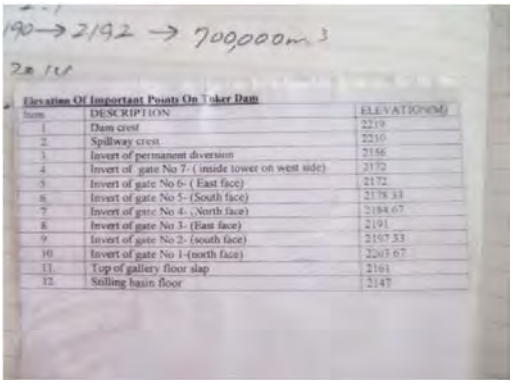


Toker raw waterpump station
Daily record for punp



Toker raw waterpump station
Traditional daily record

Toker dam
List of water level and storage capacity



Toker dam
List of water level and intake gare

O&M　(3/7)

S.V W.T.P　Water leakage
water leakage at receiving well

S.V W.T.P
Scattering of broken material

S.V W.T.P
Scattering of broken material

S.V W.T.P
Aging staff

Toker W.T.P
ALUM is put in directly at the time of blackout

Toker W.T.P
Chlorine gas cylinders piled up.

Toker W.T.P
Storage of the catalog (equipment specifications).

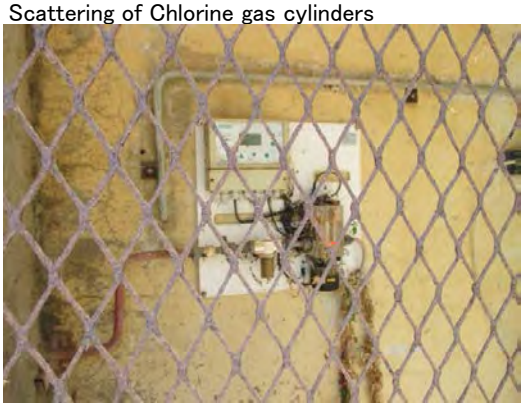
Mai Nefhi W.T.P
ALUM is put in directly

O&M (4/7)

Mai Nefhi W.T.P
ALUM at top of receiving well

Mai Nefhi W.T.P
Scattering of Chlorine gas cylinders

Mai Nefhi W.T.P
Water leakage is discharged by a small pump.



New Sembel pumping station
Broken chlorine gas injector

Monopolio reservoir
sludge at bottom of reservoir

Hazhaz reservoir
Broken level indicator

Tsetserat reservoir
Water leakage from pipe

Godaif pumping station
Decrepitude pump

O&M　(5/7)

Distribution network
Valve box

Distribution network
valve operation

Distribution network
Valve box

Service pipe
corroging pipe repairing

Meter reparing
Meter checking machin of Grand aid from France in 2000

Meter reparing
Broken meters

Meter reparing
AWSD staff goes to meter repairing by bicycle

Mai Nefhi filling station
Water is not stopped.

O&M (6/7)

Mai Nefhi filling station
Broken meter and Water leakage

AWSD head office
Water charge collection desk

Expo filling station
Crowded water truck.

Expo filling station
Water supply sales office

AWSD head office
Complaint reception desk.

AWSD head office
Complaint application form.

AWSD head office
Material storage room

AWSD head office
Material storage room

O&M （7/7）

AWSD head office
Broken PC etc.

AWSD head office
2t truck with crane

AWSD head office
2t Damp truck

Water quality (Water quality test equipment of WRD possession) (1/2)

1、Dr/2000 and Dr/2800 spectrophotometer
NO3, NO2, SO4, F, NH3, Fe, Mn, Free Cl2

2, BWB flam photometer
Na, K, Ca, Mg, Ba,

3, Portable PHA-100plus
Hydrocarbon

4, Hanna HI88703 turbid meter
Turbidity

5, Portable HM3000 metalzer
Heavy metals (Not trained person)

6, Digital EC/TDS/PH meter
EC, TDS, PH,

7, 210/211 VGP atomic absorption spectrophotometer
Heavy metals (Not trained person)

8, BOD/COD incubators
BOD, COD (No reagents)

Water quality (Water quality test equipment of WRD possession) (2/2)

9, SBH200 block heater
COD reactor

10, Bacteriological incubators for faecal and total c. bac
Coliform bacteria

11, Digital colony counter
Counting bacteria

12, Oven for sterilization
Sterilization

13, Water distiller
Distell water production


JICA