MINISTRY OF WATER & ENERGY (MoWE)
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
SOMALI REGIONAL WATER RESOURCES DEVELOPMENT BUREAU

THE STUDY ON JARAR VALLEY AND SHEBELE SUB-BASIN WATER SUPPLY DEVELOPMENT PLAN, AND EMERGENCY WATER SUPPLY IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

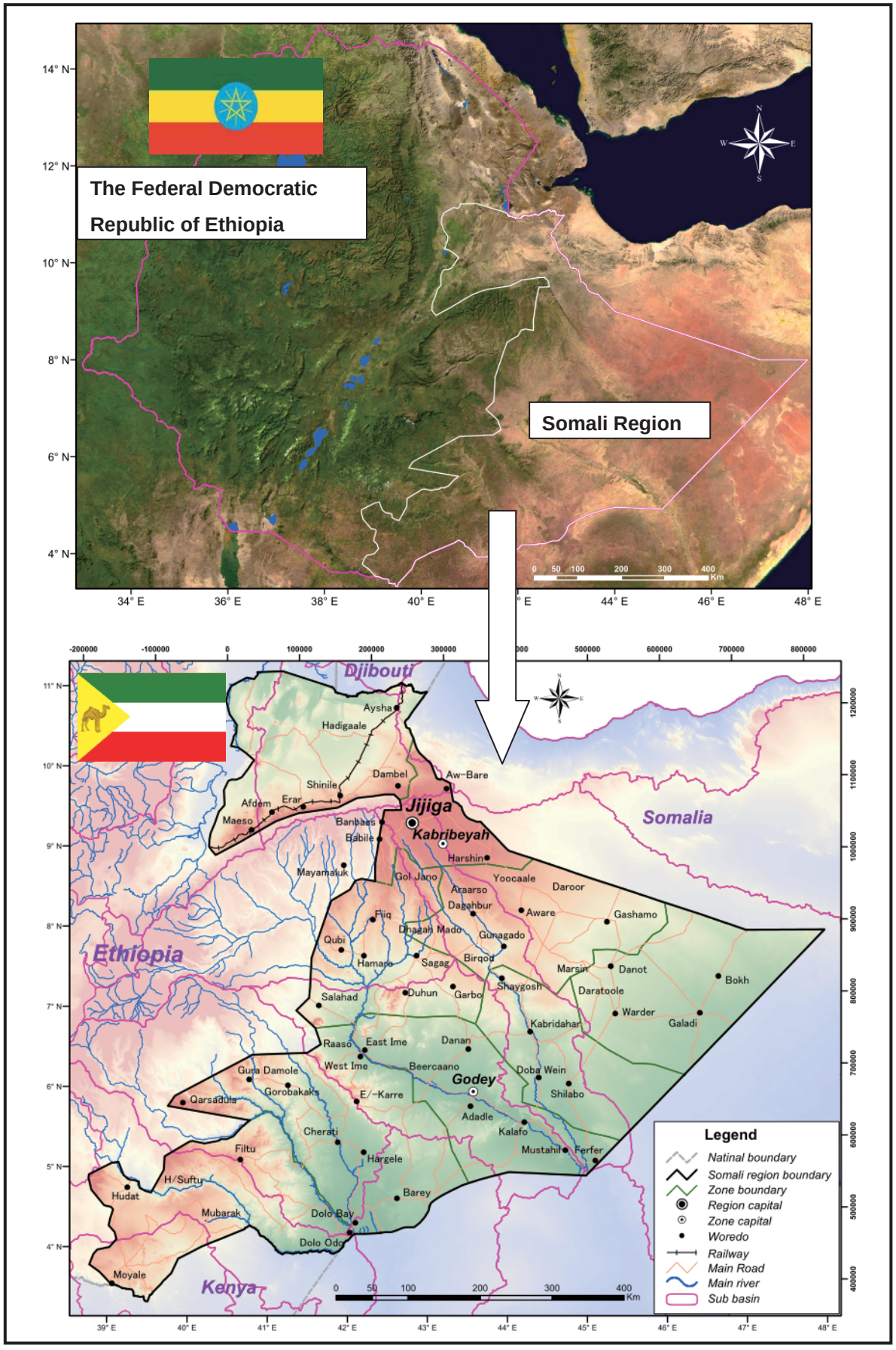
FINAL REPORT (1/7)

MAIN REPORT

August 2013

Japan International Cooperation Agency (JICA)

Kokusai Kogyo Co., Ltd.



Location Map of Study Area

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Abbreviations

ABE	Alternative Basic Education
ARRA	Administration for Refugee and Returnee Affairs
BoFED	Bureau of Finance and Economic Development
BPR	Business Process Reengineering
CGIAR	Consultative Group on International Agricultural Research
CSA	Central Statistical Agency
CSE	The Conservation Strategy of Ethiopia
COD	Chemical Oxygen Demand
C/P	Counterpart (organization or personnel)
DFID	Department for International Development
DF/R	Draft Final Report
DTH	Down the Hole Hammer
DPPB	Disaster Prevention and Preparedness Bureau
EC	Electric Conductivity
EIA	Environmental Impact Assessment
EPA	The Environmental Protection Authority
EPC	The Environmental Protection Council
ESA	European Space Agency
ESIA	Environmental and Social Impact Assessment Unit
EU	European Union
EU-WATCH	Water and Global Change (WATCH) program funded by the European Union
EWTEC	Ethiopia Water Technology Center
FAO	Food and Agriculture Organization of the United Nations
F/R	Final Report
F/S	Feasibility Study
GEM	Global Environment Monitoring
GIS	Geographical Information System
GLCF	Global Land Cover Facility
GLG	Grass Land GIS
GMT	Greenwich Mean Time
GSE	Geological Survey of Ethiopia
GPS	Global Positioning System
GUPE map	Groundwater Utilization Potential Evaluation map
IC/R	Inception Report
IEE	Initial Environmental Examination
IRC	International Rescue Committee
ISCGM	International Steering Committee for Global Mapping
IT/R	Interim Report
JICA	Japan International Cooperation Agency
JSS	JAXA Supercomputer System
JWSO	Jijiga Water Supply Office
MODIS	MODIS Land Cover Product by using Moderate resolution Imaging Spector radiometer of Earth-Observing-System EOS
MoFED	Ministry of Finance and Economic Development
MoWR	Ministry of Water Resources
MoWE	Ministry of Water and Energy
MrSID	Multi-resolution Seamless Image Database
NFE	Non Formal Education
NGO	Non-Governmental Organization
NMA	(Addis Ababa) National Meteorology Agency
NOAA	National Oceanic and Atmospheric Administration

NRCS	Natural Resources Conservation Service, United States Department of Agriculture
O&M	Operation and Maintenance
OJT	On the Job Training
POSTEL	Postal land surface thematic centre
P/R	Progress Report
PA	Preliminary environmental assessment study
PALSAR	Phased Arrayed L-type Synthetic Aperture Radar
R/D	Record of Discussion
REA	Regional Environmental Agencies
RGSR	Regional Government of Somali Region
RWBs	Regional Water Bureaus
SAGE	Center for Sustainability And the Global Environment at the University of Wisconsin Madison
SEDAC	Socioeconomic Data and Applications Center
SEPMEDA	Somali Regional State Environmental Protection, Mine and Energy Development Agency
SHAAC	Shaac Consulting Engineers
SRTM	Shuttle Radar Topography Mission
SRWDB	Somali Regional Water Resources Development Bureau
SWWCE	Somali Water Works and Construction Enterprise
TDM	Time Domain Method
TEM	Transient（or Time-domain）Electromagnetic Method
TOT	Training of Trainers
TVETC	Technical and Vocational Education and Training College
UAP	Universal Access Program
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children’s Fund
USDA	United States Department of Agriculture
USAID	United States Agency for International Development
USGS	United States Geological Survey
UTM	Universal Transversal Mercator
VES	Vertical Electrical Sounding
WASH	Water Supply, Sanitation and Hygiene Programme
WASHCO	Water Supply and Health Committee
WATSANCO	Water, Sanitation & Hygiene Committee
WFP	World Food Programme
WLR	Water Level Recorder
WMO	World Meteorological Organization
WRI	World Resources Institute
WRIM	Water Resources Information Map
WSDP	Water Sector Development Program
WTP	Willingness to Pay

Photo of Project Activities (1/6)

April to September in the year 2012

Discussion of IC/R

The explanation and discussion of IC/R were carried out on 5 April, 2012. M/M was also exchanged on 6 April.

Explanation of IC/R at UNHCR

The IC/R of Study was explained to UNHCR. The surveys in Kabribeyah water supply system will be conducted in collaboration with UNHCR.

Geophysical survey (1)

Geophysical survey (VES) was executed in Jarar Valley due to secure new water resources. The aspects of Valley can be seen.

Geophysical survey (2)

Geophysical survey (geomagnetic survey) was carried out in a highland valley. This was made difficult by a great many cacti.

Well developing in JICA Well No-2

Two wells were drilled in Jarar Valley, which obtained a total yield of 10L/s. This is view of well development.

ESTV filming the drilling sites

The first JICA assistance in Somali Region and the drilling sites were introduced on Ethiopia Somali TV.

Photo of Project Activities (2/6)

April to September in the year 2012

Kabribeyah water supply system

Experts discussed the scale build up in pipe of distribution pump station. Scale removal is one of the issues in the system.

Godey town water supply facilities

The storage tanks in Godey Town: Left tank was built in 1959, volume is 150m^3. Right tank was built in 2010, volume is 1000m^3. Both are in use.

Strata distributed along Shebele River

Terrace gravel layer and conglomerate below were seen near the water supply facilities along the Shebele River. The thickness of gravel is 1.7m.

Maintenance workshop in SRWDB

There is generator under repair in maintenance workshop; however, so far there have been very few systematic repairs.

UNESCO workshop

Mapping technology and technical training have been executed by UNESCO in Somali Region. Discussion of demarcation for works will be done.

Refugee camp

Kabribeyah refugee camp has more than 16,000 refugees. JICA cameraman is shooting for public news in the target area for water supply plan.

Photos of Project Activities (3/6)

October 2012 to February 2013

Discussion of PR/R and relevant issues

The first Steering Committee meeting was held for the explanation and discussion of PR/R and issues on 1 November at Hamda Hotel in Jijiga.

Construction works of water supply facilities (1)

Generator houses were constructed beside each of the 2 wells in Jarar Valley in the Project. The generators were set up inside and were connected with the wells.

Construction works of water supply facilities (2)

The new surface pumps were set up at the pumps stations and booster pump stations by JICA in the Jarar valley water supply system. The photo shows one of new surface pumps.

Construction works of water supply facilities (3)

The construction of 5 new animal troughs, as seen in the photo in Kabribeyah Town was completed in the beginning of February 2013.

Construction works of water supply facilities (4)

The construction of 5 public taps in Kabribeyah and Godey, pictured, was completed in the beginning of February 2013.

Construction works of water supply facilities (5)

The construction of tanks and public taps in Kabribeyah Town was completed in the beginning of February 2013.

Photos of Project Activities (4/6)

October 2012 to February 2013

Training for WASHCO in Godey Town

Training for the local WASHCO was given on Jan 29&30 in Godey Town. A WASH trainer of NGO(Save The Children) gave training on O&M of water points.

Practical training for O&M of machineries

Training for maintenance of water supply electric machinery was given in the workshop of SRWDB on December 3 to 6 2012. 24 persons participated.

O&M maintenance – interview for water use

Interview survey of seasonal condition of water use amount and of intended purposes targeting sampled households was conducted in Godey Town.

Socio-economic survey- town HHs interviews

Socio-economic survey of household budget expenditure regarding water use and others was conducted in Godey Town.

Equipment procurement for emergency water supply

5 water trucks and 150 pieces of water tanks were procured by JICA study team. 76 tanks were distributed to woredas with water shortage of high priority by the end of February 2013.

Environmental and social consideration

The concern about construction of new water supply facilities was surveyed, because there are many retailers of water with donkey carts in Godey Town.

Photos of Project Activities (5/6)

March to April in the year 2013

Discussion of IT/R and relevant issues

The Second Steering Committee meeting was held to explain and discuss IT/R and other issues at Hamda Hotel in Jijiga. 26 people joined.

Counterpart meeting for IT/R

A meeting with SRWDB 8 counterparts was held, and presentation by JICA study team experts was made in the meeting.

Completion ceremony in Godey Town

Completion ceremony of water supply facilities constructed in the pilot project was held in Godey Town.

Completion ceremony in Kabribeyah Town

The construction of Water supply facilities in Kabribeyah Town and Jarar Valley was completed. The ceremony was held on April 10, 2013

Technical transfer in Remote Sensing / GIS

Technical transfer related to GIS and Remote sensing technique used in this study was conducted at SRWDB.

JICA mission team visits Godey Town

JICA mission team visited Godey Town. Several issues of the future of Godey town water supply system were discussed with counterparts.

Photos of Project Activities (6/6)

March to April in the year 2013

Feasibility study (F/S) in Godey Town

Site survey for detailed water supply plan as F/S was repeatedly conducted with Godey town water supply utility office staff.

Information-boards at JICA borehole sites

Information-boards showing the details of the well were installed alongside of JICA well No-1 and No-2 in Jarar valley.

Pre-operation test of constructed wells

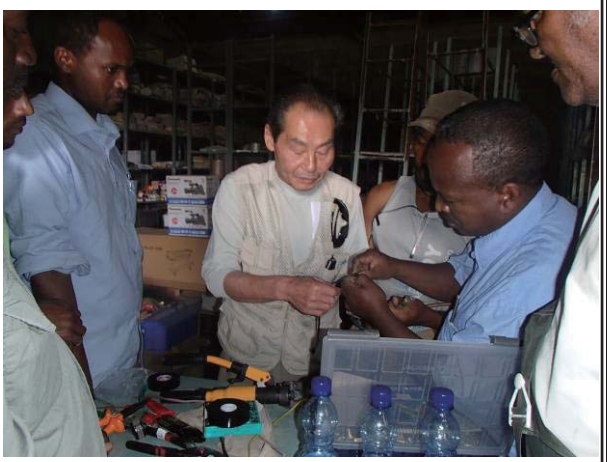
The function of the well was checked before using the wells constructed by JICA study team.

WASHCO training in Kabribeyah Town (1)

Management of water supply facilities constructed in the pilot project will be done by WASHCO members. The training was given for the selected members.

WASHCO training in Kabribeyah Town (2)

35 people living near the facilities were chosen and joined the training as WASHCO members.



Training for MWS mechanical equipment

Different training for the use and management of equipment and tools to be loaded in mobile workshop vehicle was carried out in SWRDB workshop.

Chapter 1

Study Summary

1 Study Summary

1.1 Introduction

This report was prepared to present the results as of the end of July 2013 of the Study of "Jarar Valley and Shebele Sub-basin Water Supply Development Plan, and Emergency Water Supply in the Federal Democratic Republic of Ethiopia (hereafter, the Study)" based on the results of the record of discussions (R/D) agreed and signed by the Federal Democratic Republic of Ethiopia and Japan International Cooperation Agency (JICA) on 23 December 2011. JICA organized a team of consultants (the Study Team) made up of 14 members (one member was added later) to conduct the Study. The Study started in March 2012 and is confirmed to end in August 2013. The Study is being executed through close collaboration between the Study Team and counterpart personnel (C/P) and others of Ethiopia.

1.2 Background of the Study

Eastern Ethiopia and its neighbors in the eastern part of the African continent are called "the horn of Africa". It is an area prone to repeated droughts and food shortages. In fact, the area was hit by the worst drought in the past 60 years from the mid 2010 to around September 2012: affected by scarce rainfall in October 2010 during the rainy season that generally has the heaviest rainfall, and also consecutively in April 2011 during the rainy season. The Ministry of Agriculture together with some donor agencies reported that around 4.57 million people across the country suffered from food shortages and required humanitarian aid as a result of the drought. About 80% of the affected population is actually in the lowland areas of the country such as Somali Region.

Moreover, Somali Region has a strong and chronic need for better water supply, with a water supply coverage as low as 59.7% (64.0% in urban areas and 49.0% in rural areas), being lower than the national average of 68.5% (91.5 % for urban areas and 65.8% for rural areas after UAP, 2011). The need for water supply suddenly increases in emergencies, especially at the time of drought such as in recent years. However, technical and organizational capacity of the Somali Regional State Water Resources Development Bureau (SRWDB) that is in charge of water supply and facilities management in the region to satisfy the water supply need is not adequate to cope with the situation. Donor agencies and NGOs are making efforts to ameliorate the situation by constructing and repairing water supply facilities, supplying water by water trucks for emergency supply, but the supply is still significantly under the demand. In order to improve the immediate situation, one of the expected measures is to provide emergency water supplies by truck, and another is to raise the capacity of the Ethiopian government to cope with droughts by themselves. Also, as a mid- to long-term measure, drawing up of a water supply plan and effective and efficient implementation of the prepared plan is envisaged.

In this context, JICA organized and dispatched a team to the region to investigate and confirm the situation of the drought, water supply needs, and detailed needs for cooperation in water supply. As a result of the investigation, JICA had discussions with relevant Ethiopian agencies to determine the scope of cooperation (October to November 2011). Then in December 2011, the Ethiopian side requested to the government of Japan for cooperation in water supply planning and execution of emergency water supply in the two areas of Jarar Valley watershed and Shebele River watersheds both of which have a high potential of water resources development. In response to this request, JICA discussed the detailed scope of the

cooperation with the relevant Ethiopian agencies and compiled the outcome in the R/D and finally both parties signed and exchanged the document in the same month.

Before starting the project, the Study Team submitted the inception report (IC/R) and discussed its contents with the Ethiopian side. After that, Minutes of Meeting (M/M) were exchanged between JICA and MoWE in consideration of the request of modification from the Ethiopian side (April 2012).

1.3 Objectives and summary of the Study

The study objectives are mainly to prepare a water supply plan based on the collection and analysis of the existing data, and the information of natural condition and socio-economic situation data in the Jarar valley and Shebele sub-basin. Other important tasks are: the arrangement of a hydrogeological information system, construction works for emergency water supply focused on Kabribeyah and Godey towns and the rest of Somali region, and training to strengthen the ability of SRWDB and other relevant organizations.

The expected outputs and the activities of the Study are as follows;

(1) Expected outcome of the implementation of the Study

1) The potential of utilization of water resources in Jarar Valley and Shebele River watersheds will be evaluated.

2) The water supply plan for the Jarar Valley and Shebele River watersheds will be prepared.

3) The technical and organizational capacity of C/P personnel in water supply planning will be improved.

4) Water supply situation in Kabribeyah Town will be improved

5) Feasibility study for the planned water supply facilities (system) will be conducted.

6) Situation of emergency water supply in Somali Region will be improved through the use of the water supply equipment and materials donated.

(2) Activities in the Study

In order to realize the outcomes stated above, the following activities will be conducted in this Study.

1) Confirmation of potential of water resources development through “water resources utilization potential survey,”

2) Proposition of concrete improvement plans for water supply systems by water supply planning, and

3) Improvement of current water supply condition by implementing emergency water supply projects

4) Capacity development of relevant staff through short-term technical training.

To sum up the above, the following Figure 1.1 illustrates the outline of this Study: the activities under (2) above will be first conducted to realize the outcomes under (1) above by the end of the Study. The Ethiopian C/P organizations, then, will be expected to realize the formulated water supply plan making the best of what they will have learnt through short- to long-term training in order to achieve the future long-term goals in the Study that are stated under the outcomes.

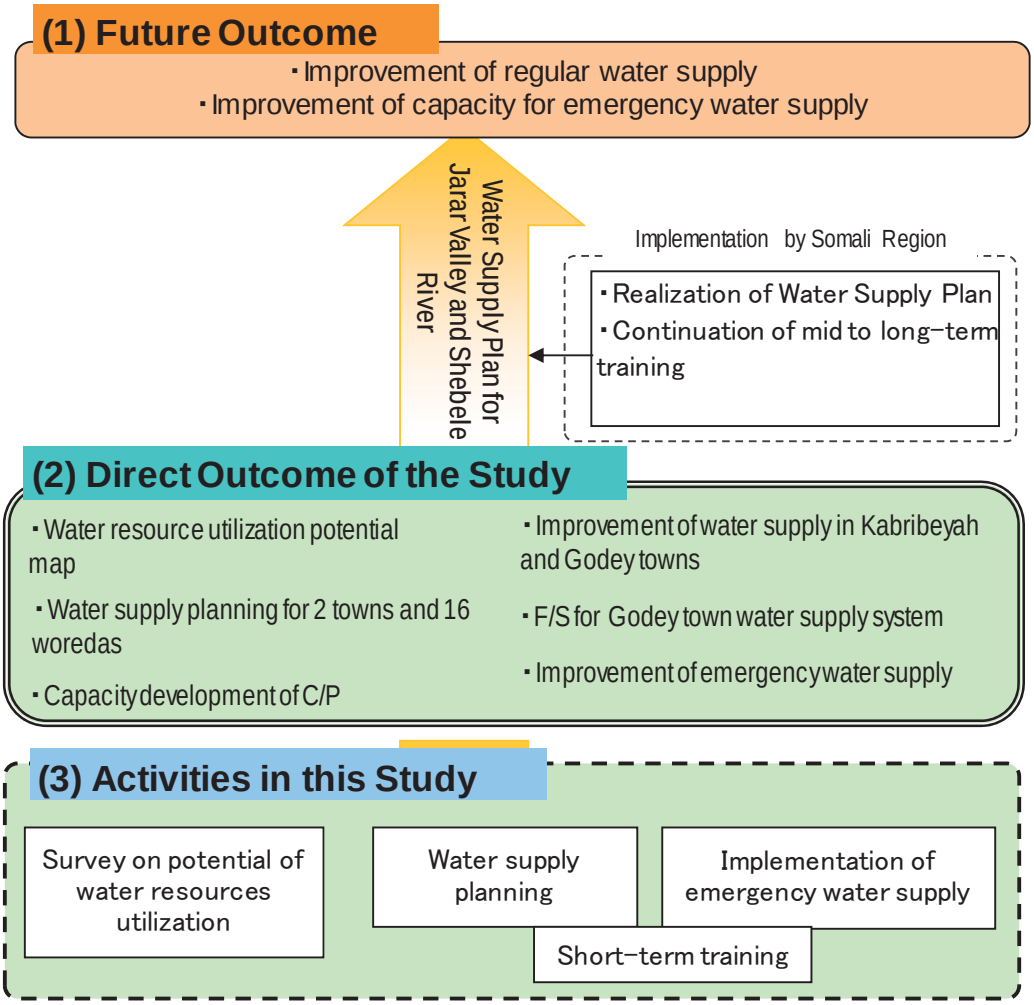


Figure 1.1: Flow of the Study (Project)

1.4 Scope of the Study

This Study will be implemented according to the R/D concluded on December 22, 2011 between MoWE and JJICA. The work and activities in the following Table 1.1 will be performed by the Study Team according to the study objectives and basic strategy of the Study. As the Study progresses, several reports will be prepared.

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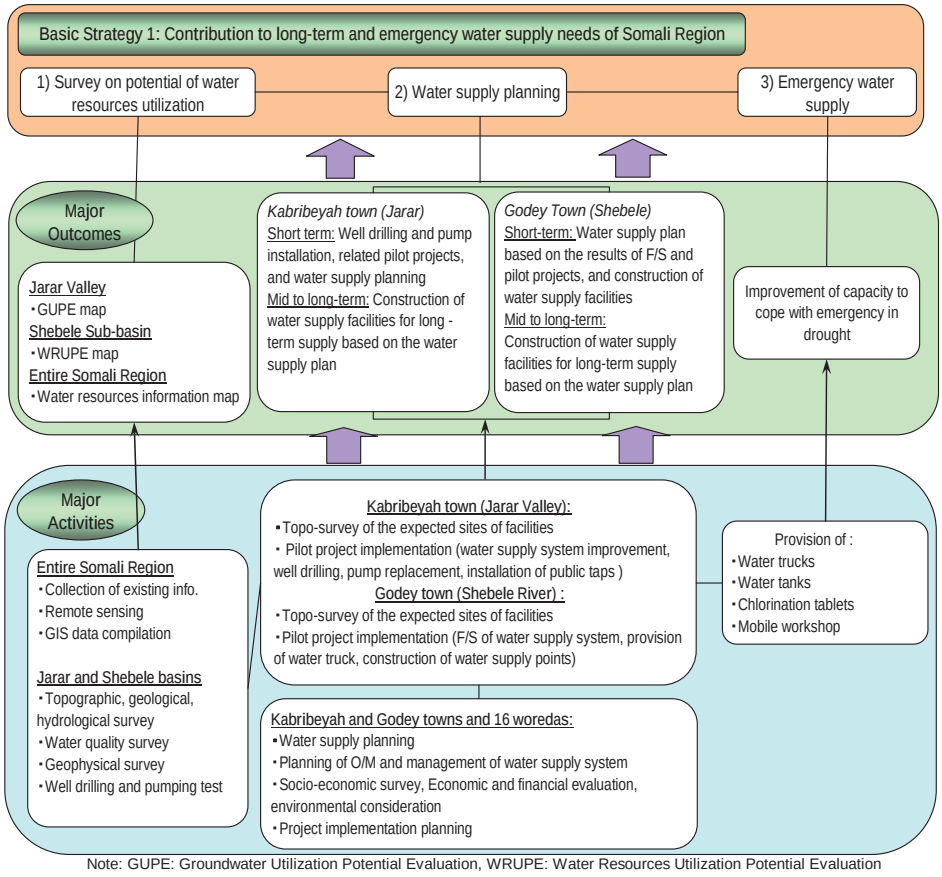
Table 1.1: The Contents of Main Work Items

Work Item	Target area/ organization	Detail
Water supply planning	Jarar Valley basin Shebele River basin	Target year: Change from 2015 to 2020 (after the first steering committee) • Plans will be drawn up for each of the 16 woredas included in the study area. • Plans for Kabribeyah and Godey towns will be prepared separately.
Study on water resources potential	Jarar Valley basin Shebele River basin	Preparation of "Groundwater utilization potential map" at 1/250,000 scale or more
Emergency water supply (Pilot project implementation)	Jarar Valley basin (Kabribeyah Town)	1) Improvement of Jarar valley water supply system • Drilling and construction of wells (200m x 2) • Replacement of booster pumps (3 pumps) • Construction of public taps (human, animal use) (5 sites) • Construction of pump house and installation of submersible pump and generator (for 2 wells) • Installation of pipeline to connect the wells to the water supply system
	Godey Town	2) Improvement of Godey Town water supply system • Conduct F/S for the prepared water supply plan • Provision of water truck (1 truck) • Construction of water supply points to be filled by water trucks (5 sites)
Emergency water supply	Whole Somali Region	1) Procurement and provision of water supply equipment and materials • Water truck (x 4) • Water tank for water supply x 150 • Chlorination tablets (for 3600m^3 water) • Mobile workshop (x 3)
		2) Provision of technical training for effective utilization of the equipment and materials above • Provision of technical training for utilization of the mobile workshop in the case of emergency
Compilation of hydrogeological data	Whole Somali Region	Collected hydrogeological and other relevant information will be compiled for future use by the Ethiopian side.
Capacity development of personnel of Ethiopian side	Staff of -SRWDB -Town water supply utility office -SWWCE	- Operation and management of water supply system - Maintenance of equipment and facilities - Capacity development in water well drilling

The main activities in line with the basic strategy of the Study can be illustrated as in Figure 1.2 and Figure 1.3.



Note: GUPE: Groundwater Utilization Potential Evaluation, WRUPE: Water Resources Utilization Potential Evaluation

Figure 1.2: Work Activities in Response to Basic Strategy

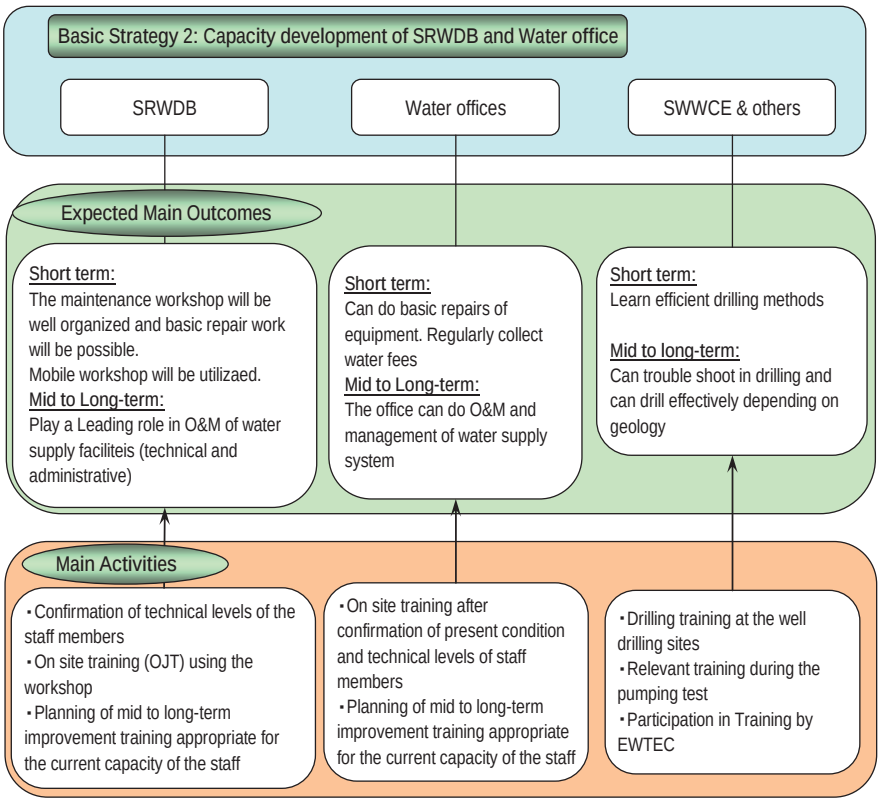


Figure 1.3: Contents of Strengthening Capacity

1.5 Work schedule

As shown in Figure 1.4 below, the Study started in the beginning of March 2012 and was confirmed to end in late August 2013. The sequence of each and all the work items (study components) are also indicated in detail in the flow chart (refer to Figure 1.5) in the following page.

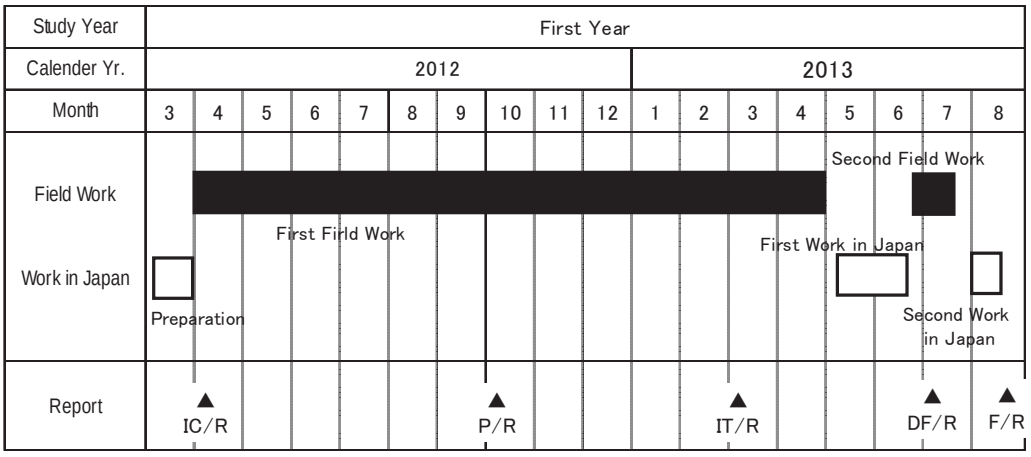


Figure 1.4: Outline of the Study Schedule

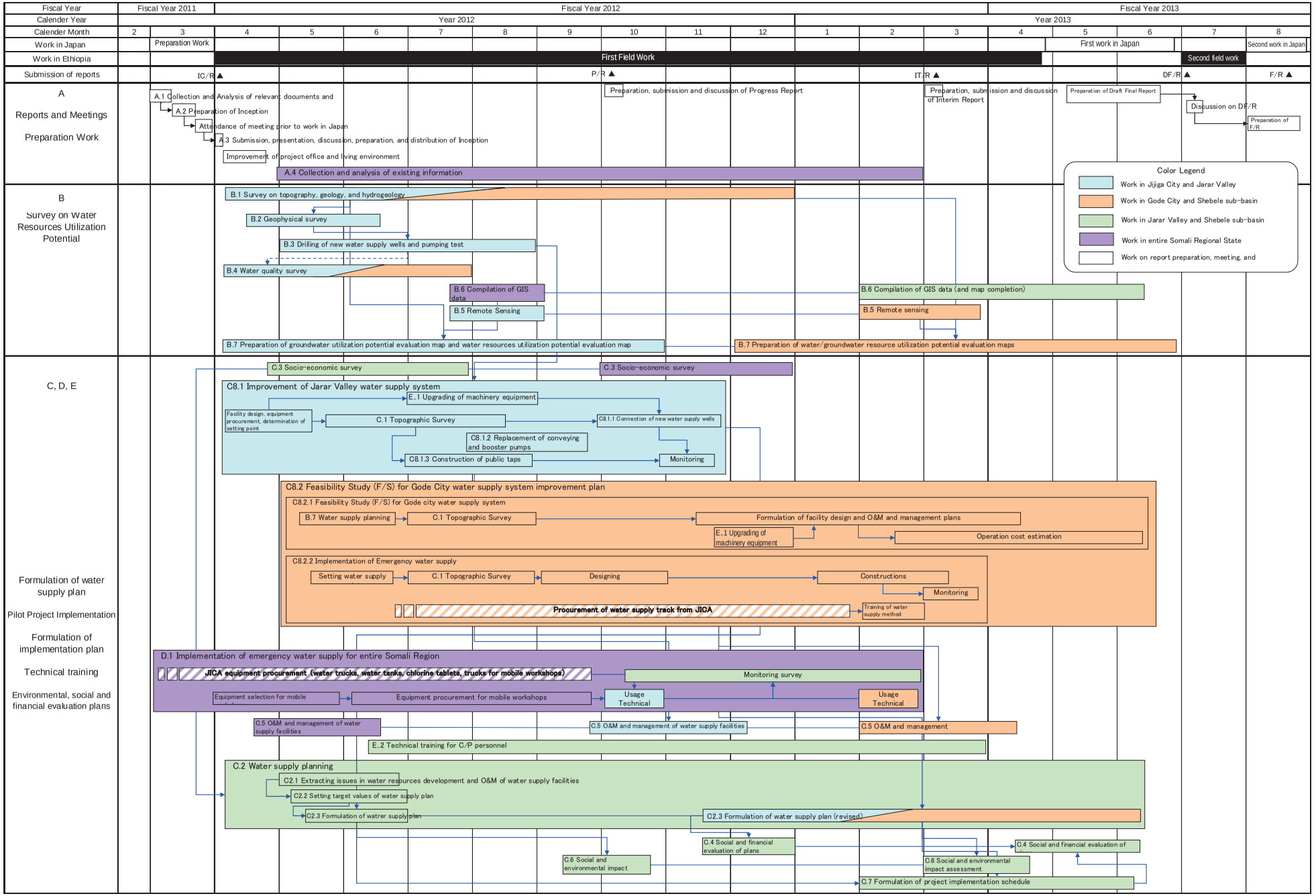


Figure 1.5: Flow Chart of Study Implementation

1.6 Study area and target areas

1.6.1 Study area

The target area differs depending on the work components of the Study: Emergency water supply works covers the whole region, water supply plan and water resources potential study targets the sub-basins of Jarar Valley and Shebele River. Also pilot projects were done in Kabribeyah and Godey towns. These areas of project components and locations of the towns are indicated in Figure 1.6 below. The outline of the sub-basins was clearly determined based on the analysis of topography in consideration of geographical extent of the target woredas.

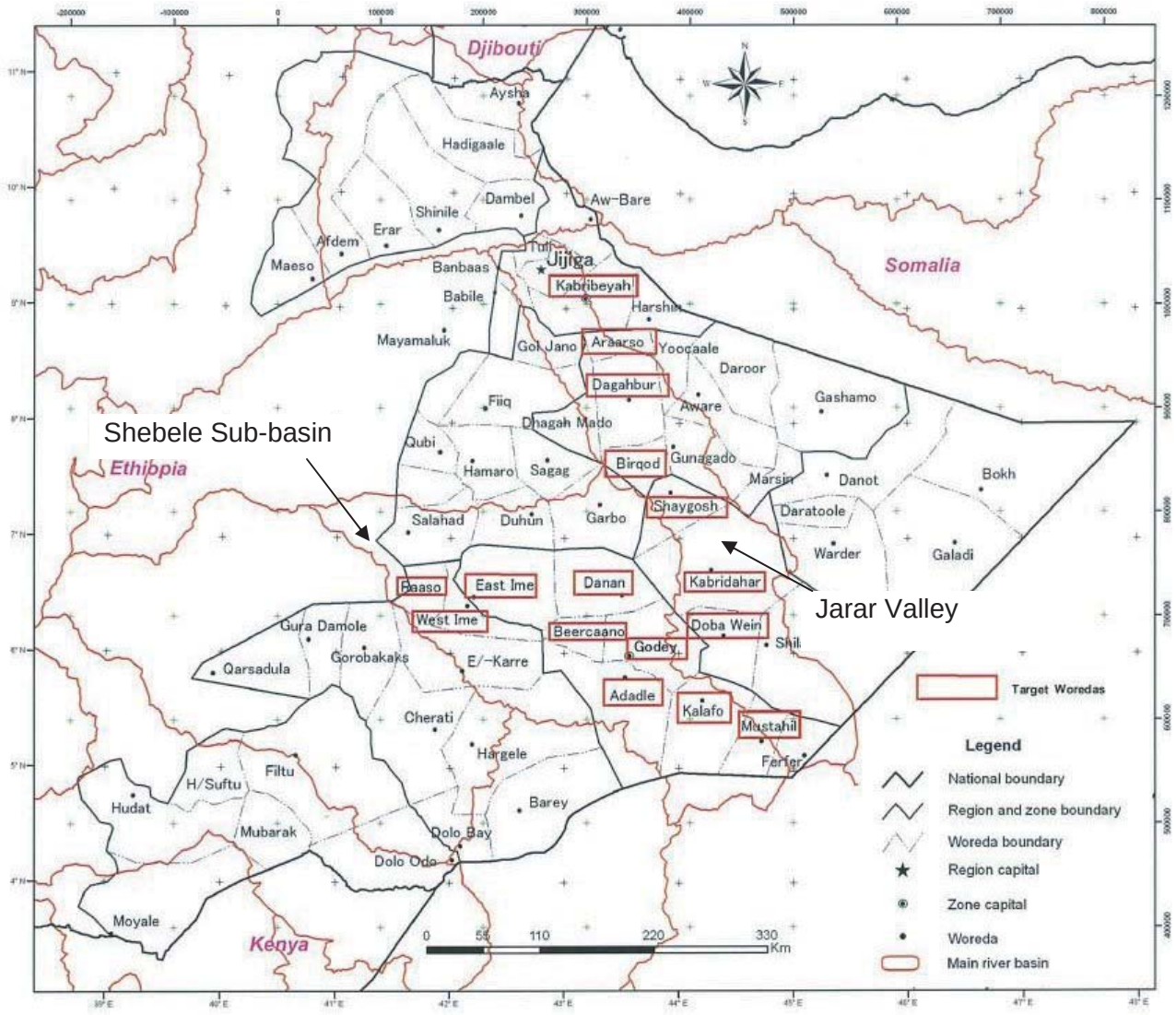


Figure 1.6: Study Area Map

1.6.2 Target towns and woredas

There were seventeen target woredas including those that contain Kabribeyah and Godey towns at first. Five of which were new and they were only officially registered after the start of the Study in April 2012. Therefore the location of the new woredas was not clear and thus, after the determination of geographical extent of the sub-basins, one woreda was found located outside the sub-basin. The names of the target woredas are shown in Table 1.2.

Marsin is located out of the sub-basin; therefore, Marsin woreda was excluded from the water supply planning although the socio-economic survey was executed in Marsin woreda. The local consultant team for the survey could not access Doba wein woreda due to security reasons. However SRWDB strongly requested to make a water supply plan for Doba wein woreda, the Study team carried out the water supply plan to take advantage of similar information of another woreda based on the suggestion of SRWDB. Therefore, target woredas is sixteen including the four new woredas as follows below;

Table 1.2: Target Towns and Woredas

Survey Area	Zone	Target Woredas	Associated new woreda	Remark
Jarar valley	Fafan	Kabribeyah		
	Jarar	Dagahbur	Araarso	
			Birqod	
	Korahe	Shaygosh		Marsin is out of survey area
		Kabridahar		
		Doba wein		
Shebele sub-basin	Shebele	East Ime	Beercaano	
		Adadle		
		Danan		
		Godey		
		Kalafo		
		Mustahil		
	Afder	West Ime	Rasso	

Note: the spellings of woreda names followed those in the administrative map and list of woredas obtained from BoFED.

1.7 Study team and persons involved

1.7.1 Study team

The JICA Study Team was composed of the following fifteen (15) experts, with Mr. Toshiyuki Matsumoto, senior chief engineer of Kokusai Kogyo Co., Ltd., as team leader (refer to Table 1.3).

Table 1.3: Members of Study Team

Area	Name	Nationality
Team leader/ water resources development	Mr. Toshiyuki MATSUMOTO	Japanese
Sub-leader/ operation and maintenance	Mr. Naoki YASUDA	Japanese
Water supply planning1/ facilities design	Mr. Kenichi ISHII	Japanese
Water supply planning1/ cost estimation	Mr. Daisuke SAKAMOTO	Japanese
Hydrogeology/ water quality	Mr. Shigeki KIHARA	Japanese
Hydrology	Mr. Shigekazu FUJISAWA	Japanese
Geophysical survey	Mr. Tsugio ISHIKAWA	Japanese
Remote sensing/ GIS	Dr. Peifeng LEI	Chinese
Mechanical equipment	Mr. Tamotsu ISHII	Japanese
Well drilling	Mr. Masatoshi TANAKA	Japanese

Socio-economic survey/ social and finance survey	Mr. Shoji MASUMURA	Japanese
Social and environmental consideration	Dr. Hirokatsu UTAGAWA	Japanese
Procurement1/ logistical support	Ms. Masami TAKAHATA	Japanese
Procurement2	Mr. Kensuke SAKAI	Japanese
Project coordinator/ assistant to water resources development	Mr. Yosuke YAMAMOTO	Japanese

1.7.2 Persons of Ethiopian side involved

The main relevant organizations of Ethiopian side were: the responsible agency, MoWE and implementation agency, SRWDB. In particular, the Director of Water Sector and Capacity Building Directorate of MoWE was the project director and the chairman of steering committee of the Study. And also the project manager was designated from the Head of SRWDB, and two Deputy Heads of SRWDB were in charge of Water Supply and Water Supply Management, and the deputy project manager of the Study was in charge of Water Resource Study and Management. And each C/P person was assigned to work exclusively with one of the Study Team members in this Study (refer to Table 1.4).

Table 1.4: JICA Study Team and C/P Members

Study Team		C/P	
Expertise	Name	Name	Position
Team Leader/Water resources development	Toshiyuki MATSUMOTO	Mr. Mohamed A Bihi	Water Supply Scheme Management (WSSM) CP Owner
		Mr. Mohamud Shele	Study and Design Case Team
Sub-leader/O&M and management	Naoki YASUDA	Mr. Solomon G/Esgeber	WSSM CP
Water supply planning 1/Facilities design	Kenichi ISHII	Mr. Mohamed Yusuf	Construction and Supervision Case Team (CSCT) Leader of Water Supply (WS) CP
Water supply planning 2/Cost estimation	Daisuke SAKAMOTO	Mr. Abdi Muhumed	
Hydrogeology/ Water quality	Shigeki KIHARA	Mr. Ali Mohamed	Water Resources Study & Management (WRSM) CP Owner
Hydrology	Shigekazu FUJISAWA	Mr. Wondisen	Study & Design Case Team (SDCT) Leader
Geophysical survey	Tsugio ISHIKAWA	Mr. Antene	SDCT of WS CP
Remote sensing/GIS	Peifeng LEI	Mr. Fuad Hassen	Deputy Head of SRWDB
Mechanical equipment	Tamotsu ISHII	Mr. Siad Abdi Mr. Abdi Mohamed	WSSM CP
Well Drilling	Masatoshi TANAKA	Mr. Ahmed Tahir	CSCT of WS CP

Socio-economic survey and social and financial survey	Shoji MASUMURA	Mr. Aydrus	WSSM CP
Social and environmental consideration	Hirokatsu UTAGAWA	Mr. Ilyas	CSCT of WS CP
Procurement/logistical support	Masami TAKAHATA	Mr. Mukhter	Finance and Administration SP
Coordinator/assistant to water resources development	Yosuke YAMAMOTO	Mr. Ahemednur Abdulahi	WSSM CP

Note: some members have been changed from the initial list. This list is as of March 2013.

There were some other organizations involved in this study to share study information with and to work closely with. The following Table 1.5 is the list of such other organizations.

Table 1.5: Other Relevant Organizations

Name of organization	Responsibility and role in this study
Ministry of Water and Energy (MoWE)	- In charge of water resources development and management in Ethiopia In this study, MoWE, as the responsible agency, is to coordinate all the related Ethiopian organizations and to provide necessary data & information, and also to deal with process for tax exemption and customs clearance.
Somali Regional Water Development Bureau （SRWDB）	- In charge of water resources development and management in Somali Region and also emergency water supply. In this study, SRWDB, as the implementation agency, is to provide C/P persons for each area of expertise of the study team members, and to assure that these C/P persons work closely with the Study Team.
Administration for Refugee and Returnee Affairs (ARRA)	- In charge of assisting refugees and returnees in Ethiopia. Jarar Valley water supply system supplies water to some refugee camps and in this sense, coordination with ARRA is required in this study.
Disaster Prevention and Preparedness Bureau （DPPB）	- In charge of disaster mitigation and prevention in Somali Region, especially drought damage. DPPB is involved in this study as the coordinator of relevant offices in emergency water supply in the region. Their capacity development is expected.
Somali Water Works and Construction Enterprise (SWWCE)	- In charge of water well drilling and related construction work as a contractor. In this study, capacity development for SWWCE is expected to raise their ability to drill water wells.
Kabribeyah Town Water Supply Utility Office	- In charge of operation and management of Jarar Valley water supply system. At the time of improvement of Jarar Valley water supply system, capacity development of the staff is expected to be done by working together with the staff. The training will include management skills of the system for sustainable operation of the system in future.
Godey Town Water Supply Utility Office	- In charge of operation and management of the water supply system of Godey town In this study, when F/S is conducted for the proposed projects, capacity development including strengthening of the management system for the staff is expected.
Other organizations	Coordination with other organizations (NGOs, UN agencies, donor agencies) that operate in the study area will be necessary.

According to the R/D, a steering committee was supposed to be established for the Study. There were many organizations concerned with this Study. Therefore, as a measure to assure good communication and information sharing with these organizations, a steering committee needed to be organized. The Study Team interacted with the Steering Committee when there are any important issues to discuss; making important decisions, sharing the progress of the Study, acceptance of various reports to be prepared in the course of the Study etc. in order to realize smooth implementation of the Study.

The following members from the Ethiopian side have been listed as the members of Steering Committee in the R/D document, and new members were selected additionally in consideration of the situation of the Study.

<Chairman>

Director of Water Sector and Capacity Building Directorate, MoWE

<Members>

1） Representative of Ministry of Finance and Economic Development (MoFED)

2） Staff of Water Supply and Capacity Building Directorate, MoWE

3） Representative of ARRA

4） Head of SRWDB

5） Deputy Head of SRWDB in charge of Water Supply Core Process

6） Deputy Head of SRWDB in charge of Water Supply Management Core Process

7） Representative of Kabribeyah town water supply utility office

8） Representative of Godey town water supply utility office

9) Representative of DPPB

10) Representative of Jijiga sub office of UNHCR*

11) Representative of Somali Regional State Environmental Protection, Mine and Energy Development Agency (SEPMEDA)*

12） Representative of Bureau of Finance and Economic Development (BoFED)*

13) Study Team

14) JICA Ethiopia Office

*: Added necessary members after the first steering committee

Chapter 2

Emergency and Long-Term Water Demand in Somali Region

2 Emergency and Long-Term Water Demand in Somali Region

2.1 Introduction

As mentioned in the background of Study of Chapter 1, although the Somali Region is an area prone to repeated droughts and food shortages, there are many areas in which the water supply conditions are not improved adequately. In such areas, it is better to build the permanent water supply systems instead of emergency water supply systems such as water trucking at times of drought. However there are areas that depend on the emergency water supply in terms of hydrogeological conditions. Therefore the potential evaluation of the water resources in relation to the groundwater and surface water are executed at first and it is necessary to create the maps which show areas of relatively high potential development and of low potential that are difficult to extract potable water regularly in hydrogeological terms. Moreover it is important to make the basic document of middle and long term water supply project through the establishment of a water supply plan for the areas which are able to secure the water resources. In the Study, the above works are carried out and the necessary materials and machineries are also procured for the short time arrangement. The results of the Study are reported in this chapter.

2.2 Survey on the potential of water resources (groundwater) utilization

2.2.1 Meteorology and hydrology

The hydro-meteorological survey was carried out so as to estimate groundwater recharge and calculate securement for the perennial river flow in the study area. The meteorological stations are shown in Figure 2.1.

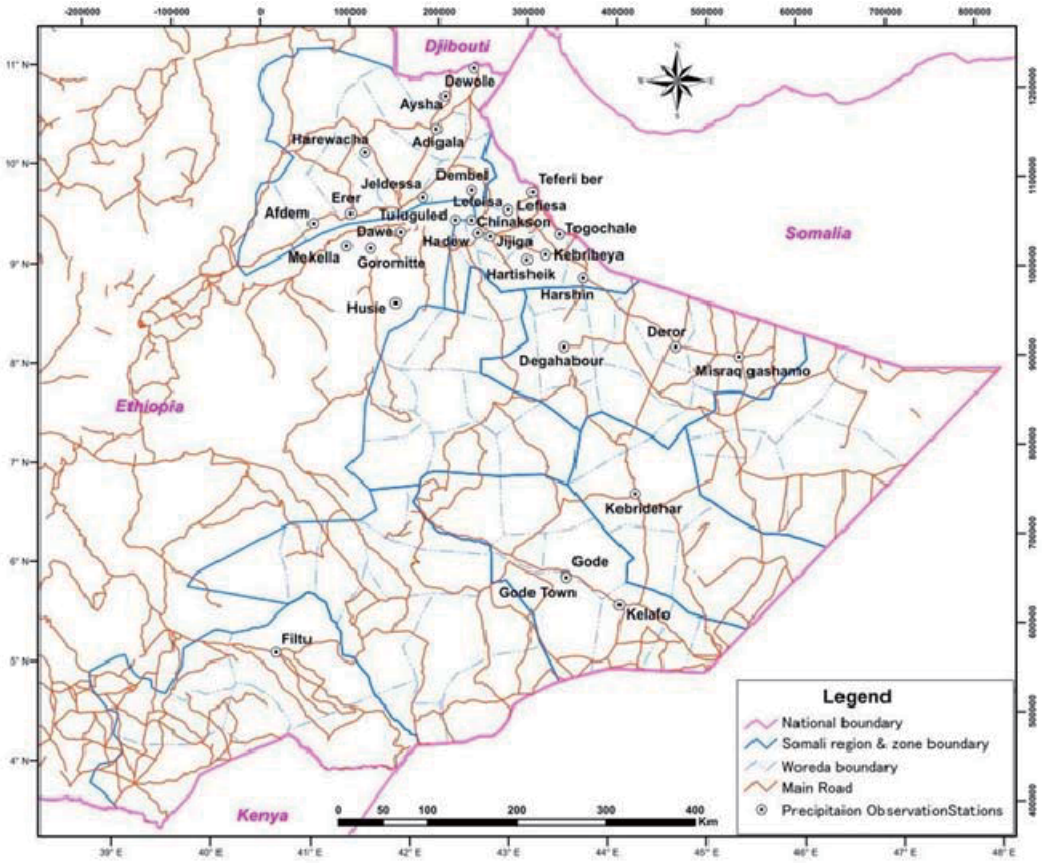


Figure 2.1: Location Map of Meteorological Stations

The meteorological stations are located in Jijiga and Kabribeyah Towns and its surrounding area in the northern part of Somali Region, the Dagahbur Town of central area and the other towns of eastern area of the region, Kabridahar Town of south central area, and Godey Town and Filtu Town in the eastern part of Godey Town. Many stations are concentrated in the northern part of Somali Region.

The annual mean precipitation of meteorological stations in Somali Region is 570mm in Jijiga Town (Altitude: 1775m), 270mm (537m) in Kabribeyah Town , 330mm (1070m) in Dagahbur Town, 220mm (1753m) in Kabridahar, 230mm-270mm (290m) in Godey Town and its surrounding area, and 440mm (1225m) in Filtu Town in the southern part of Somali Region.

The annual mean temperature of stations of Somali Region is a maximum of 28 degrees Celsius, minimum of 12 degrees Celsius in Jijiga Town and its surrounding area, 27.4 and 13.9 respectively in Kabribeyah Town, 31.4 and 18.5 respectively in Dagahbur Town, 33.3 and 20.7 respectively in Kabridahar Town, and 34.9 and 23.4 respectively in Godey Town and its surrounding area.

The annual evaporation data of the stations are 2100mm in Jijiga Town, 2600mm in Dagahbur Town, 4500mm in Godey Town and 2300mm in Filtu Town in the most south west of Somali Region. These data were observed using evaporation pans.

In this project, the study team collected the necessary meteorological data from Addis Ababa National Meteorology Agency (here after “NMA”) and Jijiga NMA office, which is under the control of Somali Region. However there is a large variation in observation time and method of recording.

The target rivers in study area are the Shebele River which is classified as a perennial river throughout the year in and around Godey Town, and the Jarar River which is classified as a Wadi (intermittent stream) and does not have flow except in the rainy season or in case of intensive temporary precipitation. The hydrological basin of those two rivers is the Shebele River sub-basin and Jarar valley sub-basin. The drainage area of two river flow stations along the river is as follows;

Shebele River: Gode discharge station (discharge area A=127,300km^2)

Jarar River: Dagahbur discharge station (discharge area A=5,184km^2)

The observation results of river flow are 25.92mm in Gode station and 1.56mm in Dagahbur station as the annual depth of runoff.

Several methods of estimating the groundwater recharge amount were employed, which included mathematical balance method (areal precipitation and potential evaporation were based on Thiessen method), BFI (base flow analysis) method and tank model method. The results indicated that the groundwater recharge in the study area ranges from 9.3mm to 47.95mm annually. Also, it was found that both in Jarar Valley and Shebele River basins, the areas in the upstream of the basins have higher values of groundwater recharge as compared to those in downstream areas. This is consistent with the finding that precipitation is higher and evapotranspiration is lower in upstream areas.

2.2.2 Geology

It is necessary to establish the geological history and stratigraphy of the target area in detail, because the distribution and sedimentation of strata are important for the hydrogeological conditions.

There is a close relationship between the topographical conditions and geological structure. Landform of the target area (Jarar valley and Shebele sub-basin in Shebele River basin) is complex; one is the landform controlled by dip direction of layer shown in Figure 3.3, the other is gradual anticline structure. Moreover, a weak zone is developed around Fafem – Jarar area where the anticlinal axis is located and around flexure scarp in left bank.

The geological formations of Somali Region range in age from Precambrian to Quaternary deposit. The oldest geological formations are undifferentiated Precambrian crystalline rocks, which include granite, granitic gneiss, amphibolite and diorite. The basement rocks are overlain by Mesozoic sediment, which are in turn overlain by Tertiary to recent volcanic and alluvial deposits.

The geological history of the region can be followed from the Precambrian Era which is represented by metamorphic and igneous rocks of the basement system. In Cenozoic age, old basalt of unknown age and new basalt are distributed. The stratigraphy of Somali Region is shown in Table 2.1 in accordance with the existing data analysis.

Table 2.1: Stratigraphy of Somali Region

Era	Period/Epoch	Stratigraphic Name	Symbol		Max. Thickness (m)	Lithological Characteristics
Cenozoic	Quaternary	Alluvial Sediment	Qa		150	Terrace deposit mainly, river bed deposit was divided as [r]
		Eluvial & Colluvial	Qc		50	Eluvial & colluvial deposit
	Quaternary – Late Pliocene	Undifferentiated Basalt	Qb		600	Recent volcanic undifferentiated
	Middle – Late Eocene	Karkar Formation	Ek		–	Exfoliative brown shele and banded fibroid gypsum intercalated in white porous chalk limestone, deep sea sediments[1)]
	Early – Middle Eocene	Talah Evaporates	Et		150	Banded massive anhydrite with altenative charty limestone irrregularly[1)]
	–	Undifferentiated Basalt	Qv		200	Undifferentiated old basalt unknown age was dotted with area
Mesozoic	Early Eocene – Late Cretaceous	Auradu Limestone	Ea		150	Light pinkish biogenic massive limestone with iron color chart and sea floor basalt lava in the base[1)]
		Jessoma Sandstone	Pj		400	Continentality to shallow sea deposits, consist of variegated quartz sandstone and silt stone[2)]
	Late Cretaceous	Beletwein Limestone	Kb		200	Shallow sea sediments, shaly limestone with some shale and sandstone[2)]
		Ferfer Gypsum	Kf		200	Lagoon and shallow area deposits, consist of dolomite, limeston, marlstone, shale, anhydrite, gypsum with sand and marl intercalations[2)]
	Early – Late Cretaceous	Mustahil Limestone	Km		300	Continental shelf deposits, consist of biogenic limestone with normal limestone, shale and marlstone[2)]
	Early Cretaceous – Late Jurassic	Korahe Gypsum	Kg	Kg2 (upper)	500	Lagoon deposits, consist of gypsum, anhydrite, marlstone, shale, iron carbonate (chalybite)[2)]
				Kg1 (Lower)		
		Amba Aradam Sandstone	Ka		150	Quartz sandstone mainly alternative with siltstone, shale, and marlstone[2)]
	Late Jurassic	Kabridahar Limestone	Jg	Jg2 (Upper)	500	Shallow sea deposits, consist of oolitic limestone, marl and gypsum mainly with gypsum and shale[2)]
				Jg1 (Lower)		
		Urandab Formation	Ju		120	Deep sea sediments, consist of darkgray black shale mainly[2)]
	Middle – Late Jurassic	Hammanlei Formation	Jh	Jh2 (Upper)	1600	Lagoon and sea deposits, limestone, shale, anhydrite, sandstone alternative with dolomaote, limestone, anhydrite, gypsum, and micritice limestone with fossil[2)]
				Jh1 (Lower)		
	Middle Jurassic – Triassic (?)	Adigrat Sandstone	Ja		253	Red and brown sandstone mainly, fine to coarse sandstone with banded shale and laterite[2)]
Proterozoic	Precambrian	Basement Rocks	PC			Consist of granite, granodiorite, gneiss, anphibolite, schist, and quartzite, crystalline rock[3)]

Source: Modified from Hydrogeological Mapping Project Report, SHAAC, 2009

1) : Kazmin, V. (1975): Explanation of the Geological Map of Ethiopia, Bull No.1 Eigs, Addis Ababa.
2) : WWDSE (2004): Wabi Shebele River Basin Integrated Development Master Plan Study Project, Final Report, Phase II – Data Collection, Site Investigation, Survey & Analysis, Section II Sectoral Studies, Volume 1 – Natural Resources, Part 1 – Geology.
3) : SHAAC Engineering Consulting plc. (2009): Hydrogeological Mapping Project, Report.

Based on the established stratigraphic sequence, geomorphological and geological analysis results combined with the log data of existing wells were further analyzed. As a result, geomorphological, geological, and hydrogeological (well information) classifications were conducted along with geological cross sections & well log database for each of the target woredas for the master planning.

According to the geological map of target area and the geological cross-section of direction of NNW-SSE along the Jarar valley, the limestone and sandstone of middle to late Jurassic, Triassic (?) (Ja, Jh of stratigraphy table: same as above) distributed from Kabribeyah woreda

to Araarso woreda. Those strata are covered by the quartz sandstone (Pj) of lower Cretaceous and Quaternary deposit. Pj formation is distributed widely in the east of Jarar valley. The Jh layer is distributed to the south of Birqod woreda to Kabridahar woreda is covered by the Ju and Jg layers of sandstone and limestone of lower Jurassic and the strata indicate a dip to the south. Gypsum layer (Kg) of late Jurassic to lower Cretaceous is distributed widely, those strata are covered by a limestone layer (Km, Kb) of late Cretaceous partly. Kg formation is distributed widely along the Shebele River, partly Km layer covers Kg layer.

The characteristic of existing wells is that the depth of wells is more than 200m in Kabribeyah and Araarso woredas, and the existing wells of 60m to 200m in depth are distributed up to the area of Kabridahar woreda. However well depth is less than 30m for the target of Quaternary deposit distributed for the top layer from south part of Kabridahar woreda, because the Gypsum layer is distributed widely, giving rise to a problem of water quality.

2.2.3 Hydrogeology

The well information covers their locations, depths, aquifer constants, and the relation between water level fluctuation and pumping yield. The collected well logs helped identify aquifers and clearly establish stratigraphic sequences through comparison with the geological characteristics of the formations. The major and potential aquifers that have been identified as a result of this study are those of the Quaternary sediments, Quaternary to Tertiary basalts, a part of Tertiary and Cretaceous formations, Jurassic sediments, and Jurassic to Triassic (?) sandstone formations. The above classification was reflected in the aquifer potential evaluation of groundwater utilization potential evaluation map.

The main characteristic of aquifer is shown in Table 2.2 below;

Table 2.2: Classification and Characteristic of Aquifer Units

Age	Aquifer Name	Symbol	Hydrogeological Characteristics
Quaternary	Quaternary	Qa, r (fluvial deposit)	• Alluvial deposit in the dry stream courses yields water for domestic use[4)]. • The alluvial deposits can yield good quality and quantity of water that can be used both for domestic and livestock[4)]. • Most hand-dug wells are located within this aquifer[4)].
Quaternary-Tertiary	Basalt	Qb, Qv	• The upper part is found to be highly weathered; however the lower part is less weathered and fresh. • The weathered and fissured parts could be a good aquifer.
Tertiary	Karkar	Ek	• This aquifer is composed of limestone, marly limestone and clay[1)]. • According to AQUATECH (1999)[1)], the well at Galadi represents the hydrogeology of this aquifer. The presence of marls and clays at shallow depth render the possibility of harnessing low yielding perched aquifers in locally depressed areas of the proluvium and carbonates.
	Talah	Et	• This aquifer is of alternating anhydrite, gypsum, and shale, with some thin interbeds of dolomite[2)]. • Gypsum does not occur everywhere in the sequence, and several boreholes yield potable water[2)].
Tertiary - Cretaceous	Auradu	Ea	• This aquifer consists of grey to white, hard and massive limestone which is often unbedded[4)]. • This maintains a fair lithological uniformity throughout the eastern Warder zone. It is widely exposed in Galadi and Bokh area[4)].

			• The infiltration occurs along the faults and fractures[4].
Cretaceous (Tertiary?)	Jessoma	Pj	• This aquifer consists of gray and variegated sandstone with intercalations of variegated shale and lateritic horizons. The available data suggests that the grain size and the thickness progressively increase from west to east[4]. • The lithological properties of this aquifer tend to suggest that the water bearing characteristic of the sandstone could be very considerable in space both vertically and horizontally[4]. • In the eastern part of the region especially in Danot area, due to the absence of retaining layer at shallow depth, whatever recharge available for the aquifer tends to percolate to greater depth until retained by the underlying impervious limestone or clay horizons of the Upper Cetaceous Formations[4].
Cretaceous	Beletwein	Kb	• This aquifer is composed of massive limestone with intercalation of shale and brown sandstone[5]. • Boreholes drilled into the aquifer have met water of relatively fresh quality in the lower part of the succession but deteriorates in the upward sections[5].
	Ferfer	Kf	• This aquifer is made up of alternation of dolomite, marl and anhydride[5]. • Karstic features are not uncommon in places such as south of Shilabo village[5]. • The aquifer acts as an aquiclude or as a saline aquifer[5].
	Mustahil	Km	• Limestone interbeded with shale and marl is characteristic for the lower part whereas in the upper part reef limestone predominates[5]. • Many dug wells are known to exploit perched aquifers, especially around Kelafo and within Fafan valley towards Kabridahar[5]. • From lithological and some indirect permeability considerations, this aquifer presents hydraulic characteristics suitable for substantial exploitation of groundwater[1]. • Nevertheless, the fact that the aquifer is sandwiched between two evaporitic sequences; namely, Korahe and Ferfer aquifers, there could be some doubt as to the chemical suitability of groundwater within this aquifer[1].
Cretaceous - Jurassic	Korahe	Kg	• The lower part is represented by alternation of dolomitic limestone, marl, shale and anhydride[4]. • Fresh groundwater exploitation through tube wells is impossible due to the bad quality of the groundwater[4]. • Therefore, any borehole drilled in such areas should be drilled until the under laying limestone formation is reached so as to obtain fresh water[4]. • Most of the boreholes drilled in this aquifer especially in Afder and Godey zones are abandoned due to high salinity content[4].
	Amba Aradam	Ka	• This aquifer consists of well washed, porous and friable sandstone[6]. • Previous studies in Ogaden basin (e.g. EIGS (1999)2) classified this unit as a poor aquifer[6) in 7)].
Jurassic	Kabridahar	Jg	• It is a thick succession of limestone beds inter bedded with marl, shale and thin layer of gypsum that covers a large area of the study area[4]. • This aquifer with near horizontal beds of limestone generally has very low primary porosity and permeability that are insignificant for groundwater conduit occurrence[22]. • Secondary permeability due to fractures and solution openings along bedding planes is more important for groundwater occurrence and movement[4]. • Water that enters along fractures causes dissolution in fracture zones that result in higher hydraulic conductivity

			than the un-fractured rocks, which create higher possibility for groundwater occurrence[4)]. • Vertical movement of groundwater in fracture zones can also result in solution openings along bedding planes for lateral movement of groundwater in the formation[4)].
	Urandab	Ju	• The aquifer conformably overlies the Hamanlei aquifer and is composed of well-bedded, fine-grained shaly limestone with alternating marl, gypsiferous clays and massive gypsum[4)]. • Boreholes drilled in this aquifer mostly were abandoned because of being dry. The lack of groundwater in this aquifer is due to presence of shale and this prevents vertical and lateral recharge[4)].
	Hamanlei	Jh	• The rocks in this aquifer are predominantly limestone and dolomite having gradational contact with the Adigrat aquifer and with the overlaying Urandab aquifer. It is divided into 5 units[4)]. • Abundant fresh water has been met in many boreholes in outcrop areas[4)].
Jurassic - Triassic (?)	Adigrat	Ja	• It is represented by medium to coarse grain, red to brown sandstone with some shale and laterite bands[3)]. • It is generally categorized as a unit with medium to high permeability and high infiltration capacity[8)].
Precambrian	Basement Rocks	PC	• High grade metamorphic rocks (granite, migmatite, etc.). • Poor aquifer[2)]. Water yields only in fractures or weathered zones.

1) : AQUATECH (AB) Pvt. Ltd. (1999): Technical Proposal to Conduct Hydrological & Hydrogeological Studies, The Nine Zones of the Somali Region.
2) : Hadwen, P., Aytenffisu, M. and Mengesha, G. (1973): Groundwater in the Ogaden.
3): WWDSE（2004）: Wabi Shebele River Basin Integrated Development Master Plan Study Project, Final Report, Phase II – Data Collection, Site Investigation, Survey & Analysis, Section II Sectoral Studies, Volume 1 – Natural Resources, Part 1 – Geology.
4) : SHAAC Engineering Consulting plc. (2009): Hydrogeological Mapping Project, Report.
5) : SHAAC Engineering Consulting plc. (2012): Water Quality Survey, Final Report.
6) : Swartz, D. H. and Arden, D. D. Jr. (1960): Geologic History of Red Sea Area, Am. Assoc. Petrol. Geol. Bull., V. 44.
7) : Tamiru, A. (2006): Groundwater Occurrence in Ethiopia, Addis Ababa University, Ethiopia.
8) : Hillini Water Well Drilling Company plc.(2011): Fafan Integrated Development Project, Water Resources Development Subproject; Well Completion Report Final of 4 Boreholes in Kobijara.

The characteristic of distribution of high potential aquifer and thickness of strata is as follows based on the existing well data;

Adigrat layer: There is few data in existing well data. The distribution area is in Jijiga Town and its surrounding area and Jarar Valley in Kabribeyah Town (thickness of layer: 10m-150m), in Godey Town and its surrounding area of south Somali region (more than 150m) and in Ogaden area (150m-200m). There are successful wells in Jijiga Town and Jarar Valley in Kabribeyah Town.

Hamanlei layer: The distribution area is in Jarar Valley and its surrounding area (Thickness of layer: more than 150m), in south to south west area in Somali Region (150m-200m) and Ogaden area (more than 150m, or 150m-200m). There are many successful wells, but the low yield area exists in some area.

Kabridahar layer: The distribution areas are dotted throughout the whole Somali Region. But this layer is not distributed in the surrounding area of Jijiga Town. The thickness of this layer is 150m-200m in the south to south west of Somali Region and Ogaden area, 10m-50m in the

west of Somali Region, and more than 150m in the other area. The yield is not so much.

Mustahil layer: The distribution of this layer is limited in Doba wein and its surrounding area. The thickness of this layer is around 100m to more than 150m. The yield is low.

Jessoma layer: The distribution area is concentrated to the direction of NNW-SSE of east of Jarar valley, basically this layer is distributed to the surrounding area of Jijiga Town to the south area of Ogaden area. The thickness of layer is 150m, or more than 150m. There are data of successful wells, but data are not clear or tend to low yield.

Old basalt: This layer is mainly distributed in the south area of Marsin woreda, the thickness of this layer is 100m-150m or less than 10m. The yield is not so much.

Quaternary System: This layer is distributed throughout the whole Somali Region, in particular the distribution of this layer is concentrated along the river of Jarar Valley, the west Somali Region and Ogaden area. The thickness of this layer is less than 10m or 10m-50m in Jijiga Town and its surrounding area and Ogaden area. There are many wells reached basement rock in Jijiga area, the Quaternary deposit covers the basement rock directly in those areas. The successful wells were confirmed in this area.

On the other hand, there are abandoned wells due to the problem of water quality in the west of Jarar valley, Godey Town and its surrounding area of southwest and east area because of the presence of Gypsum formation.

2.2.4 Water quality

The water quality testing was executed using sampling water of 103 (one hundred and three) points such as the borehole of 30 points, the hand dug well of 39 points, the treatment water of 14 points and the river water of 20 points. Moreover, three types of water (raw water, treatment water and tap water (in the case of level 2 facilities)) are sampled in the point with a water treatment facility. The borehole points mainly distributed along the Jarar Valley, and the hand dug wells distributed along the Shebele River and in inland area in the type of water resources.

The water quality analysis involved field analysis of samples and laboratory analysis at Haramaya University. The main items analyzed are as follows;

- Filed analysis items: Temperature, Electric Conductivity (EC), pH, Iron, Mn, F, Nitric acid (HNO_3), As, NH_4, COD, Residual chlorine, Coliform, General bacteria

- Laboratory analysis items: Turbidity, Total Dissolved Solids (TDS), Suspended Solids (SS), pH, Electric Conductivity (EC), Total hardness ($CaCO_3$), Ca, Mg, K, Na, Fe, Mn, Cl, SO_4, NO_3, Alkalinity (CO_3^{2-}, HCO_3^-), F, TP, Ammonium ion (NH_3+NH_4)

The results of the water quality analysis were plotted on tri-linear and hexa-diagrams. The plots indicate that many samples are classified as either CaCl type or $CaSO_4$ (non-bicarbonate) type in terms of the characteristics of major ion concentrations and that some fall between the two. The first two types correspond to hot spring water, mine spring water, or fossil water. The latter intermediate type samples probably correspond to groundwater or river water that are locally in circulation.

The water samples were analyzed for 19 items of water quality in a laboratory and the results were compared with the WHO and Ethiopian standards. In turbidity, TDS, Cl ion and total hardness, many samples exceeded the standard values. In case of each water resource, the total hardness of boreholes, hand dug wells and treatment water are in high ratio that exceed the WHO standard and the turbidity of river water is in high ratio that exceeds the WHO standard. The Fluoride ratio of more than 20% of borehole and dug well and 57% of river water exceed the WHO standard but not the Ethiopian standard. The Fluoride is not so high compared to the value of Rift Valley area. There is probably due to a difference in the geology in each area. The ratio which exceeds the WHO standard was compared with each water resources as shown in Table 2.3.

Table 2.3: Comparison of Water Quality using WHO Standard

Analysis items	Standard value(mg/l)		Ratio of each water resources exceeded WHO standard (sample number)			
	WHO (acceptable & guideline value)	Ethiopia	Borehole(30)	Dug well(39)	Treatment water(14)	River water (20)
Ammonium ion	1.5	2	4%(1.997)	5%(1.634)	0%	0%
Sulfate ion	250	483	0%	0%	0%	0%
Nitrate ion	50	50	0%	0%	0%	0%
Turbidity	5NTU	7NTU	50%(702)	41%(619)	43%(80)	95%(844)
Fluoride	1.5	3	23%(1.84)	21%(2.007)	0%	57%(2.141)
TDS	1000	1776	74%(4284)	80%(7858)	25%(3023)	7%(2002)
pH	—	—	All samples are acceptable			
Chlorine ion	250	533	67%(1055)	51%(1095)	29%(455)	5%(395)
Natrium	200	358	14%(325)	18%(589)	0%	0%
Manganese	0.1	0.13	7%(0.575)	18%(2.529)	0%	0%
Iron	0.3	0.4	21%(1.585)	13%(0.765)	0%	35%(0.794)
Total hardness	—	392	93%(2500)	100%(3890)	71%(4800)	75%(700)

()Max value, Total hardness: comparison with Ethiopia standard

The main distribution tendency of items that exceed the standard is that the turbidity is distributed along the Jarar valley except Kabridahar Town and its surrounding area and all points along the Shebele River, Fluoride is distributed in the central part of Jarar valley, upstream of Shebele River and the part of southwest in Godey Town, TDS and total hardness are distributed in almost all sample points, and Cl ion is dotted with the Kabridahar woreda and its surrounding area in Jarar valley and along the Shebele River. Fe ion is in high value along the upstream of the Shebele River.

2.2.5 Groundwater utilization potential evaluation map

The groundwater utilization potential map that was presented shows classification of relative groundwater potential. The standard (legend) shows the relation between yield and water quality for the aquifer potential and the geology is classified relatively. The groundwater potential is high relatively along the Jarar valley and the left side of Jarar valley. And also, the low potential area is distributed on the right side of Jarar valley. On the other hand, as the gypsum layer is distributed widely along the left and right side of Shebele River, the relative potential becomes low. However, the high potential for the water resources is indicated along the Shebele River and small rivers in the Shebele sub-basin.

2.2.6 Water resources information map for Somali Region

The water resources information map (WRIM) will be prepared based on the water resources (groundwater) utilization potential maps for Jarar Valley and Shebele River sub-basin areas. WRIM will cover the areas outside these basins and will use water resources evaluation by

remote sensing technique to evaluate these areas. The procedure of remote sensing analysis to prepare WRIM can be summarized as follows.

1) Necessary data collection

2) Merging, compiling, and adjustment of collected data

3) Setting the classification criteria for each factor, and creating classed maps or tables

4) Setting weights for each factor according to its degree of effect to WRIM.

5) Integrating all the factors with different weights to complete the WRIM.

The analysis of the factors affecting water resources information was executed based on the procedure shown above. The main factors are four ones: groundwater recharge (the method of the relative comparison between precipitation and potential evapotranspiration), topography, geological strata and lineament. Their influence over WRIM is not the same. So the factors should be weighted accordingly. The final map was created by integrating all the weighted factors. The result of recharge rank classification was assigned the greatest weight of 40%, the second highest weight of 30% was assigned to topography and for the other two factors of geological strata and lineament, and the weights of 20% and 10% were assigned respectively. The maps were created in consideration of eighteen types of weight range of each factor, and a map which is similar to the evaluation map was selected from eighteen maps. The final WRIM is covered by the water quality distribution map (UNESCO, 2012).

2.3 Water supply plan

2.3.1 Basic data of water supply plan

a. Target year and estimated population

Water supply master plans were prepared for urban and rural areas of 16 woredas in Jarar Valley and Shebele River sub-basins. In particular, the pilot project for the water supply construction was implemented in Kabribeyah and Godey Towns, and the water supply plan facilities were reported in detail.

Taking into consideration the progress of the water supply access ratio in Somali Region and the design criteria in the revised UAP strategy, the target year of the water supply plan was set as 2020. The proposed water supply access ratio is 100% as of 2020. The population growth rate employed is 2.91% per annum, which was estimated from the data of CSA, for both urban and rural areas. The total population of urban and rural areas in Kabribeyah Town is expected to change from about 201,000 in 2012 to about 253,000 in 2020. And population of Godey Town has also been changed from 29,379 in 2012 to 36,958 in 2020.

b. Water demand

The per capita water demand of the revised UAP figures was followed to adopt the values of 20 lit/capita/day for urban water supply and 15 lit/capita/day for rural water supply. Other water demands were also discussed in regard to the institutional and commercial water use, industrial water use, water for livestock, water for firefighting, and water loss. The Study

adopted the value of 20% of the whole water demand as the livestock water demand. The water demand of rural water supply is calculated in consideration of potable water, water for livestock and water loss for the factors of water demand. The water demand of each woreda will become about 1.15 times range from 2015 to 2020. The design water supply volume was determined to be the total water demand in 2020 minus 80% of the water demand to be attained in 2015 based on the projection of UAP access ratio of water supply. However, the areas using river water have adopted the water demand value of 2020 in consideration of the current utilization of river water for the design water supply volume. The design water volume of Kabribeyah and Godey Towns are 2,699m^3/day and 2,212m^3/day respectively. The lowest design volume is 76m^3/day at urban area of Beercaano woreda.

2.3.2 Water resources and existing facilities

a. Water resources

The data from the socio-economic survey was used to grasp the conditions of existing water resources. In consideration of this data, utilization/development plan of new water sources was drawn up. In the plan, it is recommended to develop deep borehole wells (deeper than 60m) in Jarar Valley area and to use river water as priority in Shebele River basin area. The birka is in wide use in the Jarar valley sub-basin for the existing water resources except borehole, the birka is able to be utilized in the difficult place of well drilling because of inland area. The well development was estimated the depth and yield of well in the each target woreda in addition to the results of geological map and socio-economic survey with information of existing wells. In consideration of water quality, the well depths become shallow extremely from south area of Kabridahar woreda because the Gypsum layer appears. And the yield also decreases. The characteristic of main existing wells is as follows;

Table 2.4: Characteristics of Existing Well at Each Woreda

Woreda	Average well depth	Current Yield	Plan Yield
Kabribeyah	220m	Unknown	5.0 lit/sec
Araarso	250m	1 lit/sec	1.7 lit/sec
Dagahbur	70m	5 lit/sec	5.0 lit/sec
Birqod	60m	3 lit/sec	3.3 lit/sec
Shaygosh	140m	Unknown	4.0 lit/sec
Kabridahar	130m	4 lit/sec	4.0 lit/sec
Doba wein	25m	Unknown	1.0 lit/sec
Danan	30m	Unknown	1.0 lit/sec
Godey	30m	Unknown	1.0 lit/sec

The river water is the most utilized for the existing water resources in the Shebele River sub-basin and second and third use are shallow wells and hand dug wells respectively. The shallow wells may be drilled as the target of shallow layer along the river in reference to the existing well.

b. Water supply facility

The number of the existing water supply facilities activated has decreased from 45 facilities of 2008 to 26 facilities of 2012 in Jarar valley. The total number of facilities of 2012 survey is 56 facilities in addition to the new facilities constructed from 2008. The conditions of 22 of the 56 facilities are not clear; while 8 of 56 facilities are not functioning. The water supply facilities are very few along the Shebele River area. Four facilities were drilled in 2008, and only two more new wells were drilled from then until 2012. Moreover, three of these six facilities were not being utilized as of 2012.

In designing the facilities and size of reservoir tanks, the designs were based on the urban water supply standards. As for the size of birka and haffir dams, their standard design and sizes were employed and required numbers were determined based on the population of the users at one site. The river water supply system will be composed of generators and intake pumps, a sedimentation pond, rough filtration pond, slow sand filter pond, treatment tank, conveyance pump, distribution pipeline, reservoir tanks, supply pipelines, public taps and animal troughs.

2.3.3 Water supply plan, cost estimation and implementation plan of each woreda

Plan and design of water supply facilities for each of the 16 worerdas were illustrated as design outline maps that took into consideration of not only the basic approach for facilities designing but also geomorphological, geological, and water resources information. This was prepared for urban and rural areas of the 16 target woredas and arrangement of facilities along with their basic design were prepared. And then, the amounts numbers of materials were calculated for the purpose of cost estimation. The proposed main water sources and their characteristics for the target woredas are compiled in Table 2.5 below.

Table 2.5: Proposed New Water Supply Sources for Each Woreda

Zone	Woreda	Urban area					Rural area		
		Population	Design WS Volume	Type of resources		New Water	Number of	Type of resources	
		2020Y	m^3/day	Name	Number	Tunk	Kebele	Name	Number
Fafan	Kabribeyah	66,713	2,440	Borehole	1	1	29	Borehole	10
								Haffir Dam	2
								Birka	126
Jarar	Araarso	8,106	255	Borehole	6	1	8	Borehole	1
								Birka	28
	Dagahbur	26,829	851	Borehole	6	1	16	Borehole	5
								Haffir Dam	3
								Birka	31
	Birqod	3,861	127	Borehole	2	1	6	Borehole	4
								Birka	4
Korahe	Shaygosh	4,826	167	Borehole	2	1	4	Borehole	2
								Haffir Dam	4
								Birka	16
	Kabridahar	19,689	621	Borehole	7	1	9	Borehole	5
								Haffir Dam	12
								Birka	12
	Doba wein	13,031	431	Borehole	7	1	4	Shallow BH	11
								Haffir Dam	1
								Birka	1
Shebele	East Ime	3,595	114	River water	1	1	11	River water	6
								Birka	53
	Danan	3,784	122	Borehole	5	1	4	Borehole	4
								Birka	13
	Beercaano	2,433	76	River water	1	1	4	River water	2
								Birka	12
	Godey	154,724	4,934	River water	1	1	9	River water	4
								Borehole	1
								Birka	39
	Adadle	5,793	184	Birka	23	1	10	River water	2
								Birka	94
	Kalafo	10,387	338	River water	1	1	9	River water	5
								Birka	51
	Mustahil	9,065	285	River water	1	1	8	River water	5
								Birka	24
Afder	Rasso	3,050	96	Birka	12	0	4	Birka	32
	West Ime	2,664	86	River water	1	1	11	River water	5
								Birka	19

Moreover, project cost is estimated by the quantity of each construction works calculated based on the design which is multiplied by the unit cost of each construction works. The project cost mainly consists of construction cost, engineering service expenses and administration expenses and contingency funds. The implementation plan of project is conducted through the cost estimation. The target year of the project plan is 2020 as well as the water supply plan. The project is expected to start in 2014 and to end in 2020 because the Study will be completed in August 2013. The borehole, shallow well, birka, haffir dam and river water for the water resources will be implemented in parallel during the construction period of seven years. The budget of project will be considered by the national and Somali Regional budget and donations etc. The budget plan of each woreda during the project term is as follows;

Table 2.6: Budget Plan of Each Woreda in Project

(Unit:USD)

Woreda	Western calendar (year)							Estimated project cost
	2014	2015	2016	2017	2018	2019	2020	
1. Kabribeyah town		936,000	934,000					1,870,000
Kabribeyah woreda (not including town)	1,493,000	1,915,000	2,335,000	2,335,000	2,335,000	2,335,000	1,916,000	14,664,000
2. Araarso	285,000	1,337,000	1,337,000	1,339,000	485,000	484,000	285,000	5,552,000
3. Dagahbur	594,000	1,869,000	1,869,000	2,008,000	876,000	876,000	878,000	8,970,000
4. Birqud	41,000	363,000	360,000	231,000	231,000	231,000	228,000	1,685,000
5. Shaygosh	442,000	895,000	894,000	594,000	594,000	594,000	595,000	4,608,000
6. Kabridahar	960,000	2,551,000	2,551,000	2,693,000	1,242,000	1,242,000	1,355,000	12,594,000
7. Doba wein	72,000	794,000	794,000	1,031,000	482,000	874,000	633,000	4,680,000
8. East Ime	540,000	1,551,000	1,551,000	1,551,000	1,590,000	1,590,000	1,589,000	9,962,000
9. Danan	133,000	374,000	374,000	550,000	309,000	309,000	302,000	2,351,000
10. Beercaano	214,000	576,000	576,000	576,000	602,000	602,000	605,000	3,751,000
11 Godey town		440,000	2,788,000	2,788,000	2,789,000			8,805,000
Godey (not including town)	398,000	1,004,000	1,003,000	912,000	912,000	912,000	906,000	6,047,000
12 Adadle	1,191,000	1,540,000	1,540,000	1,540,000	1,540,000	1,540,000	1,539,000	10,430,000
13 Kalafo	519,000	1,436,000	2,045,000	2,046,000	2,042,000	1,433,000	1,434,000	10,955,000
14 Mustahil	244,000	1,083,000	1,692,000	1,691,000	1,767,000	1,158,000	671,000	8,306,000
15.Rasso	449,000	449,000	449,000	449,000	449,000	449,000	441,000	3,135,000
16 West Ime	193,000	573,000	964,000	965,000	1,172,000	780,000	784,000	5,431,000
Estimated project cost	7,768,000	19,686,000	24,056,000	23,299,000	19,417,000	15,409,000	14,161,000	123,796,000

Out of several economic benefits of the Project, only benefits of time saving for fetching water and health improvement benefits have been included in the calculation of economic benefits in entire woredas. Value of time savings is measured from the average time saved multiplied by the economic labor cost. The value of productive activities is assumed to be 100 Birr per day on the basis of the unskilled labor cost in the study area. Consequently, time saved of 2.4 hours on average per day will have the value of 15 Birr per day (100×0.5×2.4/8) per each household. Health improvement benefits are derived as a result of an improvement in water quality and increased supply of water. It is assumed that provision of clean water supply will lead to 10% reduction in medical expenses every year in the target communities.

The economic indicators mentioned above signify the economic viability of the majority of the projects as the EIRR exceeds the opportunity cost of capital of 10%.

The total capital costs of the projects covering 16 target woredas amounts to more than USD 110,000,000. It is the policy of the Government of Ethiopia that the Government shall finance the capital costs of water supply projects under the condition that each local community will be responsible for operation and maintenance costs of the water supply facilities. However, it is better to discuss the donor assistance in case the capital cost is large amount.

Financial evaluation in terms of Financial Internal Rate of Return (FIRR) to assess the project cost recovery has not been applied in this analysis as water revenues generated from the proposed projects are not sufficient to cover the whole project costs. The comparison of the expected water fee to be collected from the water users at 20 Birr per cubic meter(m^3) and the amount of operation and maintenance (O&M) cost required each year indicates that the former exceeds the latter every year. The calculation also shows that even if the water fee recovery rate is max 86% and min 18% in the 16 woredas, the collected water fee will be sufficient to cover the annual O&M cost.

2.3.4 Water supply plan, general design, cost estimation and implementation plan of Kabribeyah Town

a. Current water supply facilities

The water sources in Kabribeyah Town are deep tube wells. Seven wells have been drilled since 1990 and the latest well was developed in 2004. One of the seven wells was utilized for livestock. Two new wells were added by UNHCR in 2012, but those wells were not active without generators. The two wells of six have been utilized for the potable water as of the end of February 2013.

Transmission pipelines can be divided into two sections. The first section is between each borehole and the water purification plant and the second section is between the surface pump station and the reservoir in Kabribeyah Town. The first section utilized uPVC pipe as the pipe material to protect from pipe corrosion. Veolia Environment Foundation accessed water leakage for the above section in 2011 in the first section. They found that 37% of water sources had leaks. Ductile cast iron pipe with 250mm diameter is used in the second section. Transmission pipelines length is more than 23,000m in total.

Water purification plant consists of aeration trays, reaction basin, sedimentation basin of 415m^3 capacities and clarification basin with the purpose of iron removal. Oxidation of aerated water proceeds in the reaction basin, it continues to the sedimentation basin. Further insoluble oxidized ferric precipitates in the sedimentation basin, clear water overflows to the clarification basin. When this facility is functioning fully, iron value in aerated water is less than WHO guidelines. After passing through the iron removal facility, water goes to the reservoir, which has a capacity of 200m^3, and stores it to flow into the surface pump station. Though aeration process functions well, this process causes calcium scaling generation (Veolia Environment Foundation, 2011). Once treated water is stored at the reservoir, it flows into the pump station, where it is then pumped up. The height difference between the surface pump station and the reservoir in the Kabribeyah Town is 330m, the booster pump station is provided in the middle.

The distribution pipeline system in the Kabribeyah Town is 11,000m in length. There are 20 public taps in the Kabribeyah Town. All of them are not functioning well. Further, distribution pipelines extend to the refugee camps and 48 public taps are provided inside the camps and all of them are functional.

b. Water supply plan

The design water supply volume estimated by water demand of 2020 is 2,699m^3/day at Kabribeyah Town. As of February 2013, three wells including JICA wells have been activated, and from now UNHCR has a plan to activate two new wells and to rehabilitate two wells. Totally, seven well are finalized for water resources of Jarar water supply system. Nevertheless, as the design water supply is still insufficient, one new borehole development with 4.5lit/sec yield is also planned. There is no commercial electrical line so that generator is installed at the site as a power source. The transmission pipeline section between deep wells and the sedimentation pond shall be replaced with larger diameter pipes accompanying with new transmission pipeline installation.

The existing sedimentation pond has 415m^3 capacity. According to Urban Water Supply Design Criteria, horizontal flow sedimentation pond detention period shall be regulated from

1.5 to 4.0 hours. Full amount of water supply volume shall be 244m^3/hr. design detention period in the sedimentation pond is 1.7 hours. Thus, no additional facility is designed.

In comparison with the daily maximum water supply and operation time, it is not critical situation to provide additional pumps taking into consideration flow capacity. Further there is no space to install additional pump at the existing pump house. At this point, no additional pumps or pump houses are designed. In regard to the existing transmission pipeline between the surface pump and the reservoir at the town, the velocity in the pipe is normal. There is no additional pipe required in the design.

The reservoir volume in 2020 shall be designed to 800m^3. The existing reservoir has 500m^3 capacities and one reservoir is required to satisfy with the water supply plan additionally. The new reservoir shall be elevated type in order to secure enough water pressure. Existing and new reservoirs have two distribution pipeline networks respectively. Each distribution area will be an independent area and can secure water pressure.

c. Project cost

The project cost of each item for Kabribeyah Town through the water supply system plan is estimated as following Table 2.7.

Table 2.7: Estimated Project Cost of Kabribeyah Town

(Unit:USD)

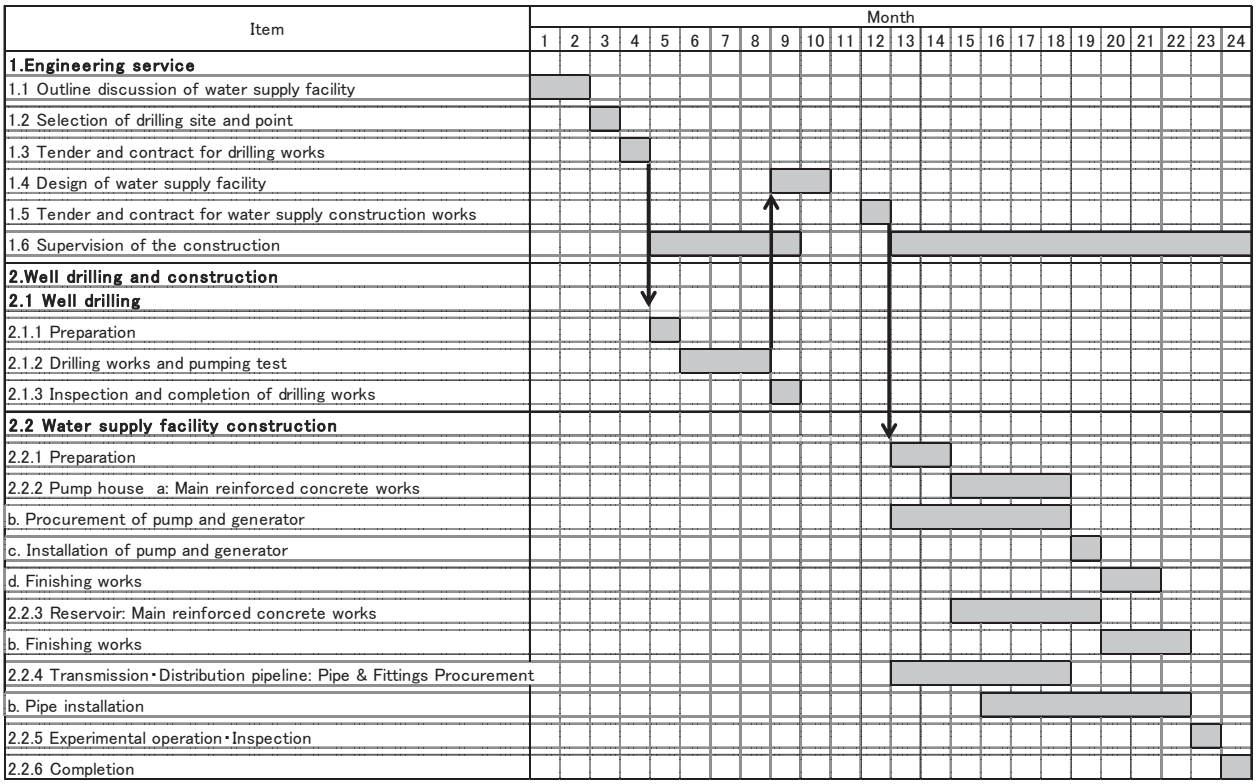
Item		Cost
1. Construction cost		
	1.1 Direct cost	
	(1) Well drilling	84,000
	(2) Pump house	11,000
	(3) Pump and generator etc. procurement and installation	48,000
	(4) Reservoir	58,000
	(5) Transmission and distribution pipeline	715,000
	(6) Other	137,000
	sub-total	1,053,000
	1.2 In-direct cost	
		442,000
	Construction cost total	**1,495,000**
2. Engineering service expenses		
(15% of construction cost, rounding up of the last three digits)		
		225,000
3. Administration expenses and Contingency		
(15% of construction cost, rounding up of the last three digits)		
		150,000
Total cost		**1,870,000**

d. Implementation plan

Implementation of the construction of water supply facility is classified mainly design stage (design, tender documents preparation, tender, contract with a construction company), well

drilling stage (drilling and supervising), and construction stage (implementation of the construction, trial operation of the facility, completion, supervising of the construction). Implementation schedule is shown in the following.

Table 2.8: Implementation Schedule of Kabribeyah Town



Construction cost, engineering service expenses and administration expenses and contingency are spread over 2 years as shown in Table 2.9.

Table 2.9: Estimated Project Cost for Each Year

(Unit:USD)

Western calendar	2015	2016	total
1.Construction cost	748,000	747,000	1,495,000
2.Engineering service expenses	113,000	112,000	225,000
3.Administration expenses and Contingency	75,000	75,000	150,000
Total	936,000	934,000	1,870,000

e. Project budget plan

The annual budget of the project cost is shown in Table 2.9 in Kabribeyah Town, which accounts for 25 % of annual budget of SRWDB based on the past record. It is possible to implement Kabribeyah town water supply system plan by the budget of SRWDB. However, the total project cost of all water supply plans for 15 woredas planned by the project is estimated to be equivalent to SRWDB budget. Therefore, it is desirable that some amount of budget is prepared by the annual budget of SRWDB for Kabribeyah Town. Moreover according to the financial evaluation, the town water supply utility office needs to collect the O&M fee of 100% for the facility, but it is not realistic to achieve 100% collection. Therefore,

as a realistic measure, it is preferable to secure insufficient budget from the aid of donors for the implementation of the project of Kabribeyah town water supply system plan.

f. O&M plan for the water supply facility

The results of the study of operation and maintenance work and personnel required for each of the proposed water supply systems are presented based on the examination of the proposed facilities in the systems. In addition, the cost of the proposed operation and maintenance plan of the water supply systems based on the details of the facilities and the implementation plan have been estimated. It is a prerequisite to improve the existing organizations and staff concerned with operation and maintenance of water supply facilities. Thus, in every type of work the operators do, a chief was assigned and provision of appropriate training was planned. In order to supply materials and equipment necessary in operation and maintenance work, it is desirable SRWDB is expected to procure such items according to the schedule and deliver them to site on time. However it is necessary to discuss with UNHCR concerning the O&M for the Jarar valley water supply system. And in the planning and cost estimation work, all the regular O&M work is assumed to be conducted by Kabribeyah town water supply utility office for convenience, although most of the maintenance work of the major part of the system will be conducted by UNHCR and JWSO as a contractor.

The work items of O&M in each facility are as follows;

- Borehole facility (Pump management, Maintenance of generator, General guarding)
- Treatment plant (Minor and major cleaning, General guarding), Reservoir of treatment plant (Tank cleaning, Chlorine dosing)
- Pump station (Pump operation, Valve management, Valve and pipe scale removal, Pump maintenance, General guarding)
- Booster pump station (Pump operation, Pump maintenance, General guarding), Reservoir of station (Cleaning)
- Reservoir (Cleaning, General guarding)
- Pipeline system (maintenance)

The type of work and number of staff members required for each of the component facilities of the proposed system were first examined and the cost of O&M for the town was calculated as shown in Table 2.10 based on the data following the cost items below.

1) Personnel (regular staff directly involved in O&M of the facilities)
2) Materials (Tools and materials necessary for O&M)
3) Fuel and electricity (Fuel for generators and electricity bill for pumps)
4) Chemicals (chlorine for household use, and treatment chemicals for the plant)
5) Spare parts (consumables and spare parts for generators and pumps)

Table 2.10: O&M Cost of Kabribeyah Town (2013 year)

Cost item	Amount (birr/year)	Remarks
Spare parts	41,796	spare parts for generators and ground pumps
Power supply	3,258,540	fuel and electricity bill for generators and pumps
Personnel	456,000	salary of field staff and daily workers
Chemical	116,592	cost of water treaement chemicals
Consumable	43,032	tools for cleaning work
Others	0	
Total	3,915,960	Equivalent to approx. US$ 211,300

Conditions of estimation
- Cost includes VAT and based on 2013 prices
- Cost was calculated as annual average over 10 year
- Cost covers all the facilities in Jarar valley includig those constructed by UNHCR until April 2013
- Cost is for the regular operation of the system and does not include major facilities/equipment replacement

g. Economic and Financial evaluation

Out of several economic benefits of the project, only benefits of time saving for fetching water and health improvement benefits have been included in the calculation of economic indicators. Benefits of time saving for fetching water are derived as a result of shortened distance to water sources after implementation of the project. Time for fetching water "with the project" is assumed to be the same as the time spent fetching water in the rainy season, namely 1.4 hours on average per household. Time saving, therefore, will be the difference between the time spent in the rainy season and the same in the dry season, namely 2.4 hours on average per household. The value of time saved on fetching water will be 50 Birr (100 Birr x 50 %) per day or 6.25 Birr per hour. Consequently, time saved of 2.4 hours per day will have the value of 15Birr per day per each household. Assuming that there will be at least 300 days of productive activities in a year, the value of time saving will be 4,500 Birr (USD 242.85) per year.

Regarding the health improvement benefits, provision of clean water supply will lead to the reduction in the incidence of water related diseases. It is assumed that provision of clean water supply will lead to 10% reduction in medical expenses every year in the target communities. An economic analysis has been conducted on the basis of the annual costs and benefits stream as estimated in the preceding sections. The result of the calculation indicates that the project is economically feasible as the EIRR exceeds the opportunity cost of capital of 10 %.

The total capital costs of the project amount to 1,870,000 USD including engineering services and administration costs. It is the policy of the Government of Ethiopia that the Government shall finance the capital costs of water supply projects under the condition that each local community will be responsible for operation and maintenance costs of the water supply facilities. However, it is desirable to discuss the donor assistance in case of high project cost. Water tariff of 10 Birr per cubic meter which is the existing water tariff in Kabribeyah Town has been used for the calculation of financial indicators. The result of the calculation indicates that the project has the Financial Internal Rate of Return (FIRR) of 6.1 % under the condition that the ratio of recovery of water fee is 100 %. So the project can be viable depending on the market interest rate. However as the 100% collection of water fee is not realistic, it is also better to discuss the donor assistance.

2.3.5 Water supply plan, general design, cost estimation and implementation plan of Godey Town

a. Current water supply facilities

The water resource of Godey Town is river water. The existing water supply facilities were constructed in 1959, and were expanded in 1996 to accommodate for town growth. After that, the sand filter ponds in the water purification plant, concrete reservoir, and the public taps were constructed. However the amount of water taken from the source is about 150m^3/day and the number of users are roughly 5,000 actually.

Originally, two intake pumps were installed inside the raw water intake pump station. Due to lack of spare parts, the Godey water supply utility office operates one raw water intake pump only. When they replace intake pump, they normally install a used pump due to budgetary limitations. Therefore pump station cannot be operated effectively. According to the Godey water supply utility office, they do not operate the raw water pump for the protection of pump when the river water level is higher than the pump elevation and raw water is turbid.

The Godey water supply system adopts the slow sand filter system. The sand filter pond number one was constructed in 2007, but it is not currently operational. According to the Godey water supply utility office explanation, the pond was clogged by floc, which the caused treated water to overflow. Afterward, the SRWDB planned and constructed the sand filter ponds No.2 and No.3, which have a total of six ponds. The sedimentation pond cannot be used at this moment due to no commercial electrical line installation to the site. As a result, Godey water supply utility office has to manually operate the sludge removing work.

In the treated water reservoir standing at the Shebele riverine area, purified water from the sand filter pond No.3 flows into the clear water reservoir by gravity and chlorine is added at there. Originally, it had three (3) transmission pumps to convey water to the reservoir in the town. However, two of them are broken presently, leaving only one pump operational. In regard to the power station, only one generator can supply electricity to the raw intake pump and transmission pump. Godey water supply utility office supply electricity for the raw water intake pump in morning time and the surface pump in afternoon time.

Transmission pipe (uPVC pipe) with 6 inch diameter is installed from the treated water reservoir to the reservoirs in Town. The total length is about 3,450m.

Three reservoirs stand at the highest elevation site in Godey Town. The capacity of the oldest reservoir, an elevated one, corresponds to the existing water production volume approximately 200m^3/day. The largest capacity reservoir with 1,000m^3 was completed in September 2010. However, it cannot satisfy water pressure for peripheral area of the town because it is a ground type reservoir.

In Godey Town, There are four distribution pipeline routes installed with uPVC pipe of diameter ranging from 37.5mm to 125mm. Total pipeline length is about 20,000m. Major facilities, which are supplied by each distribution pipeline route are the military camp, general hospital, airport, and international organizations, etc. There are 15 public taps in the distribution pipeline network. Initial three public taps and additional six are not operational because they are broken.

b. Water supply plan

The design water supply estimated by water demand of 2020 in Godey Town is 2,212m^3/day, and the groundwater potential as water resource is low. Therefore river water was selected for the water resources in Godey Town. There are five intake points along the Shebele River in Godey Town. The intake point of this water supply plan is located the most upstream compared to the existing intake points. The structure of existing pumps is easily damaged because it is installed in the river directly and there is no screen and settling basin. In order to reduce turbidity and protect the pumps against trouble, an intake canal and a settling basin will be constructed at the new intake structure and pump station is built on the settling basin.

Water purification plant facility shall be planned to be maintained manually in view of weak power supply. The rough filter purification system and slow and filter system were adopted for the Godey town water supply system in consideration of the water turbidity of Shebele River. In particularly, it is necessary to operate the pumps 24 hours a day for the latter system. Therefore it is important issues to utilize the electric power in Godey Town.

The transmission pipeline starts from the surface pump station and is installed to the additional reservoir which is located at the highest elevation point in Godey Town. The distance between the surface pump station and the new reservoir is about 4,900m and pipe diameter is 300mm.

The reservoir volume in 2020 shall be designed to be 800m^3. The existing 3 reservoirs are located at the same point; two existing reservoirs of elevated type will be used for backup purposes and a new reservoir has a capacity of 400m^3 in order to satisfy the water supply plan. It is also a ground type reservoir. The new 400m^3 reservoir supplies water for higher elevation areas of the town. The existing 1,000m^3 reservoir will supply water for lower locations. The boundary of these two water supply areas is set at an elevation of 293m. Water stored at the existing reservoir is supplied for less than 293m elevation area.

The distribution pipelines are planned to replace the existing deteriorated ones and expand the distribution area. Besides, five public taps constructed by the JICA Study are located surrounding Godey Town. There are no pipelines connected to them. The new distribution pipeline will extend to each of the public taps and connect to them.

c. Project cost

The project cost of Godey town water supply plan was estimated as following Table 2.11.

Table 2.11: Estimated Project Cost of Godey Town Water Supply Plan

(Unit:USD)

Item	cost	Foreign Component	Foreign	Local
1. Construction cost				
1.1 Direct cost				
(1) Riverbed protection	5,500	40%	2,200	3,300
(2) Intake canal	37,500	40%	15,000	22,500
(3) Settling basin	26,300	40%	10,520	15,780
(4) Pump house				
1) Pump house	37,700	40%	15,080	22,620
2) Pump, pipe, fittings	245,900	97%	238,523	7,377
(5) Generator house				
1) Generator house	29,200	40%	11,680	17,520
2) Generator and fittings	72,800	97%	70,616	2,184
(6) Sedimentation pond				
1) Civil works	135,300	40%	54,120	81,180
2) Pipe and fittings	62,500	97%	60,625	1,875
(7) Rough filter				
1) Civil works	166,200	40%	66,480	99,720
2) Pipe and fittings	157,400	97%	152,678	4,722
(8) Slow sand filter				
1) Civil works	320,100	40%	128,040	192,060
2) Pipe and fittings	119,000	97%	115,430	3,570
(9) Clear water reservoir				
1) Civil works	132,000	40%	52,800	79,200
2) Pipe and fittings	47,000	97%	45,590	1,410
(10) Transmission pipeline	1,429,600	70%	1,000,720	428,880
(11) Elevated reservoir				
1) Civil works	229,500	40%	91,800	137,700
2) Pipe and fittings	32,200	70%	22,540	9,660
(12) Distribution pipeline	1,660,700	70%	1,162,490	498,210
(13) Public tap	56,700	40%	22,680	34,020
(14) Cattle trough	13,500	40%	5,400	8,100
(15) Other	251,400	70%	175,980	75,420
sub-total	5,268,000		3,520,992	1,747,008
Average			67%	33%
1.2 In-direct cost				
	1,775,000	67%	1,189,250	585,750
Construction cost total	**7,043,000**		**4,710,000**	**2,333,000**
2. Engineering service (15% of construction cost, rounding up of the last three digits)				
	1,057,000	**67%**	**708,000**	**349,000**
3. Administration and Contingency (15% of construction cost, rounding up of the last three digits)				
	705,000	**67%**	**472,000**	**233,000**
Total cost	**8,805,000**		**5,890,000**	**2,915,000**

d. Implementation plan

Implementation of the construction of water supply facilities is classified into mainly the design stage (design, tender documents preparation, tender, contract with a construction company) and construction stage (implementation of the construction, trial operation of the facility, completion, supervising of the construction).

It is considered that design stage for the project of Godey Town will take 16 months. Duration of the construction will differ according to the formation of construction teams. In this plan, it is assumed that one team is assigned for intake, purification and transmission facilities construction, two teams are assigned for distribution facility construction (including transmission pipe), one team is assigned for public taps and cattle trough construction, therefore the construction will be implemented by four (4) teams. Under this construction plan, implementation of the construction will take 26 months.

In the implementation of construction, procurement of materials and equipment that are needed for the construction, will be highly critical for the implementation schedule and length of the implementation. Materials and equipment which are not manufactured in Ethiopia and not easy to procure in the Ethiopian local market such as ductile iron pipe (DIP) and steel use stainless (SUS) pipes, submersible and surface pumps and generators must be procured from foreign countries. Therefore it is considered to take time. Especially on the pipeline works of the project of Godey Town, total pipeline length is estimated to be more than 46 km. Thus procurement of pipe materials will need time regardless of procurement in Ethiopia or from foreign countries. In addition to this, the total length main pipeline as important facilities is approximately 8 km and DIP will be used for this main pipeline. Since DIP is not manufactured in Ethiopia, it will be needed to be procured from foreign countries. The implementation schedule was prepared taking into account the procurement of these materials and equipment.

The implementation schedule is shown in the following Table 2.12.

Table 2.12: Implementation Schedule of Godey Town Water Supply Plan

Item		Month (1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42)
1. Engineering service		
1.1 Design		
	a. Discussion of Design policy	
	b. Survey	
	c. Detail design of purification facility	
	d. Detail design of facilities	
1.2 Preparation of tender documents		
1.3 Tender		
1.4 Contract with a local contractor		
1.5 Supervision of the construction		
2.Construction		
2.1 Preparation		
2.2 Intake・Purification・Transmission facilities	a. Survey	
	b. Intake facility construction	
	c. Purification facility construction	
	d. Transmission facility construction	
	e. Pump/Generator procurement	
	f. Pump/Generator install	
	g. Pipe and fittings procurement in Ethiopia	
	h. Pipe and fittings procurement from foreign countries	
2.3 Distribution facilities	a. Survey	
(including transmission pipe)	b. Facility construction	
	c. Pipe and fittings procurement in Ethiopia	
	d. Pipe and fittings procurement from foreign countries	
	e. Pipe installation (procurement in Ethiopia)	
	f. Pipe installation (procurement from foreign countries)	
2.4 Public tap and cattle trough	a. Survey	
	b. Public tap construction	
	c. Cattle trough construction	
	d. Pipe and fittings procurement in Ethiopia	
2.5 Experimental operation・Inspection		
2.6 Completion		

e. Ratio of price change and the project cost including price change

The ratio of price change was estimated for the local currency (ETB) and foreign currency (USD).

The ratio of price change in local currency (ETB) was estimated based on the consumer price index published by the Central Statistical Agency of Ethiopia (CSA). The ratio of the price change in local currency (ETB) was estimated to be 11.3 % per year based on the consumer price index from January 2012 to March 2013.

The ratio for the price change foreign currency (USD) was estimated based on the projection of the consumer price index of major advanced economies published by the International Monetary Fund (IMF). In the projection, the rate of 2013 is 1.6 % and 2014 is 2.0 %. Therefore, based on this projection, the rate is set as 1.8 % per year on average in 2013 and 2014.

Price change of the engineering service was taken into consideration with the period from May 2013 (time of the cost estimation) to estimated commencement of the design stage. Price change of the construction cost was taken into consideration for the period from May 2013 to the estimated date of tender for the construction.

The annual project cost including price change is as follows;

Table 2.13: Project Cost for Each Year including Price Change

(Unit:USD)

Western calendar (year)	2015	2016	2017	2018	Total including price change	Total not including price change
1.Construction cost		2,680,000	2,680,000	2,669,000	8,029,000	7,043,000
Foreign		1,650,000	1,650,000	1,650,000	4,950,000	4,710,000
Local		1,030,000	1,030,000	1,019,000	3,079,000	2,333,000
2.Engineering service expenses	282,000	282,000	282,000	297,000	1,143,000	1,057,000
Foreign	182,000	182,000	182,000	183,000	729,000	708,000
Local	100,000	100,000	100,000	114,000	414,000	349,000
3.Administration expenses and contingency	192,000	192,000	192,000	186,000	762,000	705,000
Foreign	122,000	122,000	122,000	120,000	486,000	472,000
Local	70,000	70,000	70,000	66,000	276,000	233,000
Total	474,000	3,154,000	3,154,000	3,152,000	9,934,000	8,805,000

f. Project budget plan

Regarding the cost recovery, it will be difficult to secure the fund after paying for the operation and maintenance cost of the facility from the income of water tariff, which is set as taking into consideration of affordability of residents and social condition in Godey Town (for details of social condition refer to “Feasibility Study Godey Town”). Therefore, as a realistic means, it is preferable to secure the budget from the aid of donors for the implementation of the project of Godey town. In addition to this, although it is difficult to secure all the budget for the project of Godey Town by SRWDB itself, it is desirable that some amount of budget is prepared by SRWDB and rest of budget is prepared by donors etc.

g. O&M plan for the water supply facility

The results of the study of operation and maintenance work and personnel required for each of the proposed water supply systems are presented based on the examination of the proposed

facilities in the systems. In addition, the cost of the proposed operation and maintenance plan of the water supply systems based on the details of the facilities and the implementation plan have been estimated. It is a prerequisite to improve the existing organizations and staff concerned with operation and maintenance of water supply facilities. Thus, in every type of work the operators do, a chief was assigned and provision of appropriate training was planned. In order to supply materials and equipment necessary in operation and maintenance work, it is desirable SRWDB is expected to procure such items according to the schedule and deliver them to site on time. And in the planning and cost estimation work, all the regular O&M work is assumed to be conducted by Godey town water supply utility office for convenience including the maintenance work of the major part of the system.

The work items of O&M in each facility are as follows;

- Intake canal (Sludge removal, Screen cleaning), Settling basin (Sludge and garbage removal)
- Pump house (Pump management, Pump spare parts replacement, General guarding)
- Generator house (Generator operation, Generator maintenance, General guarding)
- Sedimentation pond (Sludge removal, Coagulant and lime dosing, General guarding)
- Rough filter (Surface sludge removal, Filter cleaning, General guarding)
- Slow sand filter (Surplus sludge removal, Filter layer conditioning)
- Treated water reservoir (Tank cleaning, Chlorine dosing, General guarding)
- Reservoir 1 (Tank cleaning, Level check and valve operation, General guarding)
- Reservoir 2 (same as above)
- Reservoir 3,4 (Tank cleaning)
- Pipe system (Repair and replacement)

The type of work and number of staff members required for each of the component facilities of the proposed system are shown. The cost of O&M for the town was calculated as shown in Table 2.14 based on the data following the cost items below.

1) Personnel (regular staff directly involved in O&M of the facilities)
2) Materials (Tools and materials necessary for O&M)
3) Fuel and electricity (Fuel for generators and electricity bill for pumps)
4) Chemicals (chlorine for household use, and treatment chemicals for the plant)
5) Spare parts (consumables and spare parts for generators and pumps)

Table 2.14: O&M Cost of Godey Town (2013 year)

Cost item	Amount (Birr/year)	Remarks
Spare parts	22,272	spare parts for generators and ground pumps
Power supply	2,211,840	fuel and electricity bill for generators and pumps
Personnel	954,096	salary of field staff and daily workers
Chemical	707,724	cost of water treaement chemicals
Consumable	33,372	tools for cleaning work
Others	0	
Total	3,929,304	Equivalent to approx. US$ 212,000

Conditions of estimation

- Cost includes VAT and based on 2013 prices
- Cost was calculated as annual average over 10 year
- Cost covers all the facilities in Jarar valley includig those constructed by UNHCR until April 2013
- Cost is for the regular operation of the system and does not include major facilities/equipment replacement

2.3.6 Pilot project results and its utilization for water supply plan

The water supply facilities construction (hereafter referred to as "the construction") as a pilot project comprises the following two construction projects: "Improvement of Jarar valley water supply system in Kabribeyah Town and Jarar valley" and "Construction of water point in Godey Town". The outline of these construction projects is shown in following Table 2.15.

Table 2.15: The Outline of the Water Supply Construction

Project (target area)	Items of the works
Improvement of Jarar valley water supply system (Kabribeyah Town and Jarar Valley)	Drilling of new water supply wells (two wells) and installation of submersible pumps
	Conveyance pipe (new water supply wells to existing pipe)
	Replacement of Surface and Booster pumps (three pumps)
	Water supply points construction (7 taps)
Water supply points construction (Godey Town)	Water supply points construction (5 taps)

The Study confirmed some problems regarding the water supply construction for the pilot project. Arrangements will need to be made for solving these problems in the future.

- Although leakage was occurring continually due to malfunction of valves and non–return valves, the operators and technical staff of the water supply utility office could not take any measures to prevent the leakage. It is assumed that staff of Kabribeyah water supply utility office does not have proper understanding and awareness of financial loss caused by leakage through the construction.

- It was observed that responsibility of safekeeping of the equipment became obscure because procurement and installation of equipment had to be carried out separately by

two different companies in regard to the procurement of materials and machineries.

- Water supply utility offices have no ideas to secure the procurement plan and route in relation to the pumps; therefore it needs to discuss the long term plan with SRWDB.

- Cattle troughs constructed in the project were designed with reference to the drawing provided from SRWDB. However, at the time of the construction, it turned out that the design of the cattle trough was for camels because the sidewall of trough was found to be very high. The design was immediately changed to lower the side walls so that cattle, goat and sheep could drink water from the trough.

- In design works, it is necessary to standardize drawings of animal water troughs for different types of animals and public taps. Standardization of drawings will help decrease effort of preparation of drawings, construction and design changes during construction stage. In the existing water supply systems, especially the drawings of existing transmission pipelines and distribution pipelines and the information of existing pipes could not be obtained. Therefore, it is required to sort out information of existing water supply facilities and maintain them as drawings and documents.

The issues in the next water supply plan to be addressed through the pilot project are as follows;

- Strengthening of O&M ability of water supply utility office (necessity of assistance from SRWDB or UNHCR in Kabribeyah Town)

- Planning of project contents including procurement and construction

- Standardization of water supply plan (pump equipment, public taps and animal water troughs, etc)

2.4 Socio-economic survey

The main objectives of the socio-economic survey were to obtain the basic data for the formulation of the water supply plan, and the main contents of survey consisted of: (1) interview survey on the water supply situation of the target woredas; (2) interview survey at the water utility offices in Kabribeyah and Godey Towns; (3) water utilization survey: and (4) interview survey at the sample households selected from the target woredas on the demand and needs of daily water use. The final target of socio-economic survey is sixteen woredas.

2.4.1 Socio-economic conditions in Somali Region

The population in Somali region is estimated to have increased from 4,445,219 in 2007 to 4,986,004 in 2011 with an average annual growth rate of 2.91 %. The Somali ethnic group is the most dominant ethnic group in the region, covering 97 percent of the regional population. The second and third largest ethnic groups are Amhara and Oromo respectively. Religious composition is that Muslim religion was the most dominant religion in Somali region covering 98 percent of the population. The percentage is higher in rural areas.

The literacy rate for the 2007 was 13.7 percent, while the corresponding figure for 1994 was 8.1 percent. These show that there were substantial improvements in the literacy status in the

last 12 years. The literacy rate in Jijiga zone was 17.85%. In 2007 the proportion of current school attendance (4.7 percent) shows a slight increment as compared to the census results reported in 1994 (4.1 percent).

The woredas in Ethiopia are the district administrative levels that are given prominence due to strengthening of the decentralization process since 2002. The woredas comprise a range of 25 to 50 kebeles. Somali region now consists of nine zones which are sub-divided into 67 woredas.

Livestock play an important role for the regional economy. Eighty five (85) percent of the population in the region dwell in the rural areas and are either pastoralists who mostly depend on livestock rearing or agro-pastoralists who depend on mixed livestock rearing and crop production. Livestock provides food, cash income, source of wealth saving, means of transport and drought power for land cultivation.

Pastoralism is the most prevalent, comprising about 60% of the region's rural population. Agro-pastoralism comprises about 25 % of the total population, and is a mixture of extensive livestock rearing and rain-fed crop production; some may be better described as pastoralists with opportunistic farming activities as in Fik and some parts of Liben Zone.

The remaining 15 % of the rural population comprises sedentary (Jijiga) and riverine (Shebele and Dawa-Ganale) farmers. Both farming and agro-pastoral groups keep some livestock but farmers' herds do not migrate and are sometimes hand-fed, only migrating with other groups if there is a severe drought.

Major food crops grown in Somali region are maize, sorghum, millet, and legumes. Major cash crops are vegetables (e.g. tomato), fruits, and groundnuts.

Livestock sector is providing important source of protein food principally in the form of meat, milk and poultry products. Livestock population is estimated to be 3,796,000 cattle, 9,053,000 sheep, 8,547,000 goats, and 2,032,000 camels in 2011.

2.4.2 Refugee conditions in Somali Region

UNHCR Sub-office in Jijiga was opened in the early 1990s. The influx increased significantly in 1991 which lead to the establishment of nine refugee camps at the eastern border of Ethiopia. The total population of Somali refugees at that time was over half a million, namely 627,000 persons. All other camps were closed in 2005 except Kabribeyah refugee camp. In May 2007, UNHCR opened a reception center in Kabribeyah, while awaiting the opening of the new camp. In several area; the newly arrived refugee camps open and close repeatedly. Recently, ten refugee camps exist in Somali Region. Out of 10 refugee camps in Somali region, only Kabribayah refugee camp is located in the study area (Population: 16,340 as of 2012). When this area was hit by the worst drought in the past 60 years from mid 2010 to 2011, about 160,000 refugees entered Ethiopia from Somalia.

ARRA provides comprehensive health care services at the camp health centers and referrals to higher medical facilities. Construction / maintenance of family and communal latrines, waste disposal facilities as well as sanitation education to refugees are provided.

In the daily life of the refugee camps, assistance is provided by several international institutions such as UNHCR, WFP, and ARRA in the fields of water supply, food and health

services. Therefore, inhabitants of the refugee camps can receive most of these services free of charge. Economic activities in the refugee camps are very limited as they do not have the base (like land) to conduct such activities. Most of the inhabitants at the refugee camps depend on the remittance of money from their relatives or friends to buy clothing or some minor items in their daily life.

2.4.3 Survey on target woreda water supply situation

The results of the Survey indicated that the staff and office equipment of water offices were very limited in terms of the number of staff as well as its office equipment. The number of staff is member 1-8, the average number is 5 persons depending on the size of the woreda. The main existing water sources are the tube wells (with submersible pump or hand pump), hand dug wells, birkas and river intake system. In general, the tube wells were utilized in Jarar valley, and the surface water (river water and birka) and shallow water by hand dug wells in Shebele River area.

In the Study Area, there are six hospitals with a total of 624 health professionals and supporting staff. Other health facilities include 21 health centers (HCs), 56 health posts (HPs) and 21 health clinics with a total of 560 health professionals and supporting staff. The major leading water related diseases are malaria, diarrhea and dysentery in the Study area. Out of 15,071 of diarrhea cases in the Study Area, Kalafo woreda accounts for 26%, Adadle woreda 14% and Danan woreda 10%, respectively. Out of 3,600 of dysentery cases, Kalafo woreda accounts for 64%, Araarso Woreda 7% and Kabridahar woreda 6%, respectively. High diarrhea cases in Kalafo, Adadle and Danan woredas are most likely due to people's taking drinking water from the river or unprotected dug-wells.

There are 860 primaries and ABE schools and 27 secondary schools (grade 9 – 12) in the Study Area. Some woredas have no secondary schools as these woredas were newly created ones.

There are lots of production volumes of maize and sorghum in the study area. And tomato was produced partly. There is very limited production of teff for the principal food of Ethiopia. Only Kalafo woreda produces teff. Out of the total production of maize, Kalafo and Godey woredas account for 40.1 % and 39.5%, respectively, accounting for almost 80% of all maize produced in the Study Area. Danan, Godey and Kalafo woredas account for 57% of the total sorghum production. As for tomatos, Kalafo woreda accounts for 70% of the total production, followed by Godey woreda.

In study area, the distribution of main livestock is that 450,000 cattle, 110,000 camels, 500,000 goats, and 500,000 sheep. A large number of livestock such as cattle, camels, goat and sheep are found in Adadle, Mustahil and Kalafo woredas in Shebele sub-basin area.

2.4.4 Survey on urban water supply system

Interview survey was conducted in four relatively big towns in the Study Area to assess the water supply situation in urban areas.

As mention the water supply plan of Volume 2, the water resources of Kabribeyah Town are boreholes along Jarar valley. The water supply was conducted in not only Kabribeyah Town, but also refugee camp. The number of connections is 300 in total, consisting of 14 institutional connections. Population served is estimated to be 11,360 persons (about 2,200

households) in the rainy season and 28,685 persons (about 5,700 households) in the dry season. From the field survey, it is observed that one water point is providing water to about 10 to 15 households near the water point.

The water resources in Godey Town are the river water taken from the Shebele River. Water is pumped from the river intake structure to the main reservoir and finally to the customers through the distribution pipes. There are 288 connections including 250 private and 38 institutional connections.

The water supply source in Dagahbur Town is groundwater. A total of six wells are presently functioning. Groundwater from each borehole is pumped into the water supply system through the main reservoir (200m^3), distribution network and water points. There are 400 connections including 360 private and 46 institutional connections. Population served is estimated to be 28,637 persons in the rainy season and 40,863 persons in the dry season.

The water supply source in Kabridahar Town is groundwater. Out of 13 boreholes, only 3 are presently functioning. The groundwater from each borehole is pumped into the water supply system through a main reservoir (150m^3), distribution network and water points. There are 527 connections including 516 private and 11 institutional connections. Population served is estimated to be 48,000 persons in the rainy season and 51,000 persons in the dry season.

Interview surveys were carried out for the water supply utility office of the four towns in regard to the annual water volume supplied, revenue, and expenditure from 2009 to 2011. However the revenues of all four offices did not match the water volume supplied. Therefore the data of water supply volume is not adequate or the financial management is poor in all four towns. The data from the interviews in the four towns is as follows;

Table 2.16: Revenue and Expenditure of Four Water Supply Utility Offices

Town Name	2009			2010			2011		
	Water Volume	Revenue	Expenditure	Water Volume	Revenue	Expenditure	Water Volume	Revenue	Expenditure
	m^3	Birr	Birr	m^3	Birr	Birr	m^3	Birr	Birr
Kabribeyah	6,576	10,900	70,802	43,447	141,000	75,902	184,752	33,427	81,882
Godey	139,348	836,088	1,095,220	130,838	1,046,704	270,298	138,047	138,047	1,380,440
Dhagahbur	3,580	250,600	277,800	2,570	179,900	271,578	3,220	22,540	279,600
Kabridahar	28,500	239,400	381,288	25,670	2,156,280	383,861	19,850	166,740	371,292

2.4.5 Water use survey

A simple survey on the water use conditions by the residents of target woredas was conducted to clarify, especially how much water is used for different purposes. The target areas were selected from both Jarar Valley and Shebele River sub-basin areas. Kabribeyah Town including the refugee camp, Godey Town, and three (3) woredas in their vicinity were surveyed. Fifteen (15) sample households chosen for urban areas and ten (10) households chosen from woredas were interviewed. The annual average amount of water used for both Jarar Valley and Sheblele River areas were found to be 18.8 L/day/head (avr.9.1 person/household) and 16.9L/day/head (avr. 7.7 person/household) respectively. The water use amount by different purposes is for drinking, cooking, washing including clothes and dishes, bathing and livestock in both areas. In the survey area, only four households use water for livestock in the Shebele River and no households use water for farming. The water use amount obtained in this survey signifies those that the sampled households receive or buy

from public/private water supply facilities or from water sellers. Thus, in the rainy season when households can use rainwater directly at home, the water use amount in the dry season is 1.2 (drinking and cooking) to 1.5 (washing and bathing) times of that of the rainy season in Jarar Valley area and the difference is as much as about 1.6 times for all the items in Shebele River basin area.

The following essential findings about the water use in the study area have been extracted from the survey data, observations and interviews with the people concerned.

- The average per capita water use amount is around 18L/day.
- People in Jarar Valley area use a little more water than those in Shebele River basin area but the water use pattern by purpose is similar between the two areas.
- In the rainy season, dependency on the water supply system decreases by 20 to 60% because the users use harvested rainwater at home.
- In major communities of woredas and towns, the water use for farming and livestock is very small.

The income conditions affect water use during droughts. According to the report of Oxfam GB in Marshin woreda, near the study area, the water use amount per person in the dry season is 2 to 23 L/day and the low income families get only 2 to 9L/day.

2.4.6 Sample household survey

The sample household survey was conducted in 7 woredas in Jarar valley area and 9 woredas in Shebele sub-basin area. A total of 176 sample households were selected in the study area. About 90% of the respondents are engaged in agricultural activities including crop production and livestock rearing. Almost three fourths of the respondents were female. Average family size is 5 people.

Main water sources for domestic use including drinking/cooking, washing and bathing are: (i) piped water system, (ii) hand pumps, (iii) hand-dug wells, (iv) haffir dam, and (v) traditional water sources such as rivers, rainwater, ponds, and lakes.

In general, water users have to travel longer distance to fetch water in the dry season compared to the case in the rainy season as well as time spent. In woredas such as Godey, Beercaano, Danan and West Ime in Shebele sub-basin, water users have to travel 1 to 2 kilometer to fetch water. In woredas such as Araarso, Birqod, and Rasso where water supply facility (e.g. hand pump) is available, distance to water sources is in the same range even in the dry season.

The sample households are not well aware of the usefulness of boiling water for drinking purpose. More than 88% of the interviewed respondents indicated that they never boiled the drinking water they took from unimproved water sources. Major leading water related diseases are malaria, diarrhea and dysentery in the Study area, and diarrhea is one of the most common diseases. Out of the sample households in Rasso and Adadle woredas in Shebele sub-basin area, the percentage of family members who were suffering diarrhea “quite often” were 15.0% and 16.7 %, respectively.

The perception of the sample households on the water price to be paid for improved water supply system differs depending on the income level and availability of water sources nearby

each household. The water price fluctuation ranges from 0 Birr (minimum) to 400 Birr (maximum) per month. Average water price to be paid by water users ranges from 23 Birr in Birqod woreda to 81 Birr in Araarso woreda. Overall average price is 36 Birr per month.

Household income sources consist of such items as crops, livestock, employment, remittance, commercial and others. Household income ranges from 24,225 Birr (Shaygosh) to 80,295 Birr (Kabribeyah), with average income of 44,952 Birr in Jarar valley area and 40,359 Birr in Shebele sub-basin area. The highest income was recorded in Kabribeyah woreda where the main income source was remittance from family members or relatives who were working in a different area. The lowest income was recorded in Shaygosh where no income came from agricultural activities. In general, higher livestock income was reported in Shebele sub-basin area.

2.5 Environmental and social consideration

The purpose of the environmental and social consideration is to assist the Ethiopian counterpart personnel to estimate environmental and social impact of installation of facilities designed by the Study, based on JICA Environment and Social Consideration Guideline (2010) and Ethiopian EIA Guideline (2011). Alternative plans and mitigation measure will also be studied if the impacts cannot be avoided. The summary of the environmental impact assessment study is to be fed back to the Study Team.

2.5.1 Outline of the project components

The item of water supply plan of the project components planned or conducted in the Study is only selected as the target item of the detailed investigation and evaluation for the social-environmental consideration. The water supply plans were prepared for sixteen woredas consisting of urban and rural areas. The water resources of each woreda consist of deep well, shallow well, river water, and birka and haffir dam by using rainfall. The maximum design of water supply volume is 1,021m^3/day in Dagahbur Town, but less than 2,000m^3/day in case of using for the groundwater by wells in target woredas. The outline of the project in each woreda is shown in detail as Volume 2 of the water supply plan in Final Report.

2.5.2 Basic environmental and social conditions

a. Natural environment

The meteorological and hydrological conditions, topography and geology and hydrogeological conditions in the Study area are as mentioned volume 1. Moreover, there are no protected areas near Jarar Valley and Shebele Sub-basin, the main target areas of the Study, defined by national laws and international treaties and conventions.

b. Environmental pollution

There is no air pollution generated from offices and factories in the Project area and its surroundings. There is also no water pollution and water contamination generated from office and factory in the Project area and its surroundings. The livestock farming in agriculture type is mainly being conducted in dry and semiarid areas, so there is no water pollution caused by chemicals or livestock excrement. As the results of water quality testing in this study, the water quality is strongly affected by a calcium carbonate and carbonate mineral occurred by

displacement with magnesium ion in the structure bottom and hydrosulfate mineral. As the judgment of main ions composition, there is no major impact on the human body, but a general gastrointestical discomfort sometimes occurs. On the other hand, an eating quality becomes low, saline materials occurs and accrete (occurrence of scale), and such water is not able to make a lather with soaps by occurrence of fatty acid calcium in the life.

Currently there are no office facilities to generate noise and vibration in the Project area. Furthermore, any damage caused by noise and vibration has not been reported because passage of heavy vehicles is quite sparse and its driving speed is suppressed due to dirt road.

c. Social environment

The population, ethnic group, religion, water related diseases, agriculture, and livestock husbandry were described based on the socio-economic survey as mentioned above.

Most of the residents in rural areas use animals such as donkeys and camels as for the transportation of goods. It results in high transport costs, leading to soaring in prices of food and supplies in inland areas. It is also causing the economic difficulties such a low-income for the agro-pastoralists and pastoralists. Currently, there is no information about the new pavement planning of the main road in the town area. There are no registered cultural assets, historical structures and heritage sites in the Project area.

2.5.3 Classification of environmental category

There are no project aspects and areas reflected the environmental affect in terms of the project contents and the environment and social conditions. So the environmental category of water supply plan is judged as the category B.

2.5.4 Environmental system and organization in Ethiopia

The Environmental Impact Assessment Proclamation, Proclamation No. 299/2002 (EIAP) was issued on December 2002 as the basic legislation in regard to the EIA in Ethiopia. Adopted Guideline for Reviewing Environmental Impacts Study Report, 2012 was edited in Somali Region in accordance with the transfer of authority to local area based on BPR. For the Projects, Somali Regional State Environmental Protection, Mine and Energy Development Agency (SEPMEDA) will review EIA and make a decision of whether to accept it. The regional government is the final decision maker; and the federal EPA will not review the report.

Examination in relation to the water supply and hygiene project in accordance with the guideline above is classified by the schedule 1 and 2 as the following Table 2.17 below. As mentioned in the project component above, there is no project of water supply plan with schedule 1 of Table 2.17 below and there are also no items such as involuntary resettlement and appropriation of land, effect of groundwater, secondary pollution, historical/ cultural heritage, effect on flora, fauna, bio diversity, and negative effect on bilateral issues. On the other hand, the rural water supply project is contained in schedule 2. So, preliminary or partial assessment study: (PA) as well as JICA guideline (IEE) will be conducted.

Table 2.17: EIA for rural/urban water supply and sanitation in Somali Regional State

Schedule-1 (Full EIA is required)	Schedule-2 (Preliminary or partial assessment is required)
• Construction of dams height 15m or more, impounding reservoirs with a surface area of 50ha • Ground water development for industrial, agricultural or urban water supply of greater than 2,000 m^3/day • Canalization and flood-relief works • Drainage Plans in towns close to water bodies	• Rural water supply and sanitation • Land drainage (small scale) • Sewerage system

2.5.5 Alternatives include zero options

The plan is discussed completely, so there are no zero options. However it is suggested that monitoring should be undertaken after construction. Therefore, alternatives are compared good or bad samples of each idea. The discussion results for the thirty items are as follows mainly;

- The shortage of drinking and domestic water and the water related diseases will be increased in target area by zero-option (no projects) plans.

- There may be possibilities of causing negative impact such as creation of unemployment, increase in amount of groundwater use, generation of noise and vibrations in facility construction in the meantime, and increasing of solid waste in the meantime. On the other hand, the Project implementation might be expect to improve drinking water shortages, fair distribution of drinking water, reduction of drought damage, proper groundwater use, the creation of employment opportunities, and increase in social capital. Furthermore, it can be expected to mitigate the negative effects by taking appropriate measures.

2.5.6 Scoping and TOR of environmental and social consideration

It is necessary to investigate the environmental and social considerations concerning the negative effects.

As mentioned above, the involuntary resettlement and appropriation of land do not occur, and as the data of well drilling and pumping test are utilized for checking of the groundwater level, it is not necessary to plan or undertake new surveys during the planning of water supply projects. The negative impacts during construction stage are air pollution caused by the construction vehicles, the noise and vibrations during facility construction, the traffic hazard caused by the traffic of construction vehicles and the laying of pipes. It is necessary to make arrangements to survey items for the evaluation of the negative effects. It is desired to conduct the quantitative survey based on the environmental standards of Ethiopia in the implementation stage of this project.

2.5.7 Results of survey

There will be no effect on the local economy with regard to water retailers using donkey-pulled water tanks (about 650 persons) such as unemployment as a result of shortages of intake water volume from Shebele River when the water supply plan in Godey Town is put into action. However, the demand for water from donkey cart retailers is likely to be negatively affected after the completion of the water supply system in Godey Town. It is desirable to conduct monitoring of any decreases in numbers of pond manager and donkey-cart water distributors during operation stage of the water supply system in Godey Town.

The traffic hazard and environmental impacts caused movement of construction vehicles is not considered to be significant because there is a wide thoroughfare allowing ample traffic movement based on the results of traffic movement measurements. It is necessary to quantitatively measure the air pollution caused by the construction vehicles and generation of noise and vibrations during construction stage of the water system based on the environmental standards (Environmental Policy of Ethiopia, 1997). It is possible to mitigate environmental effects to a certain degree by setting a speed limit for vehicles in this Study.

2.5.8 IEE, mitigation measure and plan of environmental monitoring

The results of IEE (Initial Environmental Examination) were indicated that there is no “a”, “b”, but “c” definition is found in regard to the existing infrastructures and services, air pollution, increase of noise and vibrations and increase of accidents during construction stage, and local economy such as employment and livelihood, and amount and quality of groundwater during operation stage. The definitions of “a”, “b”, “c” and “d” are as follows;

a: Significant negative impact is expected.

b: Negative impact is expected to some extent.

c: Extent of negative impact is unknown.

(A further examination is needed, or the impact could be clarified as the study progresses)

d: No impact or negligibly small impact is expected.

The mitigation measures for the IEE are basically those that are feasible, for example, the suggestions of the mitigation plan are conducted in regard to the control items for the construction vehicles and the abatement of the construction in the construction stage. And also, conservation measures will be suggested as appropriate and the monitoring will be carried out in the operation stage.

The environmental monitoring plans are prepared in relation to air pollution, noise and vibrations and decreasing of groundwater level. The impacts of construction stage will be monitored following the construction works. Therefore, it is necessary to discuss the responsibility of the relevant people of the construction and SRWDB of project owner through the setting of complaints contact point or the strengthening of mitigation measures.

2.5.9 Discussions with stakeholder

WASHCO was organized so as to conduct the O&M for the water supply facilities built in the pilot project of the Study, and the training to strengthen the ability of WASHCO was carried out in the Study. The water supply utility offices in each town in charge of technical assistance of WASHCO are trying to organize training of the actual activities of O&M created by JICA Study Team. The relation of stakeholders is different between Kabribeyah Town and Godey Town in the water supply system. However it is necessary to strengthen the water supply utility office for the O&M of water supply facilities. In any event, there is no need to discuss the land expropriation and involuntary resettlement with stakeholders in this study.

2.5.10 Conclusion

There are considerable environmental items (definition "c" means the low impact) in the construction and operation stages of this project. However, it is possible to avoid serious impacts through suitable mitigation measures and necessary conformation, and monitoring of project. And the negative impacts for the water supply plan of the project are not expected in relation to the major four impacts such as involuntary resettlement, discharge of pollutants (heavy metals and hazardous substance), damage and loss of registered cultural assets, historical structures and heritage and negative impacts on natural protected areas. Consequently, the implementation of the project plan has no possibility to cause significant negative impacts on the natural and social environments in the project area.

2.6 Emergency water supply

The specifications of emergency water supply equipment and other associated items procured (or to be procured) and their status as of the end of May 2013 in this study are listed in Table 2.18 and Table 2.19 below.

Table 2.18: List of Emergency Water Supply Machineries and Specifications

Equipment	Q'ty	Status	Delivery route	Spec, model
1.Supplied machineries and materials				
a)Water truck	5	Delivered	MoWE→SRWDB (4 for Jijiga, 1 for Godey)	ISUZU With a pump and tank capacity 10m^3
b)Water tank for water point	150	Delivered	MoWE→SRWDB	Fiber Glass Water Tank (10,000 Liter)
c)Chlorination chemical	For 3,600 m^3	Delivered	MoWE→SRWDB	Powder (Bishan Gari) 70% Tablets (Aqua tab) 15% liquid (Waterguard) 15%
2.Operation and maintenance equipment				
a)Mobile workshop vehicle (Single cabin)	3	Delivered	MoWE→SRWDB	NISSAN (Single cabin pickup truck with canvas top)
b)Equipment for mobile workshop (tool kits)	3	Delivered	MoWE→SRWDB	Refer to Data Book

Note: "Delivered" signifies the items have been officially received by the MoWE

Table 2.19: List of Others Related Equipment and Specifications

Equipment	Q'ty	Status	Delivery route	Specification, Model
Project car 1	2	Delivered	MoWE→SRWDB	TOYOTA (4WD, Station wagon)
Project car 2	2	Delivered	MoWE→SRWDB	TOYOTA (4WD, Pickup truck double cabin)
Surface water pump	3	Delivered	MoWE→SRWDB	ROVATTI ME100K80-90/4A 75kw,100HP
Submersible pump and Generator	2 sets	Delivered	MoWE→SRWDB	Submersible pump WILO(made in Germany) TWI 6.18-20-8-SD-R / Generator PRAMAC(made in Spain) GBW45p

Note: "Delivered" signifies the items have been officially received by the MoWE

ETF (Emergency Task Force) led by DPPB with representatives of NGOs as members plays a measurable role in coping with emergency water supply. WASH program by UNICEF also supports SRWDB through provision of emergency water supply related materials. On the other hand, SRWDB dispatches maintenance teams, distributes chlorination agents, drills new wells at the time of emergency. However, collaboration with ETF is reportedly not sufficient and it is considered an issue.

SRWDB is supposed to prepare a distribution plan and decide their deployment sites for the procured equipment and materials. Due to the lack of emergency budget, SRWDB asked UNICEF and NGOs for help in distribution of the water tanks. Thus, the tanks were mostly distributed by NGOs. It is one of the future issues for SRWDB to secure budget for its emergency water supply activities.

In any case, the use of the vehicles (MWS vehicles and water trucks) and materials for emergency water supply is expected to enable SRWDB to work more extensively and to respond more quickly to situations. Especially mobilization of Mobile Workshop vehicles together with trained staff of SRWDB will enable repair and improvement of facilities and equipment at local levels and this is expected to contribute to the overall technical O&M capacity of SRWDB. Furthermore, the use of the procured water trucks makes it possible for SRWDB to prepare its own plan for water trucking and also to help reduce the rent of commercial water trucks by cutting down on the number of times of dispatching commercial water trucks.

Also provision of submersible water pumps and generators to drive the pumps installed at the two deep wells that were drilled, and the surface pumps that were installed at the conveyance pump station and at the booster pump station will contribute to the improvement of the Jarar Valley water supply system. One good example of such contribution was when two existing wells simultaneously broke down in Jarar Valley at the time of preparation of Interim Report, a long-term interruption in water supply was somehow avoided by operating one of the newly constructed JICA wells on a trial basis.

Chapter 3

Operation and Maintenance of Water Supply Facilities

3 Operation and Maintenance of Water Supply Facilities

3.1 Present condition of O&M of water supply facilities

3.1.1 Operation and maintenance manuals

In Ethiopia, no manuals or guidelines that exclusively deal with O&M issues of water supply facilities has been prepared at the federal level. Some limited descriptions can be found in the federal-level documents such as “Water Resources Management Policy, 1999” and in “Water Sector Development Program, 2001”. Each region prepares its own manuals and guidelines in accordance with these documents. In Somali Region, the Water Supply Scheme Management Core Process that is responsible for O&M issues of water supply facilities in the region, made the manual (Water supply scheme management core process, Operational Manual, 2010) and clarified the general tasks and purposes of the activities of its staff. However, the overall contents of the manual rather focus on the principles and purposes and the document is not specific to the O&M work of water supply facilities. An interview with SRWDB staff members revealed that the bureau does not have any plan to prepare such manuals. This was found mainly because most technicians at the sites cannot understand written manuals and also because they do not have a custom of using manuals. The manuals are simply wasted even when they are prepared.

3.1.2 Organizations concerned with water supply and their relations

It is SRWDB that is mainly in charge of issues of water supply and water resources and under it are subordinate government branch offices of SRWDB, and woreda water supply utility offices dealing with actual maintenance of water supply facilities. Other than these government water offices, there are other organizations involved in water supply to refugee population and in emergency water supply. This makes the situation of water supply in Somali region a bit complicated compared with the situation in other regions. The organizations concerned with water supply in Somali Region can be summarized as follows (refer to Table 3.1). And Figure 3.1 shows the relations of each organization.

Table 3.1: Organizations Engaged in Water Supply in Somali Region

	Type	Duty/Activity	O&M aspect
Regional water bureau	Govt.	Drawing up the water supply plan for the entire region, implementation of large scale water supply construction works, Technical and managerial support to subordinate government offices, Emergency water supply, O&M of water supply facilities	Repair and change of the equipment and device of water supply in woredas (including towns)
Zonal water office	Govt.	Improvement planning, O&M, construction works of small scale water supply facilities in rural areas in the zone	Technical and managerial support to woreda offices
Woreda water development office	Govt.	Improvement planning, O&M, construction works of small scale water supply facilities in rural areas in the woreda	Simple repair and improvement of small scale water supply facilities in rural areas
Town water supply utility office	Govt.	Management and O&M of town water supply system of the area in charge	Basic light maintenance of the facilities
Woreda administration	Govt.	Discussion and advising on water supply issues in woreda through the water board	None

WASHCO	Users	Management and operation of individual water supply points	Daily management of water supply point
UNHCR	UN	Dealing with refugee issues (including water supply), instruction and monitoring of JWSO	Provision of operational fund to JWSO
JWSO	Govt.(UN)	Maintenance, expansion and protection of water supply facilities in Jijiga and Kabribeyah towns,	Repair of facilities in Jijiga and Kabribeyah towns
ARRA	Govt. (UN)	Provision of various support to refugee population in the camp	Repair of public taps within refugee camps
NGO	NPO	Implementation of water supply and hygiene projects in the areas of interest	Mainly rehabilitation and construction of small scale water supply facilities, fund provision to woreda offices

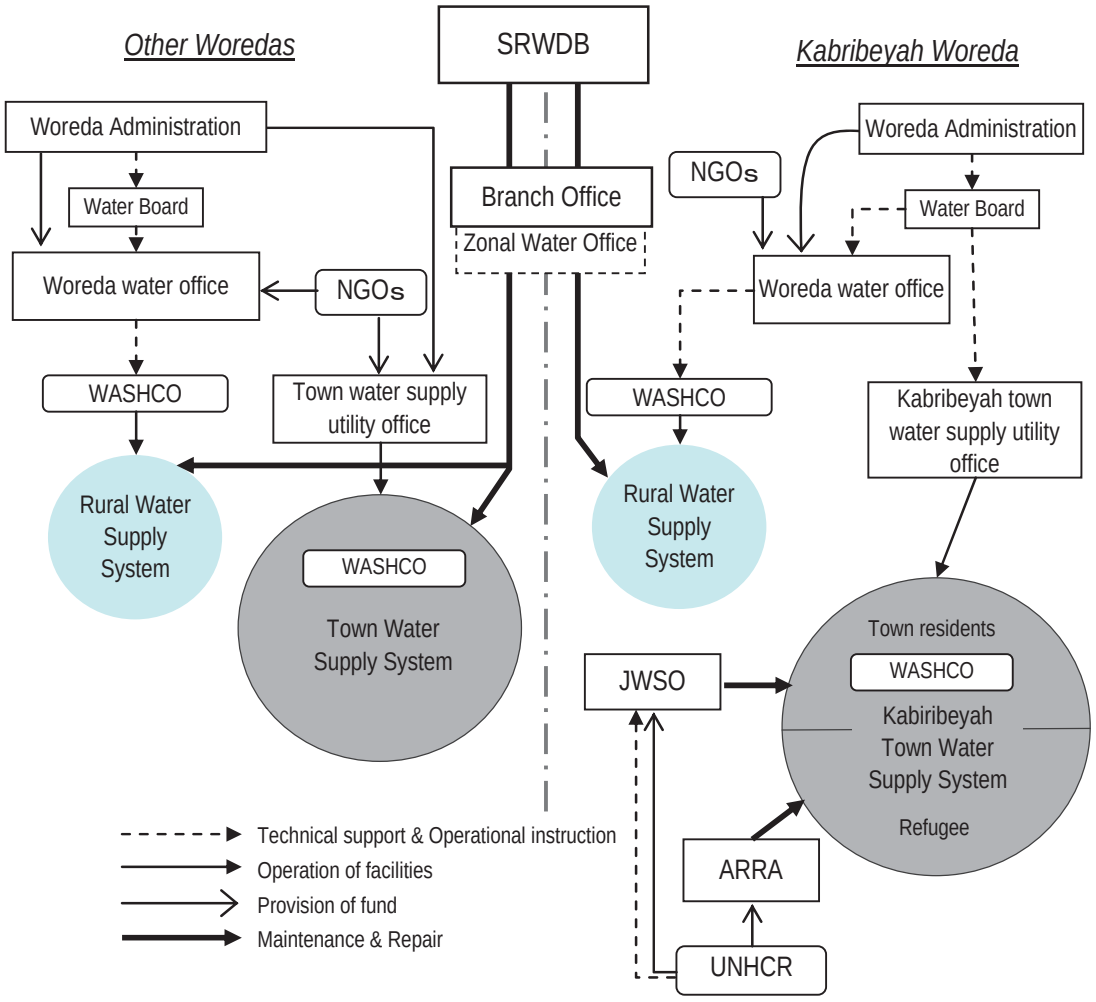


Figure 3.1: Inter-relationship among the Organizations Concerned with Water Supply

The chart above (Figure 3.1) illustrates the interrelationship among the organizations engaged in the management and O&M of water supply facilities in Somali Region. As can be seen in the chart, the situation is different in Kabribeyah woreda where UNHCR is involved in water supply due to the existence of large scale refugee camps. In Kabribeyah town, Jijiga Water Supply Office (JWSO) plays an important role in the O&M of water supply facilities.

SRWDB is the subordinate organization at the regional level of Ministry of Water and

Energy and is responsible for preparation of plans/policies and execution of projects in water resources, water supply, energy, and irrigation. SRWDB is especially responsible for maintenance of water supply facilities in rural areas. The maintenance work is classified into three levels of 1) light maintenance, 2) medium maintenance, and 3) heavy maintenance depending on the equipment involved. SRWDB was solely in charge of the maintenance work of all the levels before the BPR. However, after this restructuring, woreda offices have been given the responsibility of conducting light maintenance.

Woreda administration is the government organization that deals with financial and administration issues of the woreda. The water board has the following rights and duties with regard to the activities of town water supply utility office.

- following up the activities of the office
- facilitating the budget procurement from NGOs and donors
- providing advise and subsidies to improve conditions of water supply facilities

The water board, on the other hand, has a great influence over the function of the town water supply utility office, possessing the power of deciding its head, evaluating and approving their annual activity plan and budget. The water tariff, the major income source of town water supply utility office, also has to be approved through the water board by the regional water bureau, the woreda water office, and the woreda administration.

Town water supply utility office is the government organization that is in charge of management and O&M of urban water supply system with piped distribution network and public and individual supply points. It is positioned below woreda water office or municipality government. In Somali Region, the four towns such as Kabribeyah, Dagahbur, Godey, and Kabridahar have a town water supply system managed by the town water supply utility office. Their usual activities are limited to the management and simple maintenance of the water supply facilities (including bill collection). The offices are, in principle, financed by the income from the sales of water collected from end users. However, the office sometimes receives some financial or materialistic support from regional water bureau, woreda water office, and NGOs.

Woreda water development offices are subordinating offices of woreda administrations and they deal with the water supply issues in the entire woreda. The office is in charge of all the water supply facilities in its woreda except for large scale urban water supply systems that are looked after by town water supply utility offices. Their target water supply systems are, thus, those in rural areas and they are usually hand pumps and small scale traditional dams. many offices are under-staffed the general capacity of woreda water offices are low and less than a half of these offices have decent office space. Especially technical equipment to facilitate their daily work is totally lacking. The ratio of functional water supply systems (borehole wells, river intake) excluding crude earth structures such as traditional dams is not very high with about 70% working out of 43 systems overall.

UNHCR, Jijiga sub-office, one of the agencies of United Nations is the founder of the water supply system in Kabribeyah town (Jarar water supply system) and still is the legal owner of the system. UNHCR has a remote office in Kabribeyah town and provides various supports to the refugee population working together with the Agency for Refugee and Returnee Affairs (ARRA). Their support to the refugees covers food security, water supply, health and hygiene, education, and general security. Kabribeyah town has a large refugee camp and the Jarar

water supply system was originally constructed to serve this population. The O&M of the whole water supply system except for the host community area is conducted in collaboration with Jijiga Water Supply Office (JWSO) and ARRA, and they do maintenance, improvement and expansion of the system. The contract between UNHCR and JWSO, however, has recently terminated.

The zonal water office is the government agency hierarchically positioned between the regional water bureau and woreda water offices and they deal with issues of water resource, water supply, energy, and irrigation. However, in Somali Region, there are no more active zonal water offices at present.

The Ethiopian water sector policy and WASH guideline dictates that a group of users (WASHCO) be assigned in order to properly manage and operate each and every water supply point. A WASHCO normally consists of 5 to 7 members and is in charge of operation of public water supply points (water delivery), collection of water fees from the users and minor maintenance of the facilities. The duties and tasks of WASHCOs are different depending on the setting of the water supply points. Their tasks in rural area, urban area, and in refugee camp are summarized in the table below.

Table 3.2: Comparison of WASHCO Tasks and Duties in Different Settings

	Facilities	Duties and Tasks	Maintenance
Rural area	・Public tap ・Small dams ・Well with hand pump ・Borehole with public taps	WASHCO is responsible for all the operation and most of the maintaining the facilities on its own by collecting water fee. In the case of heavy maintenance, they receive technical assistance from woreda water office or SRWDB.	All the facilities except for Birka and Haffir dams are practically maintained by SRWDB
Urban area	・Public tap	Conduct daily operation of the facility. Collect water fee from the users to give to the water offices in charge of maintenance. Maintenance is done by water office.	Water offices (town or woreda) conduct the maintenance of the facilities
Refugee camp	・Public tap	Daily operation only. No water fee collection	JWSO and ARRA does the maintenance

3.1.3 Ability and actual performance of workshop in the SRWDB

The maintenance of the water supply equipment in the region is conducted by the maintenance workshop (hereafter called “the workshop”) of SRWDB. The tools and equipment owned by the workshop is far from sufficient and the study team selected tools and equipment to be used with the mobile workshop vehicles based on the current situations of the existing tools. Every year, this patrol team visited three zones using the only one existing mobile workshop (pickup truck loaded with equipment in the cargo space). The maintenance of the vehicle performed in between the field patrol is nothing more than the reactive repair work to fix problems that have happened. Their work covers many facilities and equipment though the required level of maintenance is not so high. This is considered a combined result of aging of the facilities and reactive maintenance work that have been performed. In addition, duties of the staff also include changing oil and the expendable supplies for vehicles and machines. With all these activities, the staff is considered fairly busy.

The staff as electric maintenance and machine maintenance staff mainly consists of above-mentioned 22 members, but a half of the staff regularly work in the field for field patrol duties and the rest remains in the SRWDB compound. There are several ways to evaluate the technical level of the staff including some simple methods, but none of them could not be used due to the condition of the day of the visit and also to lack of apparatus. Therefore their technical level was estimated through visual observation of their behavior in addition to observation of tidiness of the workshop (proper arrangement of equipment and materials) and how the machines and apparatus are stored. The result is far from satisfactory for the staff of SRWDB.

3.1.4 Present condition of O&M of Kabribeyah and Godey towns

The total number of staff members who are engaged in operation and maintenance of the Jarar valley the water supply system in Kabribeyah town is 15 and all are the field staff of Kabribeyah town water supply utility office. When they do cleaning of water tanks, valves, and pipes, the office sends two plumbers and one or two technical staff members to supervise the work. The operation of pumps and generators are done by two or three operators. Another work regularly done is the input of chlorination agent at the reservoir tank adjacent to the conveyance pump station. The tasks regularly performed and related to maintenance of the system are cleaning of pipes, valves, and reservoir tanks. Since the hardness of the source water is very high, a thick layer of scale is produced on the inner walls of pipes and valves and on the walls of reservoir tanks etc. in a short period of time. In order to remove the scale within pipes and valves, these must be detached from the main system. Two (2) plumbers from the office are sent to the site and they work with the operators. Likewise, one technician from the office is sent to the site of reservoir cleaning to supervise the work. The work of scale removal in reservoir tanks is manually done by mechanically scraping off the scale. The work will require up to 45 daily workers. The office organizes a comprehensive pipeline repair work once in 8 months, covering both conveyance and distribution pipes based on the information the staff has come across or on the information that has been reported. Most of the operators working in the field do not have sufficient educational background and many of the guards have no official educational record. The pump operation at the pump stations is not a difficult or time-consuming work in itself but the work starts early in the morning and continues until late in the night, involving switching on and off of the pumps 5 times a day. One person takes charge of this operation for an entire day and three members work in a shift.

In Godey town, the town's water supply system is operated mainly by the field staff of town water supply utility office. The total number of staff members assigned to all the component facilities is 15 persons. All the component facilities are operated by the specially assigned field staff of town water supply utility office except for the distribution reservoir tanks in the town which are operated by an available non-field technical staff member of the office. Their tasks involve operation of pump and generators, regular cleaning and sludge removal in tanks and repair of intake pipes. The suction end of intake pipe is currently placed directly into the natural river stream. Thus, regular cleaning of clogged intake filter will be necessary. Also the intake pipe is damaged due to torrential river flow and floating objects in the rainy season. This makes it necessary to regularly repair and replace the intake pipe especially in the rainy season. There is only one set of pump and generator at the intake facility and there are no backups. They do not conduct regular maintenance of these pumps and generators either. When they clean reservoir tanks or remove sludge from the treatment plant chambers, they hire a few to 20 daily workers and the work is done manually under the supervision of the technician and the operator. As for the maintenance of pipeline system, the office does not

conduct regular inspection work but performs comprehensive repair work covering both conveyance and distribution pipelines based on the information obtained during their regular course of work. Both operators and technicians have insufficient education but the technicians have much longer work experience with the system. Furthermore, one of the technicians has had a total of a few months of training in the relevant field. Both operators and technicians have insufficient education but the technicians have much longer work experience with the system. Furthermore, one technician has had a total of a few months of training in the relevant field.

3.1.5 Condition of water fee collection and WASHCO activities

The system of management of water supply facilities by the users through establishment of WASHCO is still a new idea in Somali Region. In Kabribeyah town, no WASHCOs have been officially formed at any sites. The persons who operate these water points at present are called “caretakers”. Since the caretakers have no technical skills, they only conduct most rudimentary maintenance of the public taps and report all the other problems to the water supply utility office and ask for their maintenance service. Each water supply point is equipped with a water meter to show the amount of water used at the point. Caretakers collects water fees from the water users and pay the bill that is calculated based on the amount of water used and on the pre-determined water tariff to the town water supply utility office. The caretakers had never received training on water point management. They were simply nominated as caretaker because the water point was constructed in their yards. Within the refugee camps, similar systems have been organized for every water supply point but they do not collect water fee. The members simply do the daily water supply operation for the users and report to ARRA in the case of any problems.

In Godey town, there are not WASHCOs at the time of the study but the town water supply utility office is planning to establish WASHCO at the six public water supply points. The office is supposed to conduct WASHCO organization with technical assistance from SRWDB. Currently, all the existing public water supply points are located in privately owned plots and the owners of the plots are temporarily put in charge of the operation of the water points as care-takers. Some care-takers decide their own water prices and that in some cases lead to a problem.

Collection of money for water by WASHCO or caretakers is, in most cases, made at the time of water fetching. In Kabribeyah town, the going rate is 0.5 Birr per 20L water tank and the rate was determined by the town water supply utility office. The caretakers, current manager in charge of public water points, pay a monthly water rate of 15 Birr / m^3 while they are collecting 0.5 Birr for 20L of water. Thus, they put the difference (about 60% of the money they collect from the users) in their pocket. A survey in Kabribeyah town indicates that in many cases, the caretakers collect around 300 Birr every month. Meanwhile, private households in urban areas that have their own yard taps and those that own private birkas in rural areas sell water to the surrounding residents. In such cases, the prices of water are higher than in the case of public water supply points. The rates are usually 1 to 2 Birr/20L tank or a monthly rate of 15 Birr.

3.2 Result s of O&M training

In this study, the following trainings were conducted.

1) O&M training on installation of electro-mechanical equipment for the pilot project

2) The training concerning mobile workshop

3) WASHCO training for the water supply facilities constructed in the pilot project in Godey and Kabribeyah towns

1): The practical training and inside lecture were conducted in the workshop of SRWDB, and as a result, the participants were able to repair two generators and one compressor without replacing any major parts as the practical training.

2): The training aimed at teaching the participants how to use four machines that they are not familiar with. A short explanation of the working principle of the machines was followed by a quick demonstration. Then, the participants practiced how to use the machines in order to familiarize themselves with the machines. The selection of the trainees for this practice considered the limitation in time and materials. Thus, relatively small numbers of trainees with sufficient experience were selectively chosen. The trainer intended to teach a few numbers of good and fast leaner's as much as he could so that these trainees would be able to teach others in future. Finally the trainer gave detailed explanation and tips on how to set up the machines on the mobile workshop vehicles after they arrive. The lecture also covered how to effectively and efficiently use the vehicles loaded with the machines and handouts on these topics were given to the participants. Through the training, it is clarified the issues of not only trainees, but also the organization. The main issues are the shortage of budget for operation, although this is a universal problem that applies to any developing country, the staffs lack systematic and comprehensive knowledge on O&M activities, and no systematic activities of each organization in regard to the O&M. The technical issues of the staff are also clarified in Kabribeyah and JWSO.

3): The WASHCO training in Godey town was conducted the target at five public taps constructed in the pilot project. The training aimed at establishing the system to protect the facilities until they are regularly used. After monitoring, the motivation of the members is especially high at site No-4 and 5 and they conducted the activities two to three times already. In Kabribeyah town, training of WASHCO was conducted at the five water points. A few members also resigned at this time after they realized that WASHCO activities are voluntary and no remuneration was paid. The same problem also occurred again in the middle of the training and 10 members left the training. The organizers had to re-select 10 members to fill their positions. Out of the finally selected 35 members, 23 were literate and 23 were also women. As the results of monitoring, the training was confirmed effective to some extent even though no activities have been done yet since all the WASHCOs were found to have understood the contents of the training. In consideration of the fact that the WASHCOs had started some activities two weeks after the training in Godey town, the motivation of the members may be comparatively lower.

Through execution of WASHCO training and its monitoring, the following issues concerning planning and execution of WASHCO training have been identified for both Kabribeyah and Godey towns as shown in Table 3.3 below.

Table 3.3: Issues Concerning Execution of WASHCO training

Common issues	・ Necessary to set aside quick and continuing budget for WASHCO training to conduct the training when it is needed. ・ Training for trainers (TOT) of staff at woreda level and manuals (Somali language) should be provided. ・ Should take advantage of the presence of the two "facilitators" who participate in the training on the trainer's side (the two are usually selected from the government offices in charge). ・ Involvement of community from the early stage of facilities renovation or construction should be encouraged. ・ Provision of fence around water supply points is recommended to be included in the construction project and ask the residents to provide labor. ・ Necessity for improvement of mentality and attitude toward water supply
Issues for Godey town	・ Should select at least two literate members for WASHCO members in consideration of literacy level of members and expected future activities ・ Better to use more pictures to explain ideas in consideration of low literacy rate. ・ Need to devise measures to sustain WASHCO activities in the case that the facilities are not used (do not produce water) for a long time
Issues for Kabribeyah town	・ Many people have negative ideas about working as volunteers and many resigned during the training and an improvement measure is required. ・ Training on money collection and on how to handle the money is insufficient. It should be given more importance.

3.3 Issues and approach for improvement of O&M

Major issues and corrective measures concerning water supply operation and maintenance of water supply facilities identified based on the results of the study that are briefly suggested as follows;

- A guideline for procurement of equipment designed to standardize specifications or manufactures should be produced by the initiative of SRWDB in order to the accumulation of knowledge in O&M work and the efficiency of O&M work.

- Procurement plan for O&M equipment and spare parts should be planned by SRWDB in order to establishment of a system of procurement and distribution of spare parts and necessary consumables.

- The source water from Shebele river in Godey town has very high turbidity. The situation requires the system to use large amount of coagulant and as a result, large amount of sludge will be produced. So the efficiency of works should be discussed in consideration of the technical level of the operation staff and power supply condition at the site.

- The groundwater from the wells in Jarar Valley has high hardness and causes scaling problem in pumps and associated pipes. In consideration of the technical level of the site, the use of chemicals is not recommended. The scale has to be regularly removed manually. Before procurement of stainless pipes, the operators should conduct proper monitoring of the two JICA wells and two UNHCR wells to confirm how quickly and how the corrosion occurs to GI riser pipes. The use of stainless steel pipes should be considered after it is found really necessary. If it is, a reliable procurement route will have to be explored.

- Regarding the high turnover of water office staff, offices provide incentives to water office staff members who need to work in rural areas.

- Under the new O&M system, the duties of WASHCO increased but their duties in O&M work are not clear. Include staff of water offices in a part of WASHCO training in order to facilitate communication between the WASHCO and water office to discuss their roles in O&M.

- The money is not properly handled either by WASHCOs or by water offices. So the training on financial management to both WASHCO and water office staff members will be provided.

- It is necessary to make training at the existing water supply facility of woredas. And woreda water office staff members should be included in the training to foster them as future trainers.

Issues and approach of improvement for relevant organizations relevant organizations of water facility are mainly the staff education and materials and equipment in SRWDB. The improvement of technical ability of the staff can be achieved through “recurrent training of repair work” and “remedial education of technical knowledge”. Both can only be realized by establishing an improvement plan by the initiative of SRWDB. The plan by the organization enables it to improve the present conditions of the maintenance workshop. The materials for technical improvement training (non-functional machines) are already readily available in the compound. And also, there is sufficient space that enables the improvement of the maintenance workshop. The improvement training plan should make the most of this favorable environment.

Regarding materials and equipment, one of the problems is the choice of unsuitable equipment in addition to the volume and diversity of the machines and apparatus to be taken care of by the workshop staff. From now on, SRWDB should take a lead to improve the situation by carefully selecting the specifications of the devices in consideration of the site condition and staff’s technical capacity. At the same time, SRWDB should make an effort to establish a system of standardization of basic water supply equipment.

SRWDB is the agency that is ultimately responsible for the water supply activities in the region. In this sense, the knowledge and ability of the staff, and facilities and equipment of the bureau should be superior to the other sub-ordinate government offices. The items to consider in future capacity development are as follows.

1) Discuss means to enable repair experiences as much as possible for the workshop staff in order to reinforce their technical capacity
2) Discuss the establishment of the procurement routes (domestic and overseas) of parts, machines to realize effective repair experience for the staff
3) Plan development of specific annual maintenance programs once the materials procurement routes are established
4) Discuss the organizational system where it is possible to perform maintenance work without the distinction of electricity and machinery
5) Keep the workshop clean and in order and conduct regular maintenance of the facilities and apparatus

Since Kabribeyah town water supply utility office is the only government body largely involved in O&M of Jarar Valley water supply system, SRWDB recently reviewed its existing structure and work to propose a new system for the office for the future(Organizational Structure for Kabribayah Town Water Supply Utility Office, January 2012 GC, Jijiga). At least its field staff such as operators of the system will have to be augmented to be able to properly conduct the operation of the proposed water supply facilities in the master plan even with the presence of JWSO (or its successor).
Some of the important issues together with other relevant significant issues on the O&M of water supply facilities by WASHCO are as follows;

- The literary rate of the residents in communities that take care of the water supply facilities is very low. It is important to record income from money collection and expenses for maintenance in WASHCO activities.

- At present, WASHCO training is conducted only by one experienced trainer of SRWDB by visiting each site because there are no other capable trainers available. The situation makes it difficult to conduct training when it is needed.

- The awareness about public services of the people in communities, especially in rural areas, is very low. The government should make every effort to actively sensitize the people in communities about the importance of water supply systems to change their mentality though WASHCO and publicity campaign.

3.4 Comprehensive evaluation for O&M capacity of relevant organizations

The comprehensive evaluation for the O&M capacity of relevant organization is as follows;

- The capacity of staff and equipment of woreda water offices are very weak. Moreover, with future shift in some of the maintenance responsibilities to woreda water offices and to WASHCOs, it is obvious that they will not be able to handle the new tasks both in terms of workforce and equipment. The situation is no different in the case of town water supply utility offices. It is very important to strengthen the ability of woreda administration and to clarify the role of water works of SRWDB.

- In order to realize appropriate O&M activities by the organizations concerned, it is highly important that the executive officers as well as technicians at the site level of all organizations concerned come to realize the principles and basic ideas on O&M activities. It needs to make planning of O&M by the executive officers. The head of organizations is important. The heads also need to acquire sufficient budget for the operation of the organization. This task will require a high level of skills.

- The Jarar valley water supply system is existed in the hands of UNHCR. Now although the Kabribeyah town water supply utility office operates the system, the O&M capacities are low, and they cannot repair and maintain the equipment in the system. In the future, the capacity upgrading of the town water supply utility office to enable the office to be self-sufficient in terms of the operation of the water supply system will merit both UNHCR and SRWDB. At this moment, no specific activities about the capacity development of the office have been conducted. It is, thus, proposed that the Somali Regional administration represented by SRWDB, UNHCR, and other partners concerned should get together to discuss step-wise capacity development plans for the town water supply utility office. Once the plan is prepared, the parties should implement it in collaboration.

3.5 O&M Plan of water supply systems

The results of the study of operation and maintenance work and personnel required for each of the proposed water supply systems are presented based on the examination of the proposed facilities in the systems. In addition, the cost of the proposed operation and maintenance plan of the water supply systems based on the details of the facilities and the implementation plan have been estimated. It is a prerequisite to improve the existing organizations and staff concerned with operation and maintenance of water supply facilities. Thus, in every types of work the operators do, a chief was assigned and provision of appropriate training was planned. In order to supply materials and equipment necessary in operation and maintenance work, it is desirable SRWDB is expected to procure such items according to the schedule and deliver them to site on time. And in the planning and cost estimation work, all the regular O&M work is assumed to be conducted by town water supply utility office for convenience include the maintenance work of the major part of the system.

The water supply systems of the woredas are categorized into the five types as Birka/ Haffir dam, Hand-dug well, Shallow well and hand pump, Borehole well and motor pump, and River intake system.

The work items of O&M in each facility of Kabribeyah and Godey towns are as follows;

Kabribeyah town

- Borehole facility (Pump management, Maintenance of generator, General guarding)
- Treatment plant (Minor and major cleaning, General guarding), Reservoir of treatment plant (Tank cleaning, Chlorine dosing)
- Pump station (Pump operation, Valve management, Valve and pipe scale removal, Pump maintenance, General guarding)
- Booster pump station (Pump operation, Pump maintenance, General guarding), Reservoir of station (Cleaning)
- Reservoir (Cleaning, General guarding)
- Pipeline system (maintenance)

Godey town

- Intake canal (Sludge removal, Screen cleaning), Settling basin (Sludge and garbage removal)
- Pump house (Pump management, Pump spare parts replacement, General guarding)
- Generator house (Generator operation, Generator maintenance, General guarding)
- Sedimentation pond (Sludge removal, Coagulant and lime dosing, General guarding)
- Rough filter (Surface sludge removal, Filter cleaning, General guarding)
- Slow sand filter (removal of surplus sludge, Conditioning of the filter layer)
- Treated water reservoir (Tank cleaning, Chlorine dosing, General guarding)
- Reservoir 1 (Tank cleaning, Level check and valve operation, General guarding)
- Reservoir 2 (ditto above)

- Reservoir 3,4 (Tank cleaning)
- Pipe system (Repair and replacement)

The type of work and number of staff members required for each of the component facilities of the proposed system are shown in more detail in Table 3.4. The cost of O&M for the town was calculated based on the data following the cost items below.

1) Personnel (regular staff directly involved in O&M of the facilities)

2) Materials (Tools and materials necessary for O&M)

3) Fuel and electricity (Fuel for generators and electricity bill for pumps)

4) Chemicals (chlorine for household use, and treatment chemicals for the plant)

5) Spare parts (consumables and spare parts for generators and pumps)

Table 3.4: O&M Cost of each Woreda and Two Towns (2013 year)

16 woredas (rural)		
Woreda	Amount (Birr/year)	Remarks
Kabribeyah	14,137,322	excluding facilitiies in urban area of Kabribeyah town
Araarso	3,751,608	
Dagahbur	6,417,767	
Birqod	1,971,192	
Shaygosh	2,710,123	
Kabridahar	6,486,672	
Doba wein	3,961,764	
East Ime	7,674,432	
Danan	1,595,124	
Beercaano	3,477,084	
Godey	5,037,504	excluding facilitiies in urban area of Godey town
Adadle	3,203,184	
Kalafo	7,413,996	
Mustahil	6,487,116	
Rasso	1,227,300	
West Ime	4,597,200	

Kabribeyah Town		
Cost item	Amount (Birr/year)	Remarks
Spare parts	41,796	spare parts for generators and ground pumps
Power supply	3,258,540	fuel and electricity bill for generators and pumps
Personnel	456,000	salary of stationed field staff and daily workers
Chemical	116,592	cost of water treatment chemicals (chlorination agent)
Consumable	43,032	tools for cleaning of facilities and engine oil for generators
Others	0	
Total	3,915,960	Equivalent to approx. US$ 211,000

Godey Town		
Cost item	Amount (Birr/year)	Remarks
Spare parts	22,272	spare parts for generators and ground pumps
Power supply	2,211,840	fuel for generators and pumps
Personnel	954,096	salary of stationed field staff and daily workers
Chemical	707,724	cost of water treatment chemicals (coagulant, pH adjuster, Chlorination)
Consumable	33,372	tools for cleaning of facilities and engine oil for generators
Others	0	
Total	3,929,304	Equivalent to approx. US$ 212,000

Conditions of estimation

- Cost includes VAT and based on 2013 prices
- Cost was calculated as annual average over 10 year
- Cost covers all the facilities in Jarar valley includig those constructed by UNHCR until April 2013
- Cost is for the regular operation of the system and does not include major facilities/equipment replacement

3.6 Capacity development plan for the relevant organizations

As explained above at present, all the organizations involved in water supply, from resident to regional level, lack sufficient capacity to execute their work properly in terms of materials and equipment, skills, budget, and human resources. In order to realize proper O&M of the proposed water supply facilities in the master plan, it is mandatory to establish a system where these organizations can fulfill their duties and perform the tasks that have been proposed in the previous section. To help realize this, a series of short to long-term training should be provided to the staff of the organizations concerned with water supply. The training sessions should start from the year 2014 when the construction of the proposed facilities is to start and be conducted in accordance with the proposed construction plan.

Since SRWDB is responsible for general assistance to the target woredas water offices and towns water supply utility offices regarding the O&M of the constructed facilities of the master, the staff should be aware of the outline of the facilities to be planned in each woreda and town and the type of work required for each type of the facilities. For this purpose, a short-term training was planned for the workshop staff members and its supervisor and also to raise their morale. The training focuses on the technical aspect of the workshop for technical staff.

The study has pointed out that the financial management of the Kabribeyah town water utility office is weak. Thus, a short-term training designed to raise the capacity in financial management was planned. In the technical aspect of the water supply system, the problem of excessive scaling has long been the issue although no realistic solution has been found. This made it necessary to deal with this problem somehow during the O&M work and a training to enable these measures effectively and efficiently was planned.

Like in Kabribeyah town, the study has pointed out that the financial management of the Godey town water utility office is weak. Thus, a short-term training designed to raise the capacity in financial management was planned. In the technical aspect of the water supply system, the problem of highly turbid river water has long been the issue although no realistic solution has been found. This made it necessary to deal with this problem somehow during the O&M work and a training to enable removal of suspended solids in water with the use of water treatment chemicals was planned.

In Woreda water office, similar to the town water supply utility offices, the study has found that the financial management of these offices is weak. Thus, a short-term training designed to raise the capacity in financial management was planned. The technical level of woreda water offices are expected to be very low. Thus, short-term training to teach the basic knowledge and skills required for their jobs should be provided first.

No official WASHCOs have been formed at many of the existing facilities. Therefore, ordinary training to form a WASHCO should be provided first in such areas. In the training, the aspect of training of future trainer of WASHCO training should be considered. The appropriate technical training should be provided to WASHCO members. The training should focus especially on the maintenance of birkas, haffir dams, hand-dug wells, and hand pumps that WASHCO members will have to look after on their own.

The study has revealed that the awareness level of the general residents is low as a whole and the situation is making it difficult to obtain their cooperation in construction and O&M work. Therefore, a publicity campaign targeting the 16 woredas in the master plan, especially the sites where construction of new facilities is planned should be conducted.

Proposed long-term training strategy for WASHCO and SRWDB are shown in Table 3.5 and Table 3.6.

Table 3.5: Proposed Long-term Training Strategy for WASHCO

1. Training Type	WASHCO related Training
2. Period and Frequency	1) TOT for to be trainers for WASHCO training (5 years from 2014) 2) Regular WASHCO training and WASHCO follow up training (conduct as new construction plan arises from 2018, The follow-up should be conducted after about one year)
3. Objectives	1) To create WASHCO trainers at zone and woreda level 2) Formation of WASHCOs at newly constructed facilities and to follow their activities at the existing sites after the implementation of Master Plan projects.
4. Target	1) Staff of water office at woreda and zone level, Staff members of SRWDB, Staff members of NGOs 2) Existing WASHCO members, Residents living near newly constructed facilities
5 Contents	1) TOT to foster future WASHCO trainers - The concept of management of water supply facilities by WASHCO - Skills of good communication with the residents - Contents of WASHCO training and how to conduct the training - Lessons learned from the past training and possible solutions 2) Continuation of the regular WASHCO related training (refer to module CM-WASH-T, CM-WASH-FT)
6. Points of consideration at implementation	1) TOT - In the beginning, the present trainer of SRWDB provides training to the staff of water offices in focal zones and woredas - The trainers should refer to ”Rural Water Supply and Sanitation and Hygiene Program, Community facilitator’s manual” which describes the principles of WASHCO training in Somali Region 2) Continuation of regular training and follow up training - Conduct follow up training only when the water office in charge judged it is necessary after monitoring of WASHCO activities - Assign the trainers who were trained in the TOT to be the trainer for follow up training as they are available so that the management system by WASHCO will be established at an early stage.

TOT: Training of trainers

Table 3.6: Proposed Long-term Training Strategy for SRWDB

1. Training Type	Capacity building for Workshop Staff
2. Period and Frequency	As it is necessary from 2014 for about 10 years
3. Objectives	To improve mainly the technical capacity of the workshop staff of SRWDB in maintenance of equipment and facilities and the system of conducting the maintenance work (institutional capacity).
4. Target	Technical staff of workshop of SRWDB and their managers

5 Contents	- The training contents follow the module RWB-MWS prepared in this study
	  - Establishment of procurement rules of spare parts and budget for the purpose
	  - Training for improving repair skills of broken machines
	  - Lectures to upgrade knowledge of staff in basic science and engineering
	  - Preparation of regular O&M plan
	  - Establishment of specification for equipment and materials to be procured
	  - Establishment of internal education system to foster capable technicians
	- Conduct site training (OJT) in towns and woredas
	- Take advantage of training courses offered by external organizations

6. Points of consideration at implementation	- It is desirable to conduct short and condensed training from time to time so the training will not interrupt their daily work. Also one of two persons at a time may be sent to join a long term training. - EWTEC regularly holds training courses in maintenance of electro-mechanical equipment in Addis Ababa. Some staff members should be sent to this training. - The region should try to employ people with higher education levels as the staff are trained. - SRWDB should promote communication with water offices of woredas, zones, and towns to exchange information.

OJT: On the job training

EWTEC: Ethiopian Water Technology Center

Chapter 4

Feasibility Study on Water Supply Plan of Godey Town

4 Feasibility Study on Water Supply Plan of Godey Town

4.1 Introduction

The feasibility study was carried out for the purpose of discussion of water supply plan of Godey Town. The appropriate water supply facilities are selected in consideration of the water resources and the conditions of existing facilities for the water supply plan. The current situation of organization control for the O&M was investigated and the issues were analyzed and the improvement plan was discussed. The project cost and O&M cost were estimated for the implementation of the Godey town water supply plan. And the economic-financial plan was evaluated to assess the feasibility of the water supply plan.

4.2 The aspects of project area

The population in Godey Town is 29,379 (2012) and is the largest town among the urban areas of the woredas in Shebele River basin. The elevation of the town is approximately 273m-300m amsl. The Shebele River flows in the direction from WNW to east. The lowest elevation was indicated at a point along the Shebele River and the land surface of the town slopes from north to south. The main geology of Godey Town and its surrounding area consists of the Korahe Gypsum strata of early Cretaceous to late Jurassic widely based on the existing geological map, and these strata were covered by colluvial and alluvial deposits or terrace gravel layer of Quaternary. The average annual rainfall is 236mm (observation term 2004-2009) in Godey Town, and is 272.7mm (observation term 1996-2012) at Gode Met. The rainy season in Godey woreda is from April to June as the small rainy season, and from October and December as normal rainy season. The main surface water source of Godey Town is the water from the Shebele River. The Shebele River is a perennial river. The drainage area is 127,300 km^2, and annual average depth of runoff is 25.92mm (observation term: 1968-1971) at Gode hydrological station along the Shebele River. In Godey woreda, shallow wells are used in Carmaare kebele in the east and Hadhaave kebele in the north, but it is difficult to use the deep borehole well in the whole Godey woreda, because the thickness of Quaternary deposits on the surface is thin, and it has a high probability to reach the gypsum layer immediately below if a well is drilled. Turbidity and total hardness exceed Ethiopia standard in the water quality of Shebele River in Godey woreda.

4.3 Socio-economic survey

The socio-economic survey consists of: (i) interview survey at the water utility office in Godey Town; and (ii) interview survey at sample households selected from the target households in Godey Town. A sample household survey was conducted at 39 households in Godey Town that were selected from the target households in the town. The population in Godey Town is estimated at 29,379 people with 4,758 households as of 2012. The population is projected to grow at an average growth rate of 2.91% per year, reaching 36,958 people by 2020. There are 13 primary schools and 2 secondary schools (grade 9 – 12) in Godey Town. There is a hospital, and other health facilities include two health centers (HC) and some health posts with a total of more than 250 health professionals and supporting staff in Godey Town. The major leading water related diseases found in Godey Town are malaria, diarrhea and dysentery. The survey results indicated that the average amount of water the residents get is 13.1 liters per day per capita (lpd) in the rainy season and 21.7 lpd in the dry season. The water use amount obtained in this survey signifies that the sampled households get water either from public tap or water vendors. The water use amount in the dry season is 1.5

(washing purposes) to 1.8 (cooking purposes) times of that of the rainy season in Godey Town. The water price fluctuation ranges from 15 Birr (minimum) to 250 Birr (maximum) per month for the willingness to pay. Household income ranges from 1,800 Birr to 72,000 Birr with an average annual income of 30,336 Birr in Godey Town. It is assumed that the maximum monthly water bill affordable for urban households is 5% of the household income (Project Appraisal Report, Water Supply and Sanitation Project, World Bank, 2004). Based on the household income data as mentioned in the preceding section, the ability to pay of water users in Godey Town was assumed to be 1,516 Birr per year (126 Birr /month), namely five (5) percent of the average household income of 30,336 Birr.

4.4 Population and water demand

The projected population in 2020 was estimated to be 36,958 persons. The water demand calculated consists of domestic water, industrial water, commercial and institutional water, livestock water and water loss. Firefighting water demand was considered to design reservoir volumes. It was set to be 10% of reservoir volume following the urban water supply design criteria. Estimated water demands are summarized in Table 4.1.

Table 4.1: Summary of Water Demands

No.	Item	Unit	Water demand
1	Domestic water demand	m^3/day	840.81
2	Industrial water demand	m^3/day	3.40
3	Commercial water demand	m^3/day	2.25
4	Institutional water demand	m^3/day	62.40
5	Livestock water demand	m^3/day	181.77
6	Average daily water demand (No.1~No.5)	m^3/day	1,090.63
7	Water loss	m^3/day	327.19
8	Average daily water demand with water loss	m^3/day	1,417.82
9	Peak seasonal daily water demand (No.8×1.2)	m^3/day	1,701.38
10	Maximum daily water demand (No.9×1.3)	m^3/day	2,211.79
11	Maximum hourly water demand (No.10×1.9÷24)	m^3/hr	175.10

4.5 Existing water supply facilities

4.5.1 Existing water supply coverage

It is assumed that the daily water production volume is about 150m^3 judging from the intake pump capacity. In the case that all water is used for domestic purposes, this volume is equivalent to water supply volume for 7,500 persons. In other words the maximum beneficiaries are 7,500 persons and the existing water supply coverage rate is about 26 % even at the highest. It can be said that the existing water supply coverage rate in Godey Town is quite low in comparison with water supply access rate in the Somali Region (74%).

4.5.2 Initial development of water supply facilities

The water resources of Godey Town are river water. The water supply facilities were constructed in 1959, and were developed further in 1996 to accommodate for growth of the town. After that, the sand filter ponds in the water purification plant, concrete reservoir, and the public taps were constructed. However the amount of water taken from the source is

about 150m^3/day and the number of users is roughly 5,000 actually.

Originally, two intake pumps were installed inside the raw water intake pump station. Due to lack of spare parts, the Godey water supply utility office operates one raw water intake pump only. When they replace the intake pump, they normally install a used pump due to budgetary limitations. Therefore the pump station can't be operated effectively. According to the Godey water supply utility office, they do not operate the raw water pump for the protection of pump in case that river water level is higher than the settled pump elevation and raw water is turbid.

The Godey water supply system adopts the slow sand filter system. The sand filter pond 1 was constructed in 2007, but it is not currently operational. According to the Godey water supply utility office explanation, the pond clogged by sludge and treated water overflowed into the sand filter pond 1. Afterward, the SRWDB planned and constructed the sand filter pond 2 and 3 with six ponds. The sedimentation pond cannot be used at this moment due to no commercial electrical line installation to the site. As a result, Godey water supply utility office has to manually operate the coagulation dosing and sludge removing works.

In the treated water reservoir stands at the Shebele riverine area, purified water from the sand filter pond 3 flows into the clear water reservoir by gravity and chlorine shall be added there. Originally, it had three (3) transmission pumps to flow water to the reservoir in the town. However, two of them are broken presently, and only one pump is operational. In regard to the power station, there is only one generator that can supply electricity to the raw intake pump and transmission pump. Godey water supply utility office supplies electricity for the raw intake pump in the morning and the transmission pump in the afternoon.

Transmission pipe (uPVC pipe) with 6 inch diameter is installed from the treated water reservoir to the reservoirs in the town. Total length is about 3,450m.

Three reservoirs stand at the highest elevation site in Godey Town. The capacity of oldest reservoir elevated corresponds to the existing water production volume approximately 200m^3/day. The largest capacity reservoir with 1,000m^3 was completed in September 2010. However, it cannot satisfy water pressure for peripheral area of the town because it is a ground type reservoir.

There are 4 distribution pipeline routes installed in the Godey town with uPVC diameter ranges from 37.5mm to 125mm. Total pipeline length is about 20,000m. Major facilities, which are supplied by each distribution pipeline route are military camp, general hospital, airport, and international organizations, etc. There are 15 public taps in the distribution pipeline network. Initial three public taps and additional six are not operational because they are broken.

4.5.3 Issues and countermeasures on water supply facilities

Current issues and their countermeasures of the Godey water supply system are summarized in Table 4.2.

Table 4.2: Issues and Countermeasures on Current Water Supply System

No.	Issue	Countermeasure
1	Insufficient water supply volume	Increase of intake water volume
2	High turbidity of raw river water	Formulation of proper turbidity removal method
3	Insufficient water pressure at the distribution pipelines	Planning on new elevated reservoir to increase water pressure
4	Expansion of water supply coverage area	Expansion of distribution pipeline network
5	Increase of water usage of the public taps	Permanent water supply and establishment of WASHCO for operation

4.5.4 Operation and maintenance of the facilities

In Godey Town, the town's water supply system is operated mainly by the field staff of town water supply utility office. The total number of staff members assigned to all the component facilities is 15 persons. All the component facilities are operated by the specially assigned field staff of town water supply utility office except for the distribution reservoir tanks in the town which are operated by an available non-field technical staff member of the office. Their tasks involve operation of pump and generators, regular cleaning and sludge removal in tanks and repair of intake pipes. The suction end of intake pipe is currently placed directly into the natural river stream. Thus, regular cleaning of clogged intake filter will be necessary. Also the intake pipe is damaged due to torrential river flow and floating objects in the rainy season. This makes it necessary to regularly repair and replace the intake pipe especially in the rainy season. There is only one set of pump and generator at each component facility and there are no backups. They do not conduct regular maintenance of these pumps and generators either. When they clean reservoir tanks or remove sludge from the treatment plant chambers, they hire a few to 20 daily workers and the work is done manually under the supervision of the technician and the operator. As for the maintenance of pipeline system, the office does not conduct regular inspection work but performs comprehensive repair work covering both conveyance and distribution pipelines based on the information obtained during their regular course of work. Both operators and technicians have insufficient education but the technicians have much longer work experience with the system. Furthermore, one technician has had a total of a few months of training in the relevant field. Both operators and technicians have insufficient education but the technicians have much longer work experience with the system. Furthermore, one technician has had a total of a few months of training in the relevant field. The system of management of water supply facilities by the users through establishment of WASHCO is still a new idea in Somali Region.

4.6 Water supply plan

The water supply plan was formulated to newly design all the facilities in accordance with the present conditions of water supply system.

The design water supply volume estimated by water demand of 2020 in Godey Town is 2,212m^3/day, and groundwater potential is low for the water resources. So river water was selected for the water resources in Godey Town. There are five intake points along the Shebele River in Godey Town. The intake point of this water supply plan is located further upstream than all of the existing intake points. The structure of existing pumps is easily damaged because it is installed into the river directly and there is no screen and settling basin.

In order to reduce turbidity and protect the pump from trouble, intake canal and settling basin is provided at the new intake structure and pump station is built on the settling basin.

Water purification plant facility shall be planned to be maintained manually in view of weak power supply. The rough filter purification system and slow and filter system were adopted for the Godey town water supply system in consideration of the water turbidity of the Shebele River. In particularly, it is necessary to operate the pumps 24 hours a day for the latter system. Therefore it is important issues to utilize the electric power in Godey Town.

The transmission pipeline starts from the surface pump station and is installed to the additional reservoir which is located at the highest elevation point in Godey Town. The distance between the surface pump station and the new reservoir is about 4,900m and pipe diameter is 300mm.

The reservoir volume in 2020 shall be designed to be 800m^3. The existing 3 reservoirs are located at the same point; two existing reservoirs of elevated type will be used for backup purposes and a new reservoir has a capacity of 400m^3 in order to satisfy the water supply plan. It is also a ground type reservoir. The new 400m^3 reservoir supplies water for higher elevation areas of the town. The existing 1,000m^3 reservoir will supply water for lower locations. The boundary of these two water supply areas is set at an elevation of 293m. Water stored at the existing reservoir is supplied for less than 293m elevation area.

The distribution pipelines are planned to replace the existing deteriorated ones and expand the distribution area. Besides, five public taps constructed by the JICA Study are located surrounding Godey Town. There are no pipelines connected to them. The new distribution pipeline will extend to each of the public taps and connect to them.

4.7 Cost estimations

a. Project cost

The project cost of Godey town water supply plan is estimated as in the following Table 4.3.

Table 4.3: Estimated Project Cost of Godey Town Water Supply Plan

(Unit:USD)

Item	cost	Foreign Component	Foreign	Local
1. Construction cost				
1.1 Direct cost				
(1) Riverbed protection	5,500	40%	2,200	3,300
(2) Intake canal	37,500	40%	15,000	22,500
(3) Settling basin	26,300	40%	10,520	15,780
(4) Pump house				
1) Pump house	37,700	40%	15,080	22,620
2) Pump, pipe, fittings	245,900	97%	238,523	7,377
(5) Generator house				
1) Generator house	29,200	40%	11,680	17,520
2) Generator and fittings	72,800	97%	70,616	2,184
(6) Sedimentation pond				
1) Civil works	135,300	40%	54,120	81,180
2) Pipe and fittings	62,500	97%	60,625	1,875
(7) Rough filter				
1) Civil works	166,200	40%	66,480	99,720
2) Pipe and fittings	157,400	97%	152,678	4,722
(8) Slow sand filter				
1) Civil works	320,100	40%	128,040	192,060
2) Pipe and fittings	119,000	97%	115,430	3,570
(9) Clear water reservoir				
1) Civil works	132,000	40%	52,800	79,200
2) Pipe and fittings	47,000	97%	45,590	1,410
(10) Transmission pipeline	1,429,600	70%	1,000,720	428,880
(11) Elevated reservoir				
1) Civil works	229,500	40%	91,800	137,700
2) Pipe and fittings	32,200	70%	22,540	9,660
(12) Distribution pipeline	1,660,700	70%	1,162,490	498,210
(13) Public tap	56,700	40%	22,680	34,020
(14) Cattle trough	13,500	40%	5,400	8,100
(15) Other	251,400	70%	175,980	75,420
sub-total	5,268,000		3,520,992	1,747,008
Average			67%	33%
1.2 In-direct cost				
	1,775,000	67%	1,189,250	585,750
Construction cost total	**7,043,000**		**4,710,000**	**2,333,000**
2. Engineering service (15% of construction cost, rounding up of the last three digits)				
	1,057,000	**67%**	**708,000**	**349,000**
3. Administration and Contingency (15% of construction cost, rounding up of the last three digits)				
	705,000	**67%**	**472,000**	**233,000**
Total cost	**8,805,000**		**5,890,000**	**2,915,000**

b. Implementation plan

Implementation of the construction of water supply facilities is classified into mainly design stage (design, tender documents preparation, tender, contract with a construction company) and construction stage (implementation of the construction, trial operation of the facility, completion, supervising of the construction).

It is considered that design stage for the project of Godey Town will take 16 months. Duration of the construction will differ from formation of construction team. In this plan, it is assumed that one team is arranged for intake, purification and transmission facilities construction, two teams are arranged for distribution facility construction (including transmission pipe), one team is arranged for public taps and cattle trough construction, therefore the construction will be implemented by a total of four (4) teams. Under this construction plan, implementation of the construction will take 26 months.

In the implementation of construction, procurement of materials and equipment that are needed for the construction will be extremely critical for the implementation schedule and length of the implementation. Materials and equipment which are not manufactured in Ethiopia and not easy to procure in the Ethiopia local market such as ductile iron pipe (DIP) and steel use stainless (SUS) pipe, submersible and surface pumps and generators must be procured from foreign countries, therefore it is considered to need time. Especially on the pipeline works of the project of Godey Town, total pipeline is estimated to be more than 46 km, thus procurement of pipe materials will need time regardless of procurement in Ethiopia or from foreign countries. In addition to this, total main pipeline as important facilities is approximately 8 km and DIP will be used for this main pipeline. DIP is not manufactured in Ethiopia, therefore it will be needed to procure from a foreign country. Implementation schedule is considered taking into account procurement of these materials and equipment.

c. Rate of price change and the project cost including price change

Ratio of price change is estimated in Ethiopian local currency (ETB) and foreign currency (USD).

Ratio of price change in local currency (ETB) is estimated based on a consumer price index published by the Central Statistical Agency of Ethiopia (CSA). Ratio of price change in local currency (ETB) is estimated to be 11.3 % per year based on the consumer price index from January 2012 to March 2013.

Ratio of price change in foreign currency (USD) is estimated based on the projection of a consumer price index of major advanced economies published by the International Monetary Fund (IMF). In the projection, 2013 is 1.6 % and 2014 is 2.0 %. Therefore based on this projection, ratio of price change is set as 1.8 % per year on average for 2013 and 2014.

Price change of the engineering service is taken into consideration of the period from May, 2013 (time of the cost estimation) to estimated commencement of the design stage. And price change of the construction cost is taken into consideration from May, 2013 to estimated date of tender for the construction

The project cost of each year including price change is as follows;

Table 4.4: Project Cost for Each Year including Price Change

(Unit:USD)

Western calendar (year)	2015	2016	2017	2018	Total including price change	Total not including price change
1.Construction cost		2,680,000	2,680,000	2,669,000	8,029,000	7,043,000
Foreign		1,650,000	1,650,000	1,650,000	4,950,000	4,710,000
Local		1,030,000	1,030,000	1,019,000	3,079,000	2,333,000
2.Engineering service expenses	282,000	282,000	282,000	297,000	1,143,000	1,057,000
Foreign	182,000	182,000	182,000	183,000	729,000	708,000
Local	100,000	100,000	100,000	114,000	414,000	349,000
3.Administration expenses and contingency	192,000	192,000	192,000	186,000	762,000	705,000
Foreign	122,000	122,000	122,000	120,000	486,000	472,000
Local	70,000	70,000	70,000	66,000	276,000	233,000
Total	474,000	3,154,000	3,154,000	3,152,000	9,934,000	8,805,000

d. O&M work for the water supply facility and O&M cost

The results of the study of operation and maintenance work and personnel required for each of the proposed water supply systems are presented based on the examination of the proposed facilities in the systems. In addition, the cost of the proposed operation and maintenance plan of the water supply systems based on the details of the facilities and the implementation plan have been estimated. It is a prerequisite to improve the existing organizations and staff concerned with operation and maintenance of water supply facilities. Thus, in every type of work the operators do, a chief was assigned and provision of appropriate training was planned. In order to supply materials and equipment necessary for the operation and maintenance work, it is desirable that SRWDB should procure such items according to the schedule and deliver them to site on time. And in the planning and cost estimation work, all the regular O&M work is assumed to be conducted by Godey town water supply utility office for convenience including the maintenance work of the major part of the system.

The work items of O&M in each facility are as follows;

- Intake canal (Sludge removal, Screen cleaning), Settling basin (Sludge and garbage removal)
- Pump house (Pump management, Pump spare parts replacement, General guarding)
- Generator house (Generator operation, Generator maintenance, General guarding)
- Sedimentation pond (Sludge removal, Coagulant and lime dosing, General guarding)
- Rough filter (Surface sludge removal, Filter cleaning, General guarding)
- Slow sand filter (Surplus sludge removal, Filter layer conditioning)
- Treated water reservoir (Tank cleaning, Chlorine dosing, General guarding)
- Reservoir 1 (Tank cleaning, Level check and valve operation, General guarding)
- Reservoir 2 (same as above)
- Reservoir 3,4 (Tank cleaning)
- Pipe system (Repair and replacement)

The type of work and number of staff members required for each of the component facilities of the proposed system are shown in more detail in Table 4.5. The cost of O&M for the town

was calculated based on the data following the cost items below.

1) Personnel (regular staff directly involved in O&M of the facilities)

2) Materials (Tools and materials necessary for O&M)

3) Fuel and electricity (Fuel for generators and electricity bill for pumps)

4) Chemicals (chlorine for household use, and treatment chemicals for the plant)

5) Spare parts (consumables and spare parts for generators and pumps)

Table 4.5: O&M Cost of Godey Town (2013 year)

Cost item	Amount (Birr/year)	Remarks
Spare parts	22,272	spare parts for generators and ground pumps
Power supply	2,211,840	fuel and electricity bill for generators and pumps
Personnel	954,096	salary of field staff and daily workers
Chemical	707,724	cost of water treaement chemicals
Consumable	33,372	tools for cleaning work
Others	0	
Total	3,929,304	Equivalent to approx. US$ 212,000

Conditions of estimation
- Cost includes VAT and based on 2013 prices
- Cost was calculated as annual average over 10 year
- Cost covers all the facilities in Jarar valley includig those constructed by UNHCR until April 2013
- Cost is for the regular operation of the system and does not include major facilities/equipment replacement

4.8 Operation & maintenance and management

According to the present condition of the O&M of the existing water supply system, the number of staff members who manage each facility of the system is 15 in total and it is not sufficient. Currently, due to the short operation time and omission of use of necessary water treatment chemicals, the system is being operated somehow by this staff only. However, the operators at the pump station are forced to work long hours due to the insufficient work force, which is an issue in regards to staff assignment. Also the financial study pointed out that the office's indoor staff cannot properly perform accounting and financial management.

As for the resident group for management of public water taps in the town, as explained above, the water points are currently being managed by caretakers. The shift in the current management system towards that by WASHCO under the region's new policy is considered to have some challenges.

The town water supply utility office has as a problem of staff with insufficient education as a whole. In fact, some security guards without decent primary education become operators after they have worked many years with the operators. The situation makes it difficult for the office to cope with various technical challenges. The new water supply system of the master plan to be constructed does not involve any advanced or new technologies, however the

office will have to handle a much larger system and have to properly do the dosing of water treatment chemicals that their staff has long neglected. The task requires the input of a large amount of three different chemicals during the water treatment process in order to cope with the high turbidity of the source water. The input also needs to be done in accordance with the daily turbidity level and flow rate of the system. In addition, the fundamental equipment such as generators is not regularly maintained properly at present, the condition may cause frequent problems with the equipment and furthermore, the staff is not likely to handle the repairs when the problems happen.

For successful operation of the system in future, it is essential for the Godey Town administration to secure the field staff that has been proposed in the master plan (refer to chapter 3 of volume 3) and it is also critical to implement all the training that was proposed in the master plan. In other words, it can be stated that the project can be feasible under the conditions that these measures are properly taken.

4.9 Environmental and social consideration

4.9.1 Results of environmental and social impact assessment

The negative impacts that may be caused by the proposed water supply plan in Godey Town are summarized in Table 4.6.

Table 4.6: Result of Scoping for the Water Supply Plan in Godey Town

	No.	Impacts	Rating		Brief description
			Const-ruction phase	Opera-tion phase	
Social Environment	2	Local economy such as employment and livelihood	**d**	**c**	There would be some job opportunities provided to locals by water users' groups. On the other hand, livelihoods of managers of current water sources and retailers may be adversely affected due to the new facilities. Therefore, it is recommended to monitor their economic and working conditions in the operation phase.
	5	Existing infrastructures and services	**c**	**d**	There would be some interference with construction vehicles and obstruction of traffic in case pipes would be laid crossing village roads. However, since there are almost no paved roads in rural areas, the burying work of a pipe crossing the road should be finished in a short time.
	22	Air pollution	**c**	**d**	There will be some exhaust emissions from trucks and machineries during the construction work, and diesel generator of Level-2 facility emits exhaust gas, which contains SO_X and NO_X gases. Therefore, SRWDB should monitor ambient air quality regularly in conformity to Pollution Control -proc # 300/2002.
	26	Increase of noise and vibration	**c**	**d**	Since heavy machineries will be operated during construction phase, noise and vibrations will occur; however, the duration is quite limited.
	30	Increase of Accidents	**c**	**d**	Traffic accidents are likely to occur due to the increase of construction vehicles during the construction phase and container trucks at the operation phase.

Rating

a: Significant negative impact is expected.

b: Negative impact is expected to some extent.

c: Extent of negative impact is unknown.

(A further examination is needed, or the impact could be clarified as the study progresses)

d: No impact or negligibly small impact is expected.

4.9.2 Mitigation

As the results of assessment of water supply plan, there is no deep impact (a evaluation) and middle degree impact (b evaluation) in the construction and operation stages. The small negative impact or no information at the present time was recognized in the five items. So Table 4.7 shows the mitigation measures and monitoring for key adverse impacts which were proposed in Table 4.6. Also, the recommended surveys at the following implementation phase are explained.

Table 4.7: Proposed Mitigation Measures, Monitoring and Surveys

Impact items	Rating	Proposed mitigation measures, monitoring and surveys
1) Construction phase		
Existing infrastructures and services	c	• To draw up a proper implementation plan to reduce traffic congestion. • To disseminate information on a construction plan (schedule, traffic restriction section, etc.) through public consultation meetings. • To consider the installation of a fence to protect the school-commuting routes.
Air pollution	c	• To provide proper construction machines and heavy vehicles in order to reduce the emission of exhaust gases. To maintain construction machines and heavy vehicles properly. To stop unnecessary idling. • To keep down dust by watering during the dry season. • To reduce the emission of air pollutants by utilizing low-emission construction machines and vehicles.
Noise and vibrations	c	• At the following implementation phase, conduct the noise and vibrations survey in order to understand the current baseline condition of the project sites. • To estimate the levels of noise and vibrations based on the predicted traffic flow, and to study the measures if necessary. • To inform construction schedule to residents in advance. To control construction works at night. • To use low-noise construction machines and heavy vehicles. • To consider traffic regulations on controlling the lane for heavy vehicles to reduce noise and vibrations.
Traffic accidents	c	• To provide pedestrian crossing. Crossing locations should take into account community preference. • To determine the routes for construction vehicles through the meeting with residents. • To disseminate information on a construction plan (schedule, traffic restriction section, etc.). • To provide adequate education and training to construction workers regarding traffic safety. • To deploy the traffic control workers and install an information board at appropriate positions to avoid traffic accidents. • To control traffic flow collaborating with traffic police.
2) Operation phase		
Employment and livelihood	c	• To disseminate information on a construction plan (schedule, traffic restriction section, etc.) through public consultation meetings. • SRWDB should monitor their economic and working conditions after relocation. • SRWDB should assign a grievance team for project affected persons (PAPs).

4.10 Economic and financial evaluation

Out of several economic benefits of the project, only benefits of time saving for fetching water and health improvement benefits have been included in the calculation of economic indicators. Time saving, therefore, will be the difference between the time spent in the rainy season and the same in the dry season, namely 2.4 hours on average per household. The value of time saved on fetching water will be 50 Birr (100 Birr x 50 %) per day or 6.25 Birr per hour. Consequently, time saved of 2.4 hours per day will have the value of 15 Birr per day

per each household. Assuming that there will be at least 300 days of productive activities in a year, the value of time saving will be 4,500 Birr (USD 242.85) per year.

Regarding health improvement benefits, provision of a clean water supply will lead to the reduction in the incidence of water related diseases. It is assumed that provision of clean water supply will lead to 10% reduction in medical expenses every year in the target communities. Economic analysis has been conducted on the basis of the annual costs and benefits stream as estimated in the preceding sections. The result of the computation indicates that the project is economically feasible as the EIRR exceeds the opportunity cost of capital of 10 %.

The total capital costs of the project amount to 8,805,000 U.S. dollars (USD) including engineering services and administration costs. It is the policy of the Government of Ethiopia that the Government shall finance the capital costs of water supply projects under the condition that each local community will be responsible for operation and maintenance costs of the water supply facilities. However, it is desirable to discuss the donor assistance in case of high project cost. Financial cost benefit analysis in terms of Financial Internal Rate of Return (FIRR) has not been applied in the evaluation as water revenues generated from the proposed project is not sufficient to cover the whole project costs. As a result of the comparison between the annual O&M cost and water fee to be collected by the water users for the four cases above, it is judged impossible to cover the O&M cost by a 100% collection of the water fee that is set at the present rate of 15 Birr/m^3 or less.

As a result of the comparison between the annual O&M cost and water fee to be collected by the water users for the four cases above, it was judged impossible to cover the O&M cost when the water rate is less than 30.9 Birr even a 100% collection is achieved. On the other hand, with the water rate being 50 Birr/m^3, it is possible to cover the O&M cost even at 62% collection ratio. In general, 100% recovery ratio is not realistic in developing countries. The study result suggests the current recovery ratio in Godey Town is 60 to 70%.(refer to “water fee collection” in chapter 9 of F/S) and 62% of recovery appears realistic. Therefore, the project can be said valid in terms of financial recovery of O&M cost.

Meanwhile, the ability to pay for water of households in developing countries is reported to be from 3 to 12% of their annual income by some studies conducted by UN related agencies. In the case of Godey Town, if the ability to pay of households is assumed to be 8% of their annual income, they will be able to pay 202 Birr/month. Since an average household of six members uses 3.6 m^3 of water per month and its cost is 180 Birr. Thus, it is sufficient to pay for the cost of water.

Chapter 5

Conclusions and Recommendations

5 Conclusions and Recommendations

5.1 Study conclusions

5.1.1 Groundwater utilization potential survey

The groundwater utilization potential evaluation map (GUPE map) for the area of Jarar valley and Shebele River sub-basins was created in accordance with the classification of aquifer evaluated by using the yield of wells, groundwater level and water quality. The scale of the map is 1:250,000 to show the combined areas of the above two major basins. The map was prepared with a relative classification indices because only little quantitative data is available. The following items were inferred from the map;

- The aquifer with good water quality and middle to high productivity are distributed along the Jarar valley and on the highlands along the left bank of Jarar valley from Kabribeyah woreda to Kabridahar woreda. On the other hand, on the right bank of Jarar Valley, aquifers with low water quality having low productivity or those with medium water quality and productivity are distributed in an elongated area. In the area on the south of Kabridahar woreda, low productivity aquifers with high water quality are distributed along the left bank of Jarar Valley in limited areas. Also areas with low productivity and bad water quality are sporadically found in the same area.

- The gypsum layers are widely distributed along the Shebele River area. The area shows medium productivity of water but since the water quality is very poor, it is not suitable to use it for drinking. The groundwater potential is low along the Shebele River, but the potential of the surface water is considered intermediate.

On the other hand, the water resources information map (WRIM) was compiled for the entire Somali Region through discussions of the water resources potential and water quality in reference to the GUPE map above. The findings extracted from the maps are as follows;

- Topographically, the focus was placed on the lowland planes in particular in regard to the shallow groundwater potential, and potential shallow groundwater extraction points were selected, in consideration of the existence of perennial rivers and flat lands that exist at on the boundary with steep-slope areas. Consequently, the areas with high potential of shallow groundwater were located and they are scattered in small spots along the Jarar Valley size in the highland and hill areas.

- The areas with high or relatively high water resource potential are distributed widely in the south western side of the Shebele River sub-basin except for Ogaden area in relation to the potential evaluation of water resources in Somali Region according to the WRIM. However, the water quality in these areas is quite poor. In Jarar Valley area, the water resources potential is expected to be from medium to relatively high. The water quality is good in general. Some areas have large variation in water quality.

Since the WRIM and the GUPE map have similar information for Jarar Valley and Shebele River sub-basin, the WRIM is very likely to be utilized for evaluation of the entire Somali Region.

5.1.2 Water supply plan

The plan and design of water supply facilities for each one of urban and rural areas of the 16 woerdas were illustrated as design outline maps that took into consideration not only the basic approach for facilities designing but also geomorphological, geological, and water resources information based on the results of the survey and analysis for water supply plan.

The project cost was estimated based on the number of materials. The implementation plan of the projects were prepared in reference to the cost estimation. The period of project implementation was planned to be seven years from 2014 to 2020. The main project costs are 1,870,000 USD (project term: 2 years) for Kabribeyah town, and 8,805,000 USD (Project term: 4 year) for Godey town. The project cost of woredas including urban area is 1,685,000 USD for Birqod woreda as the minimum cost, and the highest project cost is 14,664,000 USD for Kabribeyah woreda excluding its urban area.

The cost of the proposed operation and maintenance plan of the water supply systems based on the details of the facilities and the implementation plan have been estimated. The cost of O&M was calculated based on the cost items such as personnel, materials, fuel and electricity, chemicals and spare parts. The replacement cost was also calculated separately from the O&M cost. The ratio of O&M cost to the project cost is about 3.4% on average as the whole woreda. The ratio of O&M cost to the project costs of the main towns are 9.6% for Kabribeyah town, and 4.5% for Godey town in consideration of price change. Those for the main woredas are 5.4% for Birqod woreda, and 4.4% for Kabribeyah woreda. The ratio of O&M cost of Kabribeyah town project is a little higher. This is because the O&M cost is applied to the existing facilities as well, while the size of the project (new construction) for Kabribeyah town is small.

In the entire woredas, the benefits of time saving for water fetching and health improvement have been included as economic benefits. The value of time savings was measured from the average time saved multiplied by the economic labor cost. Consequently, the saved time of 2.4 hours per day on average was converted to the value of 15 Birr per day (100 x 0.5 x 2.4/8) per each household. Health improvement benefits were derived from an improvement in water quality and increased supply of water. It was assumed that provision of clean water supply would lead to a 10% reduction in medical expenses every year in the target communities.

The results of the economic analysis signify that the economic viability of the majority of the projects is secured as the EIRR exceeds the opportunity cost of capital of 10%. This evaluation is considered appropriate.

The total capital costs of the projects covering 16 target woredas amounts to about 110,000,000 USD. It is the policy of the government of Ethiopia that the government shall finance the capital costs of water supply projects under the condition that each local community will take on the duty of operation and maintenance work and pay for the O&M costs. However, it is better to discuss possibility of obtaining donor assistance in case the capital costs are considered too large.

Financial evaluation in terms of Financial Internal Rate of Return (FIRR) has not been applied to analyze the recovery of the project cost, as the revenue generated from the proposed projects is far from sufficient to cover the whole project cost. The comparison of the expected water fee to be collected from the water users at 20 Birr per m^3 and the amount

of operation and maintenance (O&M) cost required each year indicates that the former exceeds the latter every year. The calculation also shows that even if the water fee recovery rate is max 86% and min 18% in the 16 woredas, the collected water fee will be sufficient to cover the annual O&M cost.

In Kabribeyah town, benefits of time saving in water fetching and health improvement have also been included in the calculation of economic indicators. The result of the computation indicates that the project is economically feasible as the EIRR exceeds the opportunity cost of capital of 10 %. This procedure is considered appropriate.

The total capital costs of the project for Kabribeyah town amounts to 1,870,000 U.S. dollars including engineering services and administration costs. It is the policy of the government of Ethiopia that the government shall finance the capital cost of water supply projects under the condition that each local community will be responsible for operation and maintenance costs of the water supply facilities. However, it is desirable to discuss possibility of obtaining donor assistance if the project cost is judged too large. Water tariff of 10 Birr per cubic meter which is the current tariff in Kabribeyah town was used to calculate the financial indicators. The result of the computation revealed that the project has a FIRR of 6.1 % under the condition that the recovery of water fee is 100 %. However 100% collection of water fee is not realistic.

To sum up, it is better to discuss receiving financial assistance from donors, even if the budget of SRWDB is partly utilized to realize the project.

5.1.3 Operation and maintenance of water supply facilities

As a result of this study, the condition of the operation and maintenance of water supply facilities in the study area is summarized as follows.

a. Summary of the results

The capacity of the governmental bodies of woreda water offices, town water supply utility offices, and SRWDB is low. In addition, the capacity of the resident groups, WASHCO, is also low. These organizations somehow manage to maintain the existing water supply facilities to keep the target water supply ratio. However, they are heavily dependent on large amount of external aids, and thus, it is difficult to cope with emergency water needs in the case of droughts. The ultimate cause of this situation is the shortage of budget for water supply of SRWDB. The other very important issue is the low level of education of the staff in various organizations. Lack of sufficient education of the staff prevents them from logically solve problems and from upgrading knowledge and skills on their own. The condition also creates the situation where the staff members cannot appropriately manage money and items. The specific problems each of the organizations face are summarized in the following sections.

a.1 Management of facilities at the resident level

For the management of water supply facilities by the residents, it is necessary to shift the current system of management by caretakers to the management system by WASHCOs. To realize this, human resources for provision of future WASHCO training at woreda and zone levels is urgently needed to conduct the training at many sites as soon as possible. Also it will be necessary to conduct awareness raising campaign to facilitate the process of shifting

management from the caretaker system to the WASHCO system. It takes a fair amount of time to change the mentality of the people because the target population is large. Nevertheless, the result of the WASHCO training associated with the pilot project in this study indicates that the training is effective in changing their attitudes even if conducted only for a short time.

a.2 Management of facilities at woreda and town levels

Woreda water offices are extremely weak in terms of human resources and of equipment. Thus it is mandatory to provide technical training along with supply of a set of minimal equipment and tools to perform their new duties after BPR. Town water supply offices are more or less in the same situation. Thus, for Kabribeyah and Godey towns, a mid-term capacity development plan has been proposed for their staffs to enable them to perform the operation and maintenance of the facilities proposed in the master plan.

a.3 Management of facilities at the regional level

Due to the lack of sufficient staff training and appropriate equipment, the workshop of SRWDB is forced to repeat ad-hoc and reactive maintenance work and they can not fully utilize the pumps and generators that have been procured. In order for the SRWDB workshop to be able to exercise its high level of techniques and solid organizational effect, as the primary organization concerned with the O&M of water supply facilities, it is necessary for the whole workshop (including the management) to first change their perception of maintenance work and then, to make effort to establish the system of conducting regular and planned maintenance work. It is also expected that the workshop will self-improve their technical capacity by taking advantage of the tools and equipment supplied to the workshop in this study. In this study, in connection with the O&M of the master plan facilities, a mid and long-term technical training that will be necessary in the long run has been proposed.

In order to actually implement the planned construction and expansion of water supply facilities in the 16 woredas and two towns, and then, to realize proper O&M of the facilities, first the appropriate budget should be secured and the O&M work has to be conducted accordingly. In consideration of this, the work and activities that will be necessary for construction and O&M the facilities in the woredas and the two towns were identified in this study. Then, the cost of conducting such O&M work was estimated.

b. Future direction

In this study, a set of vehicles and equipment to be used for emergency water supply activities and regular O&M activities were provided to SRWDB, the main counterpart body of this study. In addition, some training on the use of the equipment was conducted for the staff of SRWDB and some other organizations concerned although the training was short. So, SRWDB, by itself, is expected to continue similar measures intended to develop the capacity of its technical staff, now that the training has been conducted by the study team. In the study, the type of work and staff assignment necessary to operate and maintain the facilities proposed in the master plan was clarified and the cost required to conduct the work was also estimated. This is considered to be the important basic data when SRWDB prepares its own O&M and capacity development plans.

5.1.4 Feasibility study of Godey Town

a. Conclusions

Presently, the Shebele River water is the only water source for Godey town. The intake site is located upstream of the existing free water access points. A retaining wall along the river slope was planned due to protect against erosion by violent river stream flows in the rainy season. For other facilities, the pump station plan suggests the intake pumps and distribution pumps are installed at the same place. Although commercial power line is expected to be extended to the town in the near future, it is risky to rely on the uncertain power source at this moment. Thus, the power supply plan was formulated to employ generators as the power source in the study. A rough filter facility and slow sand filter facility were planned in the purification plant by using generator due to unavailability of 24 hour-electric power supply. The transmission pipeline starts from the surface pump station and the total length is 4,998 m. The total reservoir volume in 2020 was designed to be 800 m^3. The existing three reservoirs are located at the same point; two of them are elevated types and will be used for backup purposes. The new reservoir of 400m^3 capacity of elevated type will additionally be used to supply water. The new one supplies water for higher elevation area of the town. The existing 1,000m^3 reservoir will supply water for lower areas of the town. The boundary of the two water supply areas (high and low) is set at elevation 293m. The water stored in the existing reservoir will service the areas with less than 293m elevation. The new distribution pipelines are planned to replace the existing deteriorated ones to expand the distribution area. Besides, the five public taps constructed in the JICA Study are located in the outskirts of the town. There are no pipelines close to them. New distribution pipelines will be extended to each of the public taps to supply water to them.

The project cost was estimated based on the total amount of number of water supply facilities. The project implementation period was estimated to be 4 years from 2015 to 2018. The basic project cost is USD 8,805,000 (project cost including price change: USD 9,934,000).

O&M cost was calculated based on the personnel, materials, fuel and electricity, chemicals and spare parts required to directly operate the system. The ratio of the O&M cost to the project cost is about 4.5 % in consideration of price change. The current O&M ability is very low and therefore, for successful operation of the system in future, it is essential for the Godey town administration to secure the field staff that has been proposed in the master plan of the Study and it is also critical to implement all the training that was proposed in the master plan. In other words, it can be stated that the project can be feasible under the conditions that these measures are properly taken.

At this stage, no possibility of negative social and environmental impacts due to the project construction was indicated in the survey of IEE level. However, the small negative impacts in regard to the local economy such as employment and livelihood during the operation stage has been pointed out and it is necessary to take measures to ameliorate the effect. There is no serious impact in the environmental and social consideration. However it is important to set up rules under construction for the mitigation measures.

Benefits of time saving in water fetching and health improvement have been considered in the calculation of economic indicators in the economic evaluation of the project. The result of the computation calculation indicates that the project is economically feasible as the EIRR exceeds the opportunity cost of capital of 10 %. The results of EIRR indicate that the economic evaluation is appropriate.

The total capital costs of the project amount to 8,805,000 US dollars (USD) including engineering services and administration costs. It is the policy of the Government of Ethiopia that the Government shall finance the capital costs of water supply projects under the condition that each local community will be responsible for operation and maintenance costs of the water supply facilities. However, it is desirable to discuss donor assistance in the case where the project cost is high in comparison with the capacity of the municipality. Financial cost benefit analysis has not been performed to evaluate the financial capacity of the water supply utility office to recover the cost of the proposed project because it is apparently not possible to recover the whole project costs. However, as a result of the comparison between the annual O&M cost and water fee to be collected by the water users, it is judged impossible to cover the O&M cost by a 100% collection of the water fee that is set at the present rate of 15 Birr/m^3 or less. In the calculation, the collected water fee can over the O&M cost if 100% collection of water fee set at 30.9 Birr/m^3 is achieved. The calculation indicates that, for the water fee that is set at 50 Birr/m^3, if 62% of the bill is collected, it can cover the O&M cost, and thus, the project can be judged valid in terms of the financial O&M cost recovery. Meanwhile, the ability to pay for water of households in developing countries is reported to be from 3 to 12% of their annual income by some studies conducted by UN related agencies. In the case of Godey town, if the ability to pay of households is assumed to be 8% of their annual income, they will be able to pay 202 Birr/month. Since an average household of six members uses 3.6 m^3 of water per month and its cost is 180 Birr. Thus, it is sufficient to pay for the cost of water.

b. Main discussion in future

The items which are necessary to discuss in future in reference to the results of feasibility study for the Godey town project are as follows;

- Usually, a slow sand filtration facility is planned together with a rough filter pond for a purification plant plan. Normally, slow sand filter is not recommended intermittent operation and is planned with 24-hour operation as a precondition. However, it is quite difficult to establish 24-hour operation system under the current Godey town's electricity situation. The Godey water supply plan is formulated to 24-hour operation time taking into consideration of electrical condition, therefore, slow sand filter operation will be conducted by using generator. It shall be necessary to compensate its function by sufficient filter management. Besides, too vast area is required for slow sand filter system in comparison with rough filter system. It shall be also necessary to conduct manual maintenance works for all filters. Operation and maintenance works are largely affected to slow sand filter's operation at this moment. Therefore, it shall be necessary to establish and strengthen operation and maintenance organization. It is quite difficult to conduct effective slow sand filter operation if their capacity will not be improved.

- In the distribution pipeline plan, the terminal water supply facilities are classified into three types: the house connection, yard connection and a public tap based on the design standard (*Project design, financial and economic feasibility study, vol.1 tool kits and annexes, MoWE, 2003*). The house and yard connections in principle utilize the pipeline from the main line. Thus, the cost of the pipe branching and connection should be paid by the user as a rule. In that case, it is anticipated that the users will feel reluctant to have the connections, which may result in decrease in the access ratio of water supply. In any event, the rule should be clarified and it is necessary to discuss sharing of the cost of the connections with water utility office for example.

5.2 Recommendations in future

5.2.1 General

The items dealt with in these recommendations are some issues for water sector in Somali Region. The main issues are that there are few accurate potential maps and no diffusion for such maps in regard to the water resources, no arrangement of feasible water supply plan in many woredas and representative towns, and vulnerability of O&M from aspect of soft and hard situations in the existing water supply facilities, in particular Jarar valley water supply system. We would like to recommend for the water resources development and management in Somali Region from now by the arrangement of following items.

5.2.2 Better potential evaluation map utilization for water resources

There are not so many existing evaluation maps for the water resources potential in Somali Region. The regional hydrogeological map covering the whole of Ethiopia was published by the geological survey of Ethiopia as [Hydrogeological map of Ethiopia (scale; 1:2,000,000), Ethiopian Institute of Geological Survey, 1988] and [Groundwater availability during drought map, Ethiopia Water Security and Drought (scale; 1:2,000,000), DIFD, 2001] was created by DFID as the information of hydrogeological condition. However both maps were not utilized adequately. [Wabi Shebelle river basin integrated master plan, Volume VII Water resources, Part 3 Hydrogeology, WWDSE, 2004] and [Hydrogeological mapping project report, UNICEF, SHAAC, 2009] were utilized as the sample of the regional study relatively. Recently the map of [Hydrogeological Map of South Eastern Ethiopia（scale; 1:500,000）, UNESCO, MOWE, and DFID, 2012」was created for the baseline survey by UNESCO, however it is not published. In this time, [Groundwater utilization potential evaluation map (scale; 1:250,000) for the Jarar valley and Shebele sub-basin] (hereafter the evaluation map), moreover [Water resources information map in Somali Region] were completed by JICA Study Team with the review of existing data and well data and hydrogeological results for water supply plan. The characteristic of these maps created by Study Team targeting sixteen woredas and two towns are as follows;

- Fourteen items of existing well data collected were examined carefully and well data with columnar section were classified strata, and the geological cross sections were described in each woreda.
- The horizontal and vertical distribution of the aquifers was clarified.
- The water quality testing for representative points and comparison of quality and quantity were executed in Somali Region.

Evaluation map was created based on the above maps

And the utilization potential evaluation for the water resources information map was also carried out visibly using second data of remote sensing by comparison of the representative parameter such as topography, geology, groundwater recharge (relation with precipitation and evapotranspiration) and lineament. How to use these evaluation maps from now, the suggestions are as follows;

① 「Water Research Study and Management CP」in SRWDB exists at a center of study for water supply and it is better to create maps and update the data by this core

process division. It is hoped that this core process division in SRWDB can be strengthened because of effective utilization of the evaluation maps by this organization.

② There are many methods of utilization for the evaluation maps, such as diffusion of those maps to each woreda, provision to NGO's and international organizations as water potential information and discussion for the selection of drilling points with Somali Water Works and Construction Enterprise (SWWCE). It is better to add the new staff so as to discuss for the effective utilization of the evaluation maps, if necessary.

③ It is important to contribute to the update of database for the Ethiopian National Groundwater Information System (ENGWIS) project of MoWE as the result of new wells using these evaluation maps in Somali Region.

④ Particular attention needs to be paid when utilizing the evaluation maps, because some woredas may have a possibility to intake water by the effective utilization of the evaluation map instead of water trucking for the emergency water supply

5.2.3 Effective utilization of water supply plan

The water supply plan was done in this time for the sixteen woredas and two towns. The main characteristics of this water supply plan are as follows;

- As the Japanese experts could not come to almost all woredas due to the security problems, water supply plan was considered in line with near the actual conditions using the satellite image for topography and information of the existing wells etc.

- Although the visible maps were created in consideration of the facility distribution plan in water supply plan, it is better to update the documents in accordance with the field conditions by the engineers of SWRDB in future, because Japanese planner could not go to each woreda. due to the security problems.

- The water supply plan is able to utilize in detail not only the actual implementation plan per year, but also the budget implemented by quantity survey when deigning the facilities.

- The plan to deal with the O&M for the facility on the occasion when the water supply plan will be done was considered in response to the activity of WASHCO after the construction of the water supply in pilot project of the Study.

It is better to make plan for the water resources development with the water resources information map in regard to others woredas except the sixteen woredas carried out in this time. The water supply plan is able to use immediately for the other donors because of including the water resources types, quantity of facilities and maps etc.

In regard to the town water supply plan of Kabribeyah and Godey towns, the Jarar valley water supply system in Kabribeyah has the extension plan for the system, and new water supply plan will be considered in reference to the drastic improvement of the current water supply system in Godey town.

The considerable points for the effective utilization of the water supply plan are as follows;

① The extension of Jarar valley water supply system will be carried out in regard to the addition of new water resources, increasing of transmission pipe diameter to pump station, the extension of running time for the surface pump in the station, and improvement of pipe connections in Kabribeyah town. In any event, even if extension works will be implemented by SRWDB or some donors, it needs to keep the collaboration with UNHCR.

② It is desired to budget the water supply plan suggested by JICA Study Team in Godey town. The budget of existing water supply plan is cheaper than that of JICA plan. So it is necessary that SRWDB considers the method to budget the water supply plan carrying out the comparison between existing plan and new plan done by JICA.

5.2.4 Utilization in future for Jarar valley water supply system

The extension of the existing Jarar valley water supply system in Kabribeyah town was suggested by JICA Study Team through the water supply plan and the results of pilot project for the water supply construction. It is shown the important points below in response to the sustainable utilization of Jarar water supply system from now.

UNHCR has the responsibility for the application of the current Jarar valley water supply system built by UNHCR, JWSO has a maintenance works for facility, and Kabribeyah town water supply utility office (commonly called water desk) is responsible for the operation works of collected money partly, operation of facility, cleaning and guard. UNHCR is still considering how to handover regarding the Jarar valley water supply system (OxFam study: Technical and institutional capacity study of Jerer valley water supply scheme, 2007), however there is no definite progress. The target office of handover may be the Kabribeyah woreda administration, woreda water office, and finally the Kabribeyah town water supply utility office is the appropriate target office for the water system. However the discussion for the handover has not made at present because there are a lot of gaps in regard to the O&M for facility, technical skills and management ability of Kabribeyah town water supply utility office. The issues are clarified and suggestion is as follows;

① It is very important to make capacity development for the Kabribeyah town water supply utility office having the responsibility for the operation works in the Jarar valley water supply system. It is necessary to discuss the methodology of technical assistance to Kabribeyah town water supply utility office. It is desired to establish the framework by which SRWDB conducts the technical transfer.

② The discussion directly between SRWDB and UNHCR has not made progress, because there is some difference of response for the host community and refugee or organization (government of Ethiopia and UN organization). So the relationship of both sides is not smooth at present. However it is necessary to support for the technical guidance, monitoring of activity, and evaluation of activity from SRWDB to water desk. So it is desired to discuss with SRWDB and UNHCR directly as soon as possible.

③ The organizational structure for Kabribeyah town water supply utility office was provided by SRWDB in January 2012. This structure is that SRWDB shall mainly follow up, monitor and evaluate the activity of the Kabribeyah town water supply

utility office, provide necessary technical support, and confirm the implementation of the rules, regulations and guidelines for the Kabribeyah town water supply utility office. And also as the points required, UNHCR shall mainly provide subsidiary funds for the overall management and O&M, provide necessary technical support and capacity development for the Kabribeyah town water supply utility office, support in conducting rehabilitation and expansion of facilities. It is necessary to strengthen the technical ability of SRWDB and to assure the budget so that SRWDB can conduct its activities. The income plan of this structure stipulates that the sources of income are to be collected from water sellers, obtained as credit or aid and gifts from governmental organizations and NGOs, also obtained as subsidiary budget from Kabribeyah woreda administration and user community. However the support from Kabribeyah woreda administration to SRWDB including the subsidiary funds of UNHCR temporarily is its actual source of income.

④ According to the organizational structure, the Kabribeyah town water supply utility office intends to establish the organization staff of 90 persons finally so as to assure the strengthening of functions. The first priority is to secure the technical staff. This effective organizational structure from SRWDB for the Kabribeyah town water supply utility office should be implemented actually. If effective organizational structure, O&M, provision of adequate and suitable water supply services and better operation manual and business plans would be able to implemented after carrying out of organizational structure, it is possible to utilize sustainably the Jarar valley water supply system in future.