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

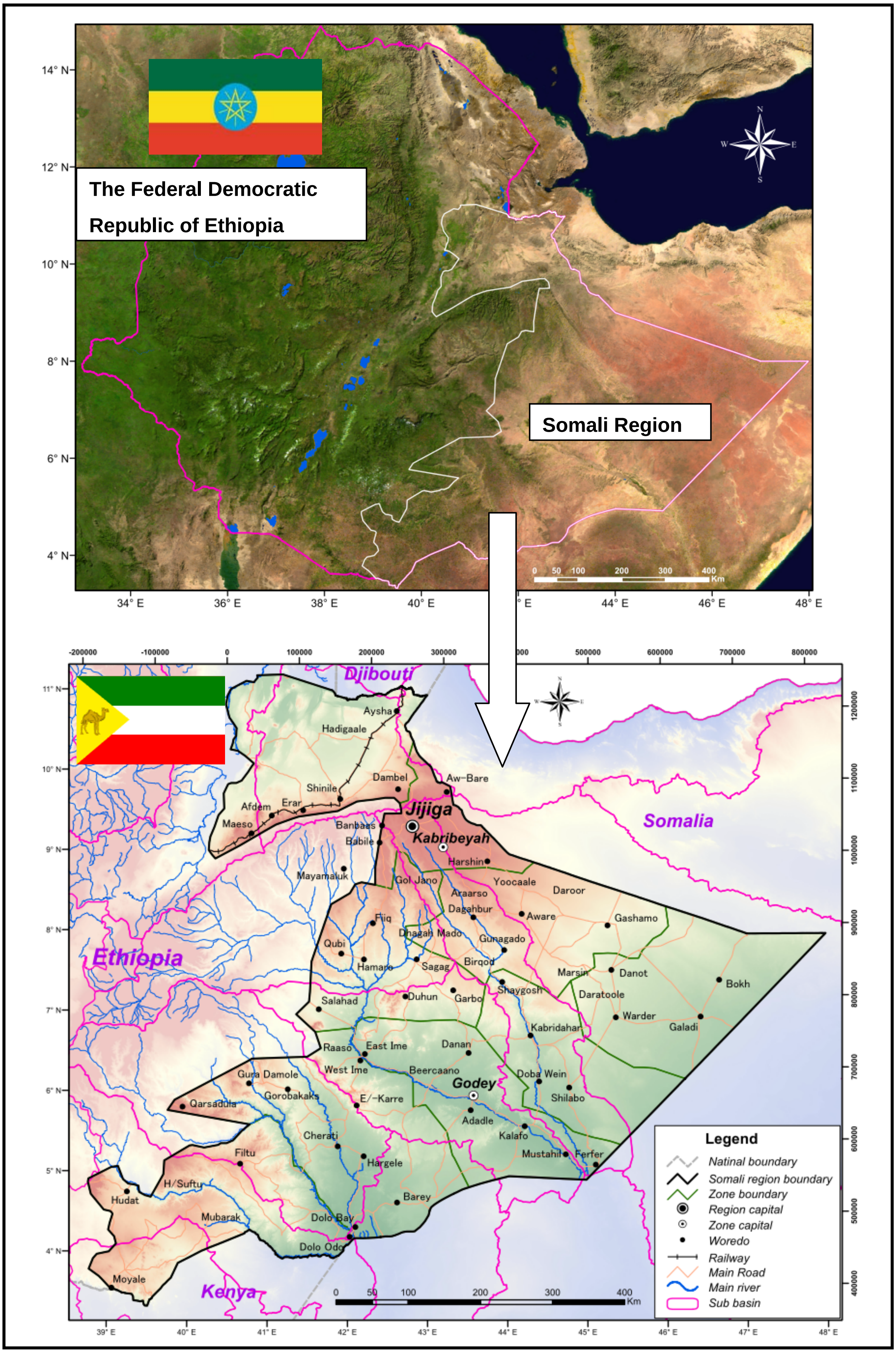
FINAL REPORT (5/7)

FEASIBILITY STUDY ON WATER SUPPLY PLAN IN GODEY TOWN

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	Socio-economic 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

Chapter 1

Summary of Feasibility Study

1 Summary of Feasibility Study

1.1 Introduction

The master plan of water supply for Godey Town was discussed in Volume 2 including the project cost and implementation plan. However, since it is necessary to discuss and assess the O&M aspect and financial evaluation of the plan in order to ensure smooth project implementation in future, the feasibility study report of Godey Town was compiled as a separate volume.

1.2 Objectives of the Study

The population of Godey Town is 29,379 (2012) and is the largest town among the urban areas of the woredas in Shebele River basin. The access ratio to water supply with the current piped water supply system is about 26%, this value is extremely low compared to the average urban water access ratio (74% : 2012) of Somali Region. The water supply system in Godey Town cannot serve the whole Town and the town administration is seriously in need of an improved water supply system. On the other hand, the O&M and implementation capacities of the water supply utility office in charge of the water supply system are very weak. Thus, the main objectives of this study are to verify whether a sustainable O&M system can be established after the implementation of the project and to evaluate if the water supply plan of Godey Town is financially feasible.

1.3 Scope of the Study

The scope of the Study follows the contents of the report 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)" that was prepared based on the results of the record of discussions (R/D) agreed and signed by the Federal Democratic Republic of Ethiopia (Ethiopia) and Japan International Cooperation Agency (JICA) on 23 December 2011.

The general procedure of the study is as follows;

- To calculate the water demand based on the population growth rate and Urban Water Supply Design Criteria.
- To select sources of water supply based on the existing water supply condition.
- To prepare plans and designs for the intake facility, treatment plants, reservoirs, distribution system, public taps and power supply based on the water sources determined in the water supply plan.
- To estimate the project implementation cost based on the capacities of facilities, and to create the implementation plan. To discuss the budget sources based on the project budget plan.
- To examine and evaluate the condition of O&M of the current facilities in the system and also to calculate the O&M cost for the planned facilities.
- To carry out the Preliminary or Partial Assessment Study (IEE in JICA guideline), and to refer to mitigation measures from the view point of environmental and social consideration.
- To carry out the economic and financial evaluation of the water supply master plan.

1.4 Data collection

The main data utilized for the Godey Town survey is the same as the data used for the whole study. The major data used is as follows;

Table 1.1: Data Collected

No	Data item	Data and source
1	Geological map	Geological Map of Ethiopia (Kazmin, 1972; Tefera et al, 1996 Geological Map of Ogaden and Surrounding Area (BEICIP, 1985)
2	Satellite images	SRTM, Landsat, ETE, PALSAR
3	Existing documents	Wabi Sheele River Basin Integrated Development Master Plan Study Project (WWDSE, 2004)
4	Hydro-meteorology	Precipitation data, Evaporation data, Temperature data (National Meteorological Agency), River flow data (MoWE)
5	Facility planning and designing	Standard designs of facilities of SRWDB (2012) Revised UAP (2010) Rural water supply and sanitation design criteria (MoWE, 2005） Urban water supply design criteria (MoWE, 2006)
6	Social and economic	General socio-economic data（This study） Population data（Central Statistical Agency） Price data (This study)

Chapter 2

The Project Area

2 The Project Area

2.1 Location

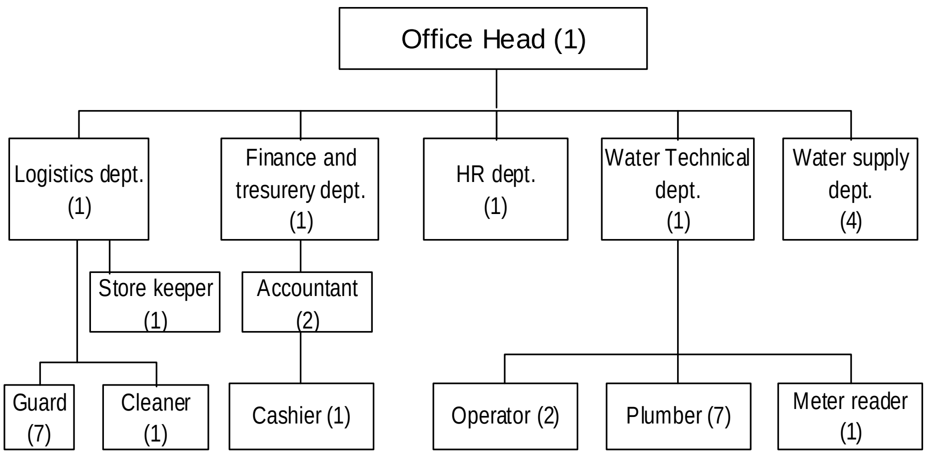
Godey Town is located at the LNG and LAT Coordinates of 43.58N and 5.88E (Godey meteorological station) and is also located slightly to the south from center of Somali Region, along the Shebele River.

2.2 Administrative structure

Godey Town is a new administration that was spun off from Godey Woreda in 2011. The water supply utility office was created at the same time as part of the city administration. The office is in charge of the management and O&M of Godey town water supply system. A water board made up of seven representatives from stakeholders was established as a consultation body about eight months ago but it is not functional yet. Thus the office is temporarily fully in charge of any decision making on the town's water issues. Decisions made by the office have to be ultimately approved by the town council. The head of the office was replaced in January 2013 and the members of the water board were also changed to be the following 10 people.

1. Chairperson: Godey town Mayor
2. Deputy Chairperson: Godey town manager
3. Secretary: Godey town water supply utility office
4. Member: Godey town administration finance office
5. Member: Godey town administration women's affairs
6. Member: Godey town administration health office
7. Member: Godey town administration education & capacity building office
8. Member: Godey town electric power cooperation authority
9. Member: Community elders
10. Member: Women's association

The office has 31 members and 12 out of them are clerical staff members who work inside the office. The office structure is as shown in Figure 2.1. The office shares a building with woreda water office and occupies four rooms including a storage room.



Note: numbers in parenthesis indicate the number of staff members

Figure 2.1: Organizational Structure of Godey Town Water Supply Utility Office

2.3 Topography

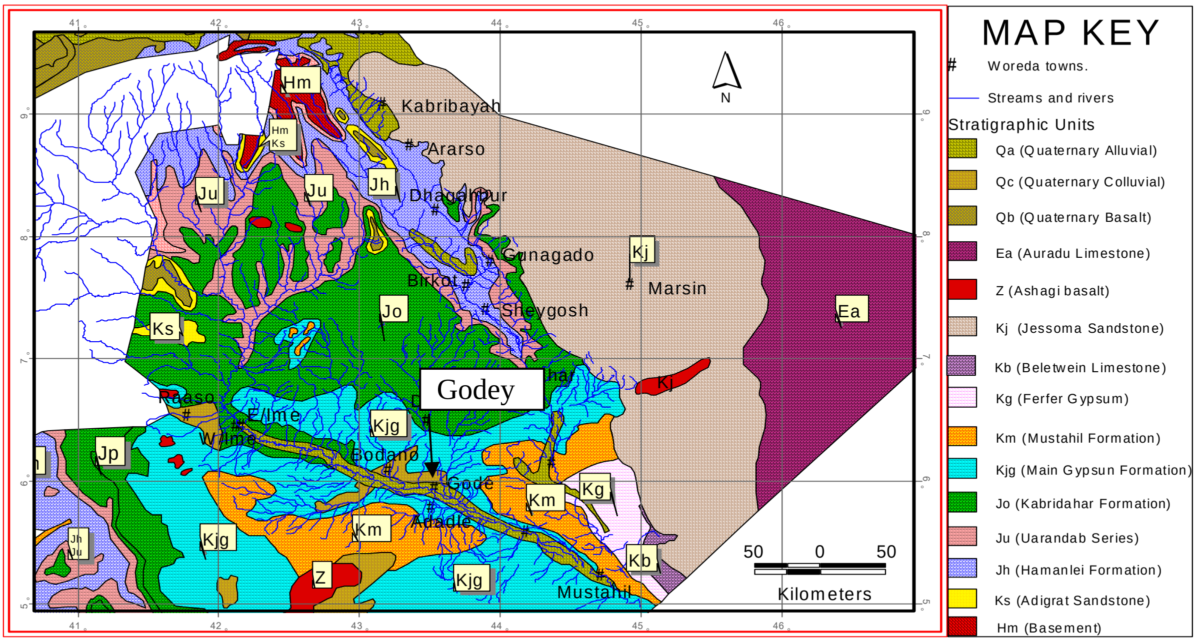
The topography of Godey Town is nearly flat based on the Landsat satellite image (refer to Figure 2.2) and from the field survey. The elevation of the town is approximately 273m-300m amsl. The Shebele River flows in the direction from WNW to east. The lowest elevation was indicated at a point along the Shebele River and the land surface of the town slopes from north to south.

Figure 2.2: Landsat Image (False Color) of Surrounding Areas of Godey Town

2.4 Geology

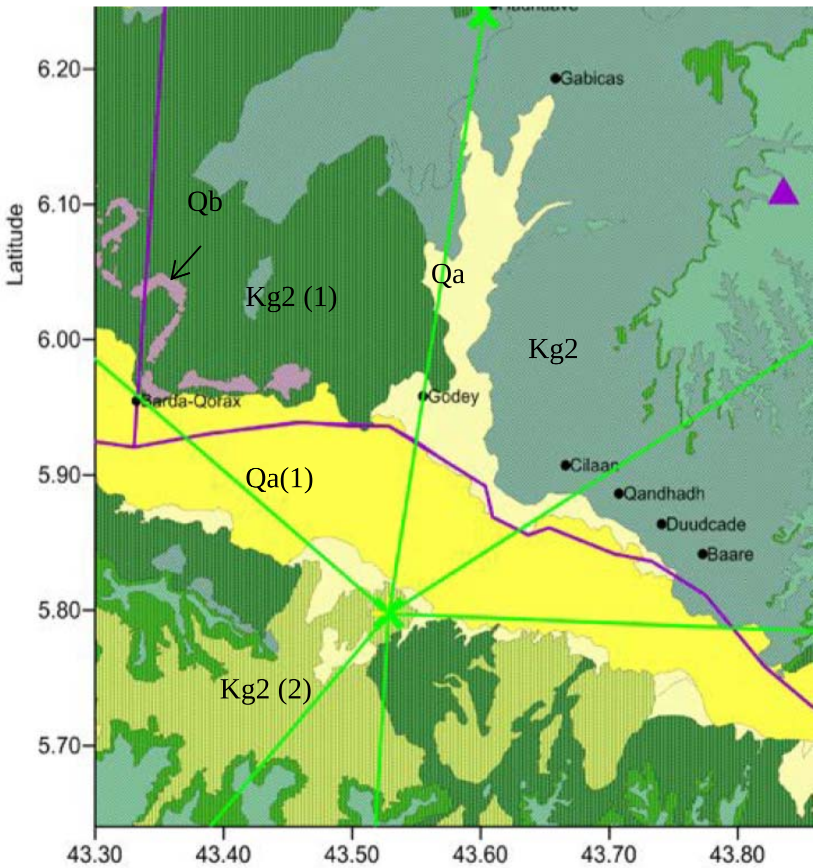
The main geology of Godey Town and its surrounding area consists of the Korahe Gypsum strata of early Cretaceous to late Jurassic widely based on the existing geological map, and these strata were covered with colluvial and alluvial deposits or terrace gravel layer of Quaternary (refer to Figure 2.3). The general topography represented by the formation is undulating plains dissected by a dense network of small, shallow dry stream channels. The upper part is dominantly massive anhydride with some beds of dolomite. The lower part is represented by alternation of dolomitic limestone, marl, shale and anhydride. The total thickness varies from 100 to 150 m but could reach up to 500 m. Owing to the impervious nature of the anhydride, the upper section of the formation can be considered as the largest aquiclude in the Ogaden basin.

The part of topographical and geological analysis of Godey woreda area was shown in Figure 2.4. As mentioned above, Quaternary deposits (Qa) mainly consist of terrace gravel layer. However the thickness of these strata is thin because of less than 2m in depth from surface according to the cross section in the field along the Shebele River.



Modified from Hydrogeological Mapping Project Report (SHAAC, 2009)

Figure 2.3: General Geological Map of Somali Region



Legend above refers to the Table3.2 of Ch3, Vol 3 Longitude

Figure 2.4: Geology of Godey Woreda

Chapter 3

Socio-Economic Survey

3 Socio-Economic Survey

3.1 Methodology of the 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. Interview survey on urban water supply situation

An interview survey was conducted at Godey Town Water Supply Utility Office to obtain basic data on the water supply situation in the urban areas.

Survey items included, among others, population, number of households, availability of water management committee, water use situation, medical and health conditions, major public and private institutions that require water supply.

b. Sample household survey

A sample household survey was conducted at 39 households in Godey town that were selected from the target households in the town.

Main survey items were, among others, family composition, collection of domestic water, distance to water sources, time to collect water, water consumption, water sources in dry and rainy seasons, household income and expenditure, health conditions, and willingness to pay for the water fee.

3.2 Results of the survey

3.2.1 Population

The population of Godey Town is estimated at 29,379 people as of May 2012. The population is projected to grow at an average growth rate of 2.91% per year, reaching 36,958 people in 2020.

3.2.2 Education

As shown in Table 3.1, there are 13 primary schools and 2 secondary schools (grade 9 – 12) in Godey Town. The number of pupils in these primary schools is estimated at 5,902, but no data is available on the number of students of secondary schools.

Table 3.1: Educational Facilities and Number of Pupils/Students in the Study Area

	Primary School		Secondary School	
Woreda	No. of School	No. of Pupils	No. of School	No. of Students
Godey Town	13	5,902	2	n.a.

Source: Socio-economic Survey, SHAAC, October 2012

3.2.3 Health and sanitation

There is a hospital with total of 184 health professionals and supporting staff. Other health facilities include two health centers (HC) and some health posts in Godey Town (refer to Table 3.2 below).

Table 3.2: Health Facilities and Staff in the Study Area

Woreda	Hospitals		Health Center		Health Post		Health Clinics	
	No. of Facilities	No. of Staff	No. of Facilities	No. of Staff	No. of Facilities	No. of Staff	No. of Facilities	No. of Staff
Godey	1	184	2	59	4	24	0	0

The major leading water related diseases found in Godey Town are malaria, diarrhea and dysentery. Out of 2,700 cases in Godey Town, malaria accounts for 67 %, diarrhea for 22 % and dysentery for 2 %. The number of water related disease patients per year is presented in Table 3.3.

Table 3.3: Estimated Number of Water Related Diseases Patients per Year

Town	Diarrhea	Dysentery	Typhoid	Cholera	Malaria	Other
Godey	600	60	0	0	1,800	240

3.2.4 Water consumption

As a complement to the socio-economic survey, a simplified survey on the use of water by the sample households in the study area was conducted.

In Godey Town, 15 households were selected and the interview was made at each sample household on the daily water use. Approximately 80 % of these sample households get water from water vendors, and the remaining households (20 %) take water from public taps or domestic taps.

a. Average water consumption

The survey results indicate that the average amount of water residents get is 13.1 liter 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. Thus, in the rainy season when households can use rainwater directly at home, the amount of water they receive from such sources diminishes by 30 to 50%. As a matter of fact, many households were found to use one or two plastic (or steel) drums with 200 liter capacity at home to collect rainwater. Some even possess a water storage facility (e.g. birka) in their own yards. Meanwhile, in the dry season people tend to use a little more water than in the rainy season in order to wash off abundant dust and to relieve thirst. This will lead to raising the amount of water use in the dry season.

The survey results indicated that more water is consumed during the dry season. The results of the survey in Godey town are summarized in Table 3.4 below.

Table 3.4: Results of the Water Use Survey in Godey Town

	Water Consumption per household		Water consumption per head	
	Rainy season	Dry season	Rainy season	Dry season
Godey Town	108 liter/day	177 liter/day	13.1 liter/day	21.7 liter/day

Source: Supplementary Water Use Survey, Study Team, 2013

b. Water use in different purposes

The water use amount in the dry season is 1.5 (washing purpose) to 1.8 (cooking purpose) times of that of the rainy season in Godey town. On average, water use amount in dry season is 1.6 times that of rainy season.

The water use amount in Godey Town by different purposes is compiled in Table 3.5.

Table 3.5: Daily Water Use Amount per Head for Different Purposes

(Unit: liter/day)

Purpose	Drinking		Cooking		Washing		Bathing	
Season	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Water use per head	2.4	4.1	2.6	4.8	4.3	6.5	3.7	5.9

Source: Supplementary Water Use Survey, Study Team, 2013

3.2.5 Willingness and ability to pay

a. Willingness to pay

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 15 Birr (minimum) to 250 Birr (maximum) per month. Overall average price in Godey Town is 67 Birr per month (refer to Table 3.6).

Table 3.6: Willingness to Pay for the Improved Water Supply System

Study Area	Town	Willingness to Pay for the Improved Water Supply (Birr/month)		
		Minimum	Maximum	Average
Shebele sub-basin	Godey	15	250	67

Source: Socio-economic Survey, SHAAC, October 2012

b. Ability to pay

b.1 Household income data

Household income sources consist of such items as crop, livestock, fishery, employment, remittance, commercial activities and others. Household income ranges from 1,800 Birr to 72,000 Birr with average income of 30,336 Birr in Godey town. Annual household income in Godey town is presented in Table 3.7.

Table 3.7: Annual Household Income in Godey Town

Unit: Birr

Household	Crop	Livestock	Fishing	Employment	Remittance	Commercial	Other	Total
001	0	0	0	1,800	0	0	0	1,800
002	0	2,800	0	0	0	48,000	0	50,800
003	0	0	0	0	0	54,000	0	54,000
004	0	0	0	0	31,842	0	0	31,842
005	10,500	8,600	0	0	0	10,800	0	29,900
006	6,000	10,600	0	10,536	0	0	0	27,136
007	0	0	0	30,000	0	0	0	30,000
008	0	0	0	33,600	0	0	0	33,600
009	0	8,800	0	21,000	0	0	0	29,800
010	0	0	0	0	0	0	43,200	43,200
011	0	0	0	33,000	0	0	0	33,000
012	15,600	4,700	0	0	0	14,000	0	34,300
013	0	0	0	0	41,760	0	0	41,760
014	16,000	8,600	0	0	0	10,800	0	35,400
015	15,600	10,944	0	0	0	0	0	26,544
016	13,000	0	0	0	0	54,000	0	67,000
017	0	0	0	0	10,536	18,000	0	28,536
018	8,600	5,750	0	0	0	10,800	0	25,150
019	0	0	0	0	43,200	0	0	43,200
020	0	0	0	0	0	21,600	0	21,600
021	0	0	0	0	0	54,000	0	54,000
022	0	0	0	0	0	0	18,000	18,000
023	0	0	0	18,000	0	54,000	0	72,000
024	0	0	0	2,500	0	0	0	2,500
025	23,000	0	0	0	0	0	0	23,000
026	0	0	0	0	0	12,600	0	12,600
027	0	0	0	11,136	0	0	0	11,136
028	0	0	0	26,400	0	0	0	26,400
029	0	10,500	0	22,200	0	18,000	0	50,700
030	15,000	8,500	0	18,000	0	0	0	41,500
031	0	0	0	0	31,608	28,800	0	60,408
032	0	0	0	25,200	21,072	0	0	46,272
033	0	0	0	0	0	72,000	0	72,000
034	0	0	0	0	0	0	3,500	3,500
035	0	0	27,600	0	0	0	0	27,600
036	6,500	0	0	0	20,400	0	0	26,900
037	0	0	0	16,200	0	0	0	16,200
038	0	0	0	0	0	18,000	0	18,000
039	0	0	2,400	0	0	0	0	2,400
Average	2,225	950	1,500	6,982	3,846	13,950	1,075	30,336

Source: Socio-economic Survey, SHAAC, October 2012

b.2 Ability to pay

The ability to pay of the water users can be estimated from their household income data. It is assumed that the maximum monthly water bill affordable for urban households is 5% of the household income.[1]

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, namely 5% of the average household income of 30,336 Birr.

In determination of the water tariff in Godey town, the amount of 1,516 Birr per year (126Birr/month) will be considered to be the maximum water bill.

[1] Water Supply and Sanitation Project, Project Appraisal Report, World Bank, 2004

Chapter 4

Water Resources Study

4 Water Resources Study

4.1 Climate and rainfall

There are two meteorological stations in Godey Town in Godey woreda, and in the surrounding area, Kalafo woreda has only one station. The names of meteorological stations in Godey Town are [Gode Town and Gode Met] and the elevations of the two stations are almost the same: 290m and 291m. They are located very close to each other. 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 (refer to Figure 4.1). Although the annual rainfall data have different observation periods for the two stations, the average annual rainfall is 236mm (observation term 2004-2009) in Gode Town, and is 272.7mm (observation term 1966-2012) at Gode Met. The annual temperatures at the two stations are maximum 34.8 degree Celsius and minimum 21.5 degree Celsius (observation term 2004-2009) at Gode Town, and 34.9 and 23.4 (observation term 1985-2005) at Gode Met. At Gode Met, there are many days of wind from the east from November to March. In most days the wind speed is over 5m/sec. After that, the wind from the southwest increases from May to October. and the wind speed is 6m/sec - 8m/sec, which is comparatively strong throughout the year.

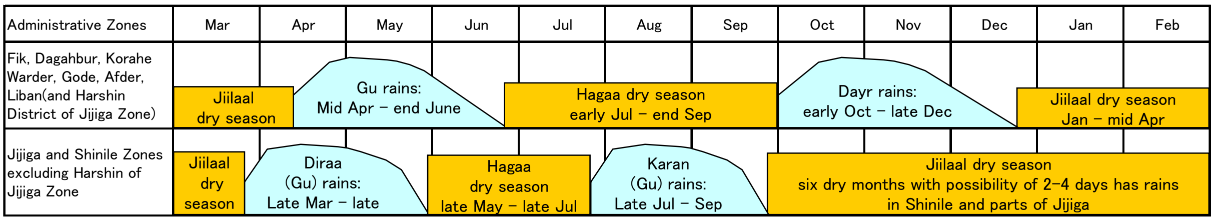


Figure 4.1: Rainy and Dry Seasons in Somali Region

4.2 Surface water resources

The main surface water resource of Godey Town is Shebele River. It is difficult to use wells in the Town; and it was discussed to utilize birkas in areas away from Shebele River.

The hydrological stations in Somali Region concentrate along Shebele River and in Jarar valley. Ten stations are distributed from upstream to downstream along Shebele River. The correlation between annual depth of runoff and drainage area is shown in Table 4.1. There is a good correlation between annual depth of runoff and drainage area (refer to Figure 4.2).

Table 4.1: Drainage Area and Depth of Runoff

	Wabi MelkaWakana	Wabi Legehida	Wabi Kelafo	Wabi Imi	Wabi Hamaro	Wabi Gode	Wabi Dodola	Wabi Burker	Maribo Dodola	Maribo confluence
Depth of Runoff(mm)	197.96	112.82	20.87	36.04	53.31	25.92	1893.07	17.84	1062.87	361.15
Watershed Area(km^2)	4,388	20,473	139,100	91,600	63,644	127,300	137	144,000	137	1,039

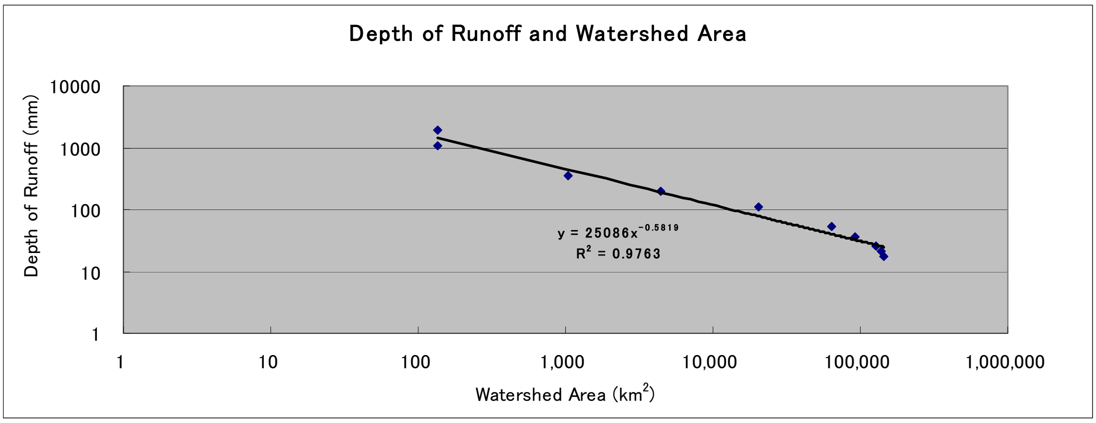


Figure 4.2: Correlation between Runoff and Drainage Area

4.3 Groundwater resources

In Godey town and its surrounding area, 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 in the whole Godey woreda including Godey town. As the thickness of Quaternary deposits on the surface is thin, it has a high probability to reach the gypsum layer immediately below if a well is drilled. The upper part of the gypsum layer is dominantly massive anhydride with some thin layers of dolomite. The lower part is represented by alternation of dolomitic limestone, marl, shale and anhydride. The groundwater from these evaporate formations is usually bad with high salinity. Thus, fresh groundwater exploitation through borehole well drilling is impossible due to the bad quality of the groundwater. Therefore, any boreholes drilled in such areas should be drilled until the underlying limestone formation is reached so as to obtain fresh water. The thickness of gypsum layer is about 500m at maximum. So it is very difficult to develop the groundwater resources including shallow wells in Godey town and its surrounding area.

4.4 Water quality

4.4.1 Groundwater

There is no data in shallow wells in Godey Town and its surrounding areas. Therefore, the data of hand-dug wells was obtained instead. The analysis items that exceeded the Ethiopian standard are TDS, Cl ion, total hardness and Na ion. The water may be indicated as saline water for drinking. Some groundwater samples from boreholes and hand-dug wells in West Ime woreda and Rasso woreda along the upstream of Shebele River had fluoride concentrations exceeding the WHO standard, but not the Ethiopian standard. However no groundwater samples in Godey woreda showed high fluoride concentration.

4.4.2 Shebele River

Turbidity and total hardness exceeded the Ethiopian standard in the water quality of Shebele River in Godey woreda (Ethiopia standard: Turbidity, 7NTU, total hardness, 392mg/L). As mentioned above, the river water also indicated high concentration of fluoride (not exceeding the Ethiopian standard) along upstream of Shebele River at West Ime woreda and Rasso woreda. The iron concentration was also high exceeding the Ethiopian standard. However, the fluoride and iron concentrations did not exceed the WHO standard in river water from Godey woreda. The turbidity of treatment water decreased by 1/10-1/100 compared to the original river water, but the turbidity exceeded the Ethiopian standard. It is an issue that needs to be considered in the method of water treatment in the water supply plan in an attempt to seek a solution.

Chapter 5

Population and Water Demand

5 Population and Water Demand

5.1 Base and projected population

It was estimated that there were 4,758 households in the town as a result of counting households on satellite photos, which were taken in 2011. Then, by multiplying the number by 6 persons (average per household), 28,548 persons were estimated to reside in the town. The population growth rate employed is 2.91% per year from 2012 to 2020 that was estimated from the data of socio-economic survey and Central Statistical Agency. The projected population of Godey town from 2012 to 2020 is tabulated in Table 5.1.

Table 5.1: Projected Population from 2012 to 2020

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020
Population	29,379	30,234	31,114	32,019	32,951	33,910	34,897	35,913	36,958

The projected population in 2020 was estimated to be 36,958 persons. This figure was used for the water demand calculation.

5.2 Water demand

5.2.1 Domestic water demand

According to the Godey town water supply utility office, water meters were installed for 200 households as of March 2013. All the households, which were installed water meter, received water by yard connection. The average number of family members per household is 6 and the population who received water by yard connection were estimated to be 1,200 persons. There are three public taps that are functioning. It is dictated that beneficiaries of one public tap are 900 persons. Thus, the total beneficiaries are estimated to be 2,700 persons. The remaining population purchased water from donkey water venders or fetch water directly from the Shebele River. Present water access ratio situation is summarized in Table 5.2 .

Table 5.2: Current Ratio of Water Access by Mode of Drinking Water Supply

No.	Water access method	Population	Percentage
1	Yard connection	1,200	4%
2	Public tap	2,700	9%
3	Others (Except piped water)	25,479	87%
	Total	29,379	100%

Ministry of Water and Energy (MoWE) prepared the ratio of drinking water access modes for town water supply projects in 2003 as shown in Table 5.3. Godey town is classified into medium town.

Table 5.3: Ration of Drinking Water Access Modes for Different Population Sizes

Population	House connection	Yard connection	Pubic tap	Others
Rural			60-80%	20-40%
Small town 2,000-10,000	0-1%	20-30%	40-60%	10-40%
Medium town 10,000-50,000	0.5-2%	30-50%	40-55%	8-15%
Large town 50,000-80,000	1-3%	40-65%	30-55%	2-4%

Source: Project design, financial and economic feasibility study, vol.1 tool kits and annexes, MoWE, 2003

The target population served by water supply as percent of total population for Godey water supply plan was set to be 100% in 2020, each population belongs to any of piped water connection. Based on the current water access ratio, house connection, yard connection, and public tap of 2020 are estimated to be 1:49:50. Unit water demand of above three categories is regulated in the urban water supply design criteria, they shall be 50lit/cap/day, 25lit/cap/day, and 20lit/cap/day respectively. As a result, domestic water demand in 2020 was estimated to be 840.81m^3/day (Table 5.4).

Table 5.4: Domestic Water Demand Projection

Category	Population	Unit demand	Total
	Persons	lit/cap/day	m^3/day
House connection	370	50	18.50
Yard connection	18,109	25	452.73
Public tap	18,479	20	369.58
Total	36,958		840.81

5.2.2 Industrial water demand

Industrial water demand is estimated based on the socio-economic survey result. The Godey woreda administration office answered numbers of restaurant, factory, and fuel station in the survey. It assumes that one restaurant has 10 seats and one fuel station supplies fuel to 30 users per day. These figures multiply by the questionnaire result, industrial water demand quantities are estimated. Unit water demand follows the urban water supply design criteria. Total industrial water demand is estimated to be 3.4m^3/day as shown in Table 5.5.

Table 5.5: Industrial Water Demand Projection

Category	Survey result	Estimated quantity	Unit	Unit demand	Total
				lit/day	m^3/day
Restaurant	31	310	seat	10	3.10
Factory	0	0	employee	5	0.00
Fuel station	2	60	user	5	0.30
Total					3.40

5.2.3 Commercial and institutional water demand

a. Commercial water demand

Hotel water demand is estimated as commercial water demand. According to the results of the socio-economic survey, the number of hotels is 9 hotels. It assumes that one hotel has 10 beds. Unit water demand is 25lit/cap/day, total commercial water demand is estimated to be 2.25m^3/day.

b. Institutional water demand

Institutional water demand consists of government offices, schools, and hospital water demands. These figures shall also be granted by the survey. Unit water demand of one person at target place and one bed shall be regulated to 5lit/day and 50lit/day, respectively. Total institutional water demand was estimated to be 62.40m^3/day (Table 5.6).

Table 5.6: Institutional Water Demand Projection

Category	Survey result	Estimated quantity	Unit	Unit demand	Total
				lit/day	m^3/day
Government officers	300	300	person	5	1.50
Primary school	5,902	5,902	person	5	29.51
Secondary school	3,643	3,643	person	5	18.22
High school	2,484	2,484	person	5	12.42
Hospital	1	15	bed	50	0.75
Total					62.40

5.2.4 Livestock water demand

It was assumed to be 20% of the total volume of domestic, industrial, commercial, and institutional water demands as described in the water supply master plan. The total of the four types of water demands is 908.86m^3/day, therefore, livestock water demand is;

181.77m^3/day = 908.86m^3/day×20%

5.2.5 Water loss

Water loss is set as 30% of above water demand value as same as the water supply master plan. It was calculated to be 327.19 m^3/day.

(908.86 m^3/day + 181.77 m^3/day) x 30% = 327.19 m^3/day

5.2.6 Summary of design water supply

Design average daily supply was calculated from the various water demand values above. The water supply facilities need to be planned by design maximum daily supply. In Ethiopia, design water supply is multiplied design average daily supply by seasonal peak factor, daily peak factor, and hourly peak factor. All these factors are regulated in the urban water supply design criteria (Table 5.7). The Study adopted the mean figures: 1.2 for seasonal peak and 1.3 for daily peak.

Table 5.7: Applied Peak Factors

Peak factor	Design criteria	Applied figure
Seasonal peak	1.0~1.2	1.2
Daily peak	1.0~1.3	1.3
Hourly peak 20,001 ~ 50,000 persons	1.9	1.9

Design maximum daily supply was used to design the intake facilities, water purification plant, and transmission pipeline. Design maximum hourly supply was used for distribution pipeline system. Estimated water demands are summarized in Table 5.8.

Table 5.8: Summary of Design Water Supplies

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	Design average daily supply (No.1~No.5)	m^3/day	1,090.63
7	Water loss	m^3/day	327.19
8	Design average daily supply with water loss	m^3/day	1,417.82
9	Design peak seasonal daily supply (No.8×1.2)	m^3/day	1,701.38
10	Design maximum daily supply (No.9×1.3)	m^3/day	2,211.79
11	Design maximum hourly supply (No.10×1.9÷24)	m^3/hr	175.10

5.2.7 Firefighting water demand

Firefighting water demand was considered to design reservoir volumes. It was separately estimated from above water demands because the objective of firefighting is different from the other water demands above. It was set to be 10% of reservoir volume by the urban water supply design criteria. Detailed calculation is described in section 7.7, Reservoir.

Chapter 6

Existing Water Supply

6 Existing Water Supply

6.1 Existing water supply coverage

It is assumed that the daily water consumption is about 150m^3 judging from the intake pump capacity. In the case that all water is used for domestic purposes, the maximum beneficiaries are 7,500 persons and the existing water supply coverage ratio is only 26% even at the highest. (The existing water supply coverage ratio in Godey town is quite low in comparison with water supply access ratio in the Somali Region (74%)).

6.2 Existing water supply system

6.2.1 Development of the water supply facilities

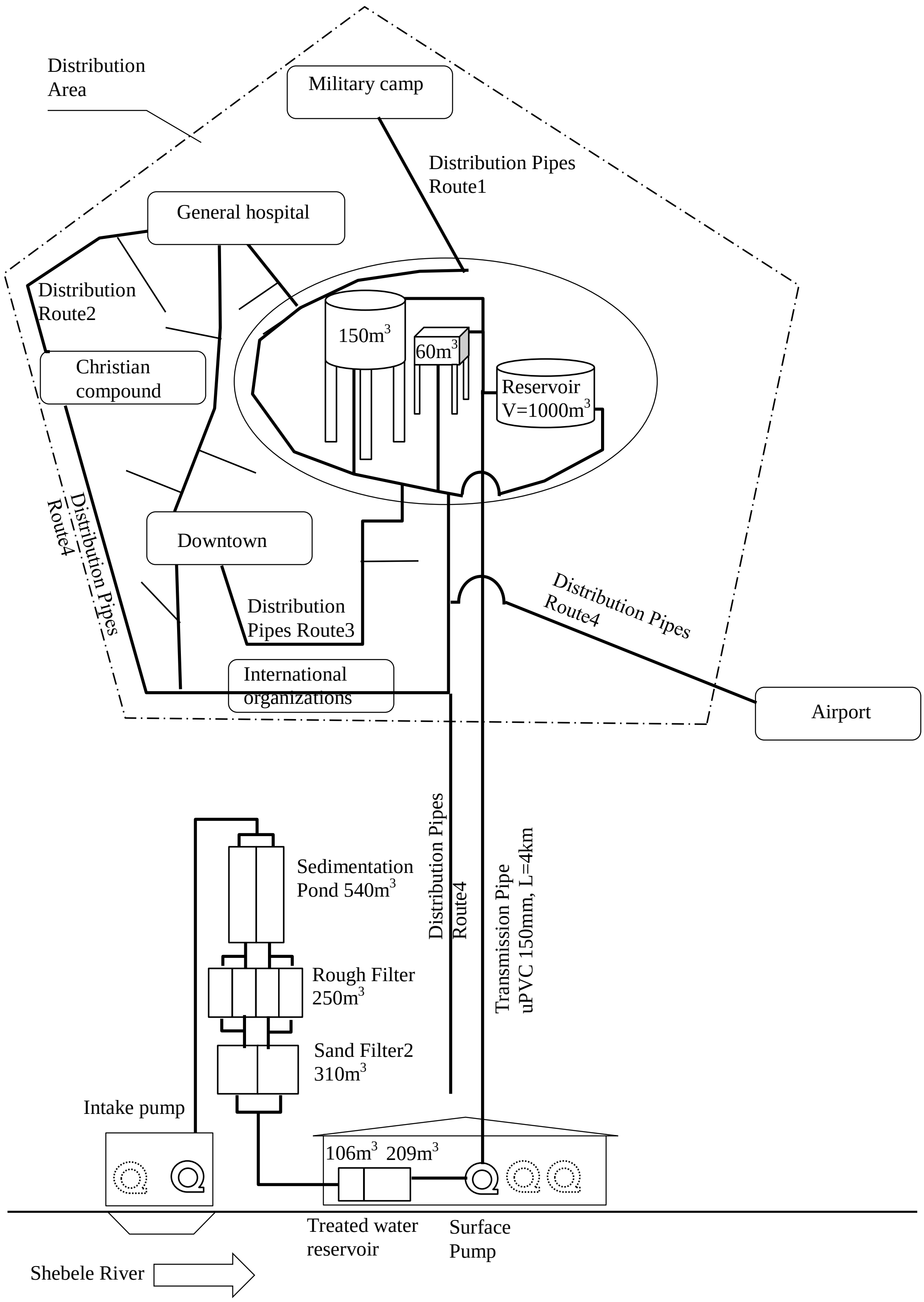
a. Initial development

The oldest operational water supply facilities in Godey Town were constructed in 1959. The initial water supply system had the objective to provide water to the major government offices and the public facilities such as the zonal administrator residence, government office, hospital, and Christian compound. The water intake, filter equipment, and chlorine treated water pond were constructed near the Shebele River and the elevated reservoir was constructed in the place where the elevation is highest in the town. One distribution pipeline with three (3) public taps was installed from the reservoir to the Christian compound.

b. Expansion of the water supply facilities

The water supply facilities were augmented in 1996 in accordance with the growth of the town. Major reasons of the town growth are 1) settlement of pastoralists and 2) immigration of Somali refugees. The intake pump station on the Shebele River was replaced to increase water supply volume. Besides, the sedimentation ponds were constructed corresponding to the new intake pump station in order to increase the purified water volume. The distribution pipelines were also expanded and six (6) public taps were provided for the Godey town population.

After the year 2000, sand filter ponds in the water purification plant, a concrete reservoir of 1000m^3 volume, and six (6) public taps were constructed. However, the system still could not cover the water supply for the Godey town population. General layout of the present water supply system in Godey town is shown in Figure 6.1.



Note: objects in dotted line signify that they are non-functional

Figure 6.1: General Layout of the Godey Town Existing Water Supply system

6.2.2 Raw water intake pump station

Originally, two raw water intake pumps were installed inside the pump station but due to lack of spare parts, raw water intake pump has not been repaired properly. The Godey town water supply utility office cannot purchase any stand-by pumps. They only operate one raw water intake pump. When pumps are replaced, used pumps are mostly installed due to budgetary limitations. As a result, replaced pumps are not expected to serve long life and they often break down within quite a short time. According to the Godey town water supply utility office, the raw water intake pump keeps from operating out when the river water level is higher than the pump elevation and when the raw water is very turbid. It seems that the intake pump station is not equipped with a screen and the intake pump has to take raw water directly from the river. So the pump unnecessarily sucks up sand grains into the water purification plant. In this case, the raw water cannot be purified effectively and they stop pump operation.

6.2.3 Water quality and treatment

a. Water quality

Water quality test was conducted in the Study including four sampling points along the Shebele River in Godey town. A similar test was also carried out by the Wabi Shebele River Basin Integrated Development Master Plan Study. All the water quality analysis results from the two studies are tabulated in Table 6.1 and sampling locations in the JICA Study are shown in Figure 6.2. Turbidity of the sampled water was much higher than WHO standard, it had to be decreased by water treated facilities. As for hardness, various values were obtained from sampling points even 1km away from each other. It is necessary to conduct additional tests before a detailed design is implemented. If it exceeds constantly, lime has to be added to raw water.

Table 6.1: Shebele River Water Quality Test Results

		WHO	Ethiopia n standard	JICA No.1	JICA No.2	JICA No.3	JICA No.4	Wabi Shebele MP	
Date				11/6/ ‘12	11/6/ ‘12	11/6/ ‘12	11/6/ ‘12	28/9/ ‘02	‘04/2/ ‘03
pH		6.5-8.5	6.5-8.5	7.93	7.81	7.14	7.77	7.70	7.96
TSS	mg/l			58	1,534	1,296	1,378	-	-
TDS	mg/l	1000	1776	529	480	496	507	381	404
EC	mS/cm			0.609	0.667	0.624	0.682	0.506	0.565
Turbidity	NTU	5	7	449	556	541	509	475	490
CO_3	meq/l			<0.9	2	2	2	-	-
HCO_3	meq/l			2	2	2	3	-	-
T.P	mg/l			0.218	0.046	0.067	0.67	-	-
NH_4	mg/l	1.5	2	0.164	0.293	0.111	0.199	0.580	0.330
SO_4	mg/l	250	483	135	96	171	90	159	151
NO_3	mg/l	50	50	1.0	1.1	0.9	1.1	6.6	7.0
F	mg/l	1.5	3	0.72	0.70	0.69	0.72	0.92	0.96
Cl	mg/l	250	533	50	60	50	65	12	19
Ca	mg/l			366	195	325	200	79	65
Mg	mg/l			104	30	89	37	11	14
Na	mg/l	200	358	48	47	32	47	11	40
K	mg/l			4	3	4	3	4	5
Mn	mg/l	0.1	0.13	0.01	0.01	0.01	0.02	0.10	-
Fe	mg/l	0.3	0.4	0.17	0.08	0.17	0.15	0.02	0.20
Hardness	mg/l $CaCO_3$	500	392	570	360	120	460	228	223

Note: the shaded entries exceed WHO standards

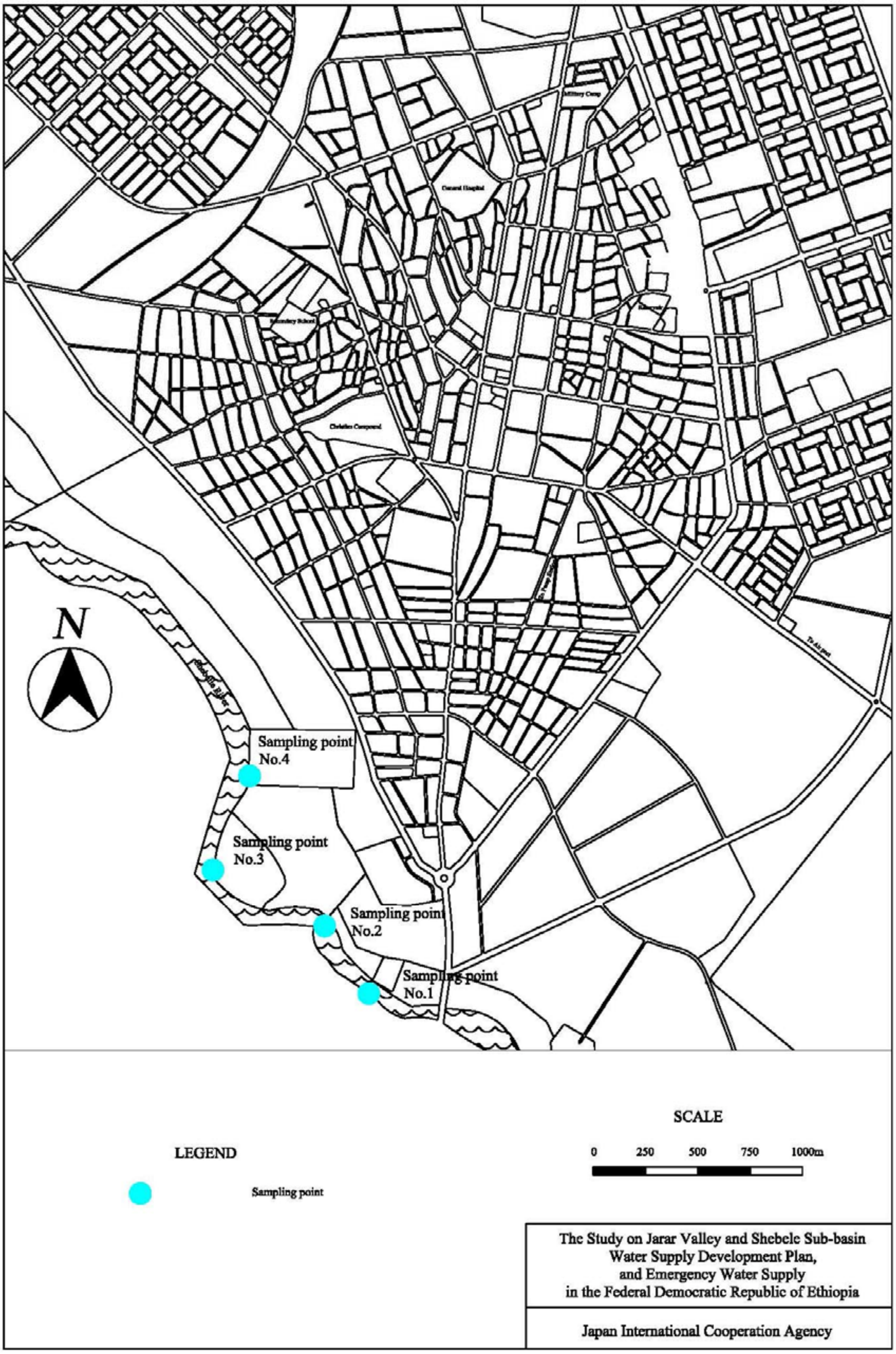


Figure 6.2: Water Sampling Points by the JICA Study Water Quality Test

b. Water purification plant

Due to intermittent electricity supply, the Godey water supply system adopts the slow sand filter system even though raw water exhibits high turbidity especially in rainy season. All water purification systems are operated by gravity flow without using electricity (refer to Table 6.2).

Table 6.2: Features of the Present Water Purification Plant Facilities

No.	Facility	Year	Dimension	No.	Total Vol.
1	Sedimentation tank	1996	25.0m x 4.5m x 2.4m/cell	2	540.0m^3
2	Rough filter pond	2009	11.5m x 3.5m x 1.6m/cell	4	257.6m^3
3	Sand filter pond 2	2009	12.5m x 8.5m x 1.5m/cell	2	318.8m^3
4	Drying bed	2009	6.2m x 4.4m x 0.7m/cell	1	19.1m^3

The slow sand filter pond 1 was constructed in 2007, but it is not currently operational. According to the Godey water supply utility office, the tank was clogged by floc and raw water overflowed from the sand filter pond 1. This phenomenon occurred repeatedly and its operation of the facilities finally stopped. Afterwards, SRWDB planned and constructed the rough filter and the slow sand filter 2.

The sedimentation tank was equipped with mechanical sludge removal equipment and the aluminum sulfate dosing pump in 2006 by an NGO. These were the instruments that were operated by electricity and could not be used at this moment due to lack of commercial electrical line installation to the site. As a result, the equipment is not currently used.

c. Treated water reservoir

The treated water reservoir stands in the Shebele river area close to the intake pump station approximately 70m away from it. Treated water from the sand filter 2 flows into the treated water reservoir by gravity and chlorine is added to the water. The dimensions and capacities are summarized in Table 6.3 below:

Table 6.3: Features of the Treated Water Reservoir

Reservoir	Dimensions	Capacity
Cell No.1	9.5m x 5.5m x 4.0m	209m^3
Cell No.2	4.8m x 5.5m x 4.0m	106m^3

Originally, the reservoir had three (3) transmission pumps to send water to the reservoir tank in the town. However, two of them are broken presently and only one pump is operating.

Water tankers also access the treated water reservoir and purchase purified water to sell to the population.

d. Power station

The generator house is built next to the treated water reservoir and two generators are installed inside. However, one generator is in poor condition and the only other generator supplies electricity to both raw water intake pump and surface pump. At the time of the survey, the operators supplied electricity for the raw water intake pump in the morning time and for the surface pump in the afternoon. Thus water supply was limited to half day. Godey water supply utility office procured an additional generator in 2012 and two generators operated as of April 2013. One is used for the raw intake pump and the other is used as a surface pump. They supply water required for whole day at this moment.

6.2.4 Transmission pipeline

uPVC pipe of 6 inch diameter is installed from the treated water reservoir to the reservoirs in town. The total length of the pipe is about 3,450m. The transmission pipeline route is almost in a straight line because the shortest distance was selected as the pipeline route. The transmission pipeline was installed before the development of the residential area. Now several houses especially close to the reservoir area have been constructed on the transmission pipeline route stand over the pipeline. In such places, the pipes cannot be repaired when leaks occur.

6.2.5 Reservoir

There are three reservoirs constructed in the town. The oldest reservoir was constructed as a part of the initial water supply development. An elevated reservoir was additionally developed in 2009 by USAID. However, it could not solve water shortage in Godey town because the additional reservoir did not have enough capacity to satisfy water consumption. Further investment was made by SRWDB and the largest reservoir with 1,000m^3 capacity was completed in September 2010. However, this reservoir could not deliver water with sufficient pressure to peripheral areas of the town. Therefore, the Godey town water supply utility office still has to rely on the oldest elevated reservoir. The capacity of the oldest reservoir corresponds to the current daily water consumption of approximately 150m^3. The characteristics of these reservoir tanks are tabulated as the following Table 6.4:

Table 6.4: Features of the Reservoirs

No.	Type	Year	Capacity	Funded by
1	Cylinder type elevated reservoir	1959	150m^3	Federal gov.
2	Rectangular type elevated reservoir	2009	60m^3	USAID
3	Cylinder type ground reservoir	2010	1,000m^3	SRWDB

6.2.6 Mode of water distribution

a. Distribution pipeline

There are four distribution pipeline routes installed in Godey Town. uPVC pipes are mainly applied to the distribution pipeline. In case that the pipeline needs to be installed on the ground, galvanized steel pipes are employed. The total pipeline length is about 20,020 m and its diameter ranges from 37.5mm to 125mm (refer to Table 6.5 and Figure 6.3).

Table 6.5: Distribution Pipeline Length in Godey Town

Diameter	Material	Length
125mm	uPVC	1,730m
113mm	uPVC	720m
100mm	uPVC	9,860m
75mm	uPVC	6,640m
50mm	uPVC	630m
37.5mm	uPVC	440m
Total		20,020m

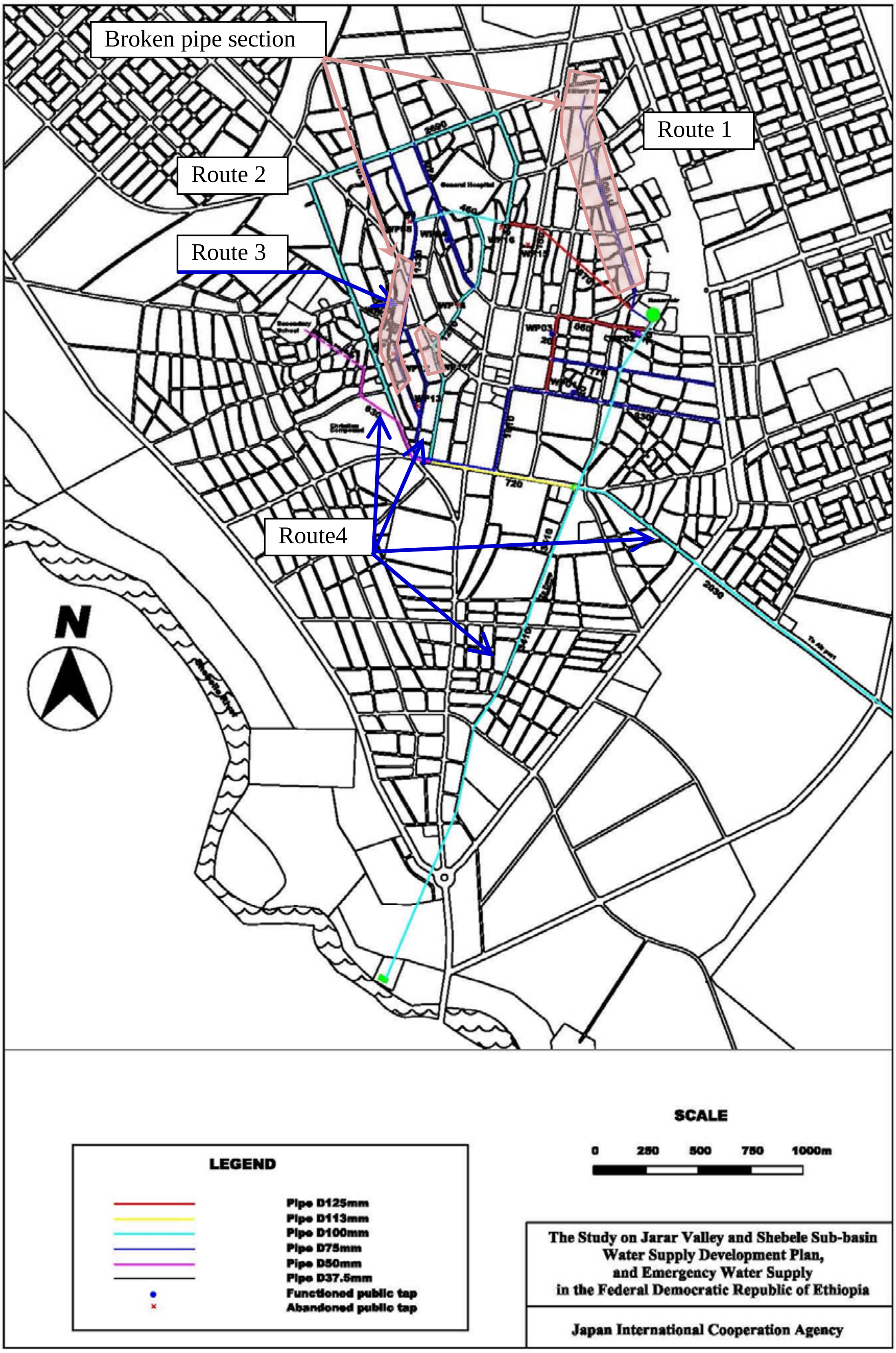


Figure 6.3: Existing Distribution Pipelines and Public Taps

The major facilities and institutions in town that are supplied by each distribution pipeline route, are summarized in Table 6.6 below:

Table 6.6: Water Supply Area in Godey Town by Distribution Pipeline Routes

Route No.	Direction	Major facilities
Route 1	North	Military camp
Route 2	North-west	General hospital Christian compound
Route 3	South South-west	Downtown Small market shops
Route 4	South South-east South-west	Airport International organizations Christian compound General hospital Downtown

Several distribution pipelines are totally broken. They are identified by the site survey with Godey water supply utility office (Refer to Figure 6.3). These sections are urgently required reinstallation of distribution pipes for renovation.

b. Public taps and house connection

There are 15 public taps in the distribution pipeline network. Initial three public taps and additional six ones are not operational because they are broken. According to Godey town water supply utility office, once distribution pipes broke and the water supply was stopped, public taps also automatically stopped operation. This kind of situation has continued until now. The latest six public taps were constructed in 2010 when the reservoir was constructed. Three of them are currently functional (Refer to Figure 6.3).

6.2.7 Issues and countermeasures on water supply facilities

Current issues and their countermeasures of the Godey water supply system are summarized in Table 6.7.

Table 6.7: 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	Increment of the public taps' usage	Permanent water supply and Establishment of WASHCO for operation

The most critical issue for the Godey town water supply system is that current water supply capacity is far too small for the town population. Even if all the water supply facilities function properly at their full capacity, it is supposed that population served by water supply per percent of total population will not even reach 30%. Therefore, it is the first priority to formulate a detailed water supply plan and a concrete implementation plan and then to increase water supply coverage. As for engineering issues, the Shebele River water is highly turbid and thus, a proper turbidity removal method that is suitable for Godey water supply utility office operation and maintenance staffs should be prepared.

6.2.8 Operation and maintenance of the existing facilities

a. Water supply facilities in its jurisdiction

There are six public taps in the town (one is non-functional). There are also 350 private connection points (yard taps). The water is distributed free of charge at public taps as a measure to help low-income households. For the subscribers of yard taps, the office charges a constant rate of 15 Birr per $1m^3$ of water. The water meters are checked normally at the end of every month and bills are prepared based on the reading but bill claim work is not done regularly on a monthly basis. The office has registered customers of 350 individuals. Besides these individual customers, there are also six large consumers such as schools and hospitals that subscribe to the service of the office. The rate for these large subscribers is also 15 Birr per $1m^3$. In addition to these, the office sells water to water trucks for road and other construction works.

b. O&M activities performed by Godey Town

In Godey Town, the town's water supply system is operated mainly by the field staff of town water supply utility office. The results of the survey on the management of the system in Godey Town are summarized in Table 6.8 below. The table shows the tasks and their frequency and the number of staff members assigned to the tasks. The component of water supply facilities in the systems in the town exists in clusters and thus can be divided into three clusters as in the table below. The total number of staff members assigned to all the component facilities is 15.

Table 6.8: Staff Assigned to Operation of Existing Godey Town Water Supply System

<table>
<tr><th rowspan="2">Cluster of facilities</th><th colspan="4">Stationed field staff</th><th rowspan="2">Temporary staff</th></tr>
<tr><th>Technician</th><th>Operator</th><th>Guard</th><th>Plumber</th></tr>
<tr><td>Intake, pump house, treated water reservoir</td><td rowspan="2">2</td><td rowspan="2">2</td><td>4</td><td>0</td><td>0</td></tr>
<tr><td>Water treatment plant</td><td>2</td><td>0</td><td>0</td></tr>
<tr><td>Distribution reservoir</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1 technician</td></tr>
<tr><td>Transmission and distribution pipelines</td><td>0</td><td>0</td><td>0</td><td>4</td><td>0</td></tr>
<tr><td>Sub-total of each staff</td><td>2</td><td>2</td><td>7</td><td>4</td><td rowspan="2"></td></tr>
<tr><td>Total</td><td colspan="4">15</td></tr>
</table>

Note)Temporary staff: unspecified technical staff from Water Desk (town water supply utility office) to assist the main staff
Shaded column is the non-field staff that is not stationed at these facilities

All the component facilities are operated by the specially assigned stationed 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. The main staff who are in charge of operation of pumps and generators are the two technicians and the two operators in the table above. They work as a pair (one technician and one operator) in an alternative-day shift. Their tasks involve operation of pumps and generators, regular cleaning and sludge removal in the water purification plant and repair of pipelines. Especially 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 repair regularly 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 is no backup. 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. The work is mainly done by the operators under the supervision of the technician. At the site of the distribution water reservoirs (3 tanks) in the town center, other than regular cleaning of the reservoir tanks, one technician from the water supply utility office checks, every day, the water levels in the reservoir tanks and operates the valves accordingly. Many of the staff members of the office have TVETC level educational background but they have little work experience especially in practical work.

At present, the operation work of the majority of the component facilities of the water supply systems is conducted only by the four members of the staff as explained above. Thus, they need to work from early in the morning to late in the night to operate pumps and in addition, they are also obliged to respond to emergency situations.

Chapter 7

Water Supply Plan and Design of Facilities

7 Water Supply Plan and Design of Facilities

7.1 General

The present water supply system has already deteriorated and also does not have capacity to supply water for the whole town population. The system will not be able to supply sufficient water for the town population if the present water supply facilities are used in the future water supply system. Thus, the water supply plan was formulated to newly design all the facilities.

7.2 Water supply resources

a. Current status

Presently, the Shebele River water is the only water source for Godey town. Due to high turbidity of the river water, possibility of shallow groundwater development was discussed in this study. The geological condition of Godey town suggests that only very shallow groundwater from several meters below ground is available in the area. Recharge from the river can hardly be expected because normally the river water level is lower than the expected groundwater aquifer. In addition, there is no information about the use of shallow groundwater around the town area. Therefore, the water supply plan should only use the Shebele River water.

There are five major public water intake sites in the Shebele River in Godey Town. One site is used by Godey town water supply utility office as the intake for the existing water supply system. Three other sites are those developed by private water venders. They install an engine pump on the river and take the water into their ponds. They store water in the ponds and sell the water to donkey water venders. The last site is freely used by anyone in town because it is the only place that people and cattle can access and take the river water manually. Though this site offers easy access to the river water, it is also affected by seasonal water level fluctuation. People cannot fetch water in the rainy season due to high water level and high turbidity. They have to access the rainwater stored in ponds in the rainy seasons. Free water access point is located at the most upstream and the existing Godey town water supply system has its intake point at the most downstream point. It does not cause negative impact on the water quality even though drinking water intake point is located downstream of the free access water point. This is because the river water is sufficiently diluted before arriving at the intake point. However, people have negative perceptions about taking water at downstream points. Therefore a new water intake site was, thus, proposed upstream of the free access water point. It has another advantage that upstream intake site is closer to the reservoir site so that initial investment cost is cheaper in comparison with taking water from the existing water intake site. Water intake sites' locations are shown in Figure 7.1. and the Godey town water supply system was illustrated in Figure 7.2.

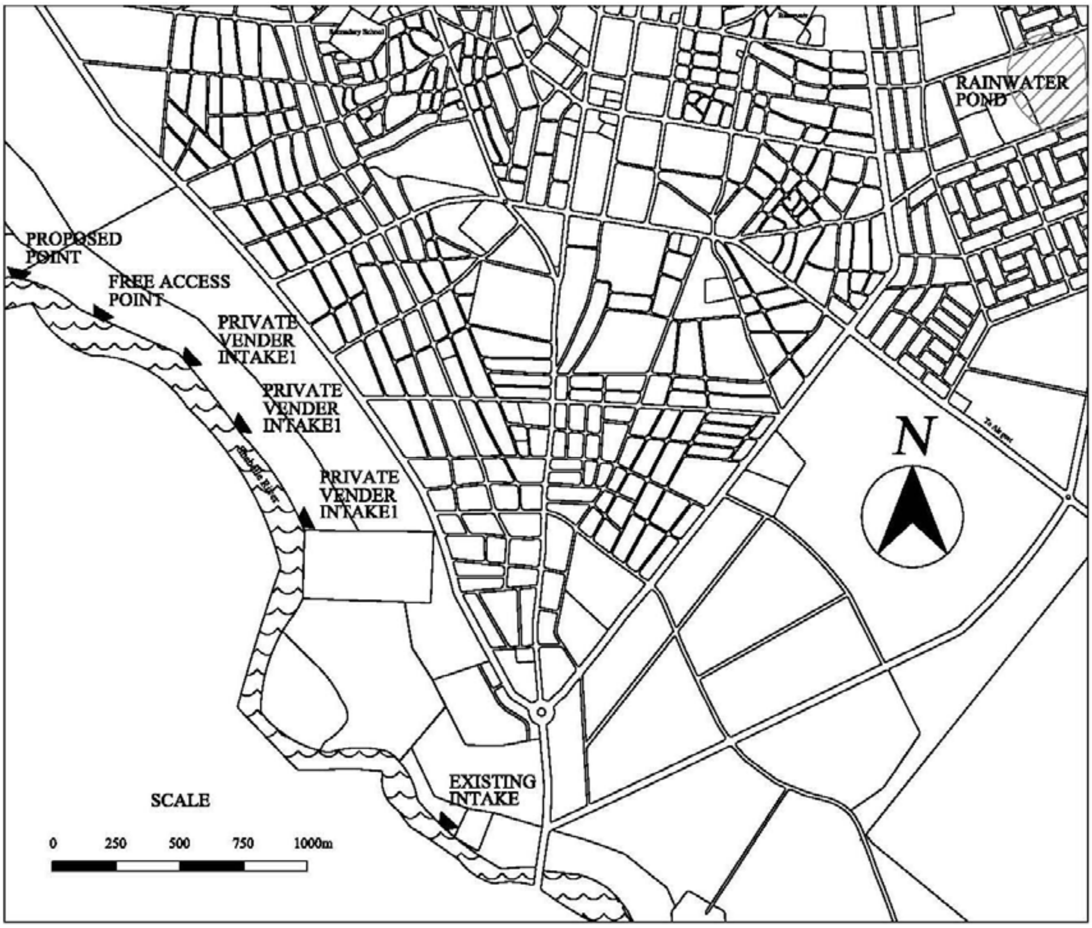


Figure 7.1: Godey Water Intakes

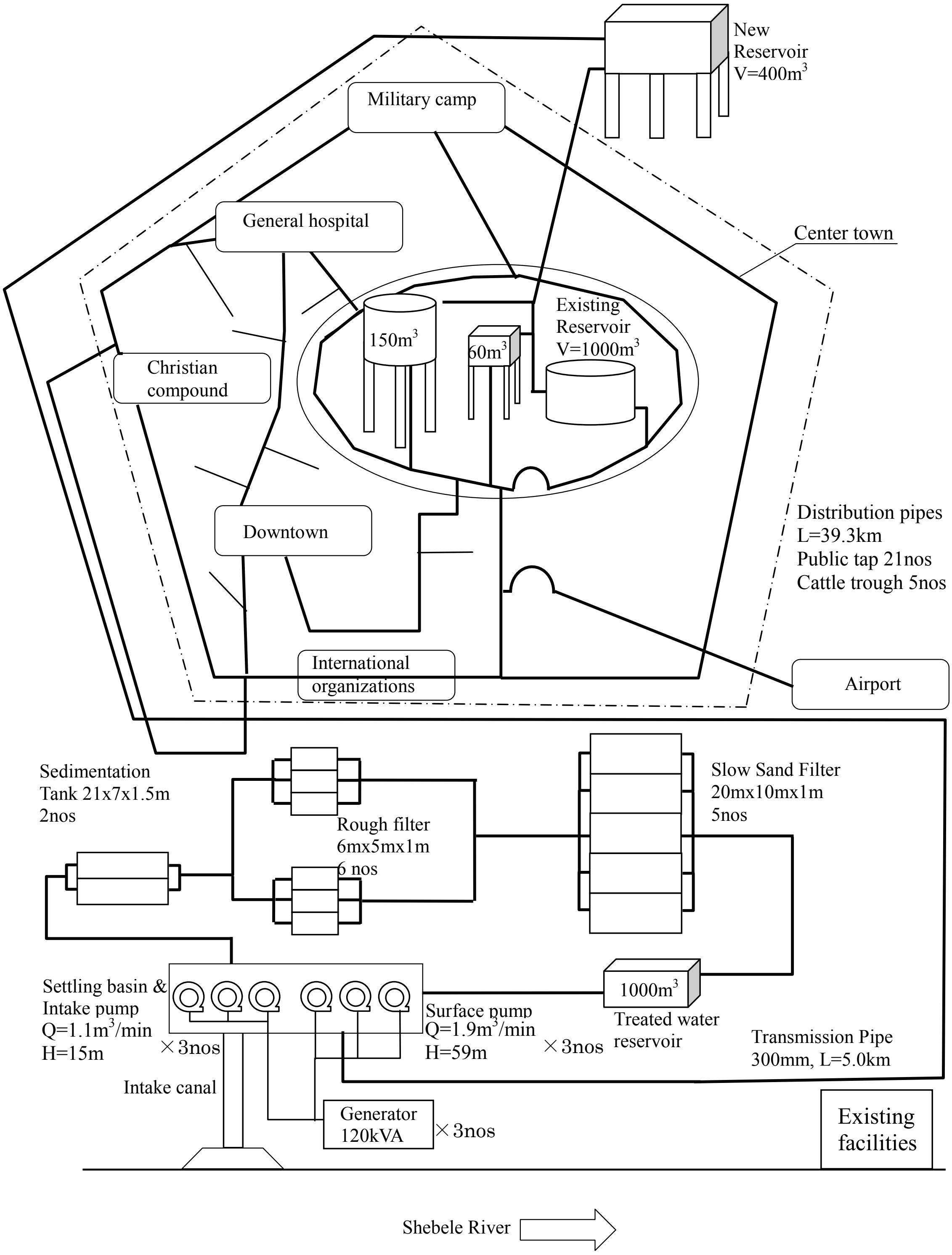


Figure 7.2: Godey Town Water Supply System Plan

b. Water intake plan

Topographic condition of the proposed intake site is shown in Figure 7.3. The location of the originally planned intake site is at the center of the river bending section. It is around 100m upstream of the existing free water access point. Due to potential risk of bank erosion by violent river flows in the rainy season, alternative sites were discussed. Generally, downstream of river bending section is the best place to construct river water intake facility. However, this place is already being used as a free water access point. Thus, the revised intake site will be shifted upstream of the Shebele River. The proposed area has two advantages: access easiness and short distance to new reservoir location. If the new intake is located further upstream of the Shebele River, advantages shown above may be lost. In addition, further upstream sites are outside the Godey town boundary. Thus, it may raise security issues. Taking into consideration these conditions, it is preferable to relocate the intake point within the same area. Finally, the site has been shifted about 60m upstream of the original site.

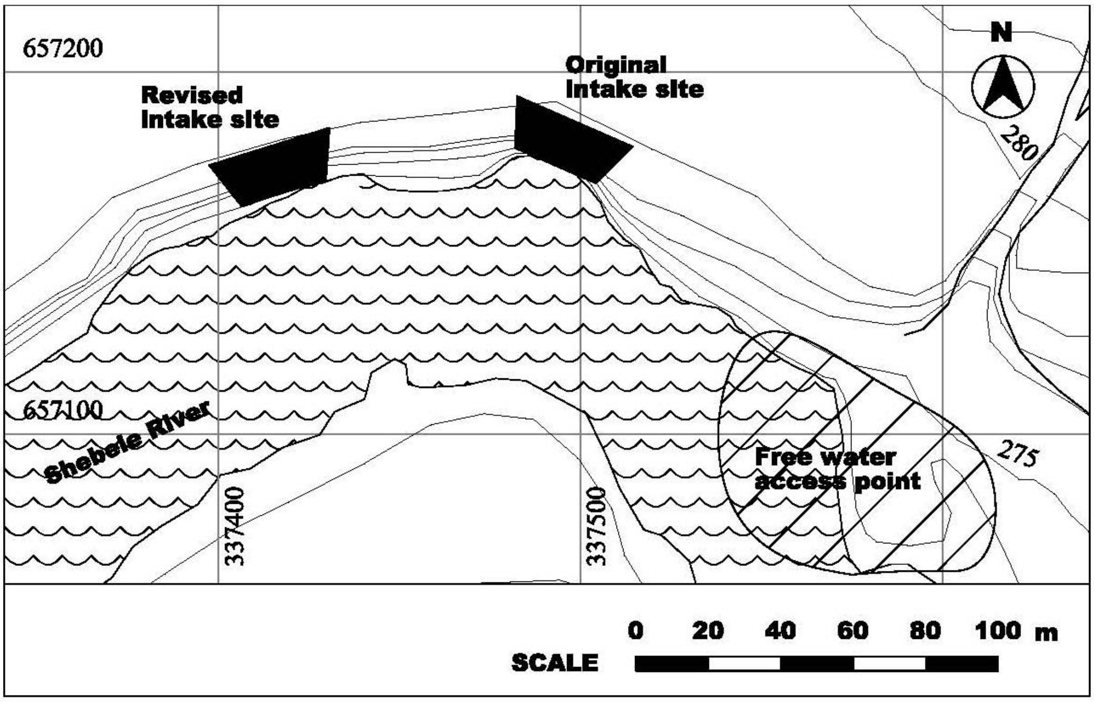


Figure 7.3: New Intake Site Location

The revised intake site is still in the river bending section and there is a possibility of bank erosion. For this reason, the following river protection methods are planned;

(1) Retaining wall along the river slope, and

(2) Stone pitching at the riverbed.

Retaining wall has the objective to protect river slope eroded by the river flow. Stone pitching will be provided to protect from riverbed washing by scouring and to stabilize river flow around the intake site.

As mentioned in chapter 6, the current raw water intake pump takes water directly from the river and it may shorten the life of the pump and result in bad water quality. The proposed intake facility provides 20m inlet canal and settling basin. Relatively large particles are settled in the canal and basin. These facilities make fewer loads for the intake pump. Inlet canal also makes pump station to be planned at a higher elevation where it will have less effect on river slope erosion.

c. General design

c.1 Stone pitching

It is provided around the intake canal inlet. Dimensions are 12.6m length and 5.0m width. Stone thickness is 0.5m. The site is in wet condition all the time, water diversion must be necessary for the work (Refer to Figure 7.4).

c.2 Retaining wall

The retaining wall is made of stone masonry. It is planned to be 5m length for both sides of the intake canal. The height is 4.5m up to the ground level, whole slope section can be protected.

c.3 Inlet canal

Concrete open channel is designed. Dimensions are 20m in length, 2m in width, and 0.5m in height. Slope is protected by stone masonry with 4.2 m in height. Steel screen is provided at the both ends of canal to protect from solid waste entering into the settling basin. Further, stop log is provided in front of the screen.

c.4 Settling basin

It is provided under the intake pump station. River water flows into the chamber part that is 5.7m in length, 1.5m in width, and 5.35m in height. Base slab elevation is 0.5m lower than the inlet canal to store river water constantly.

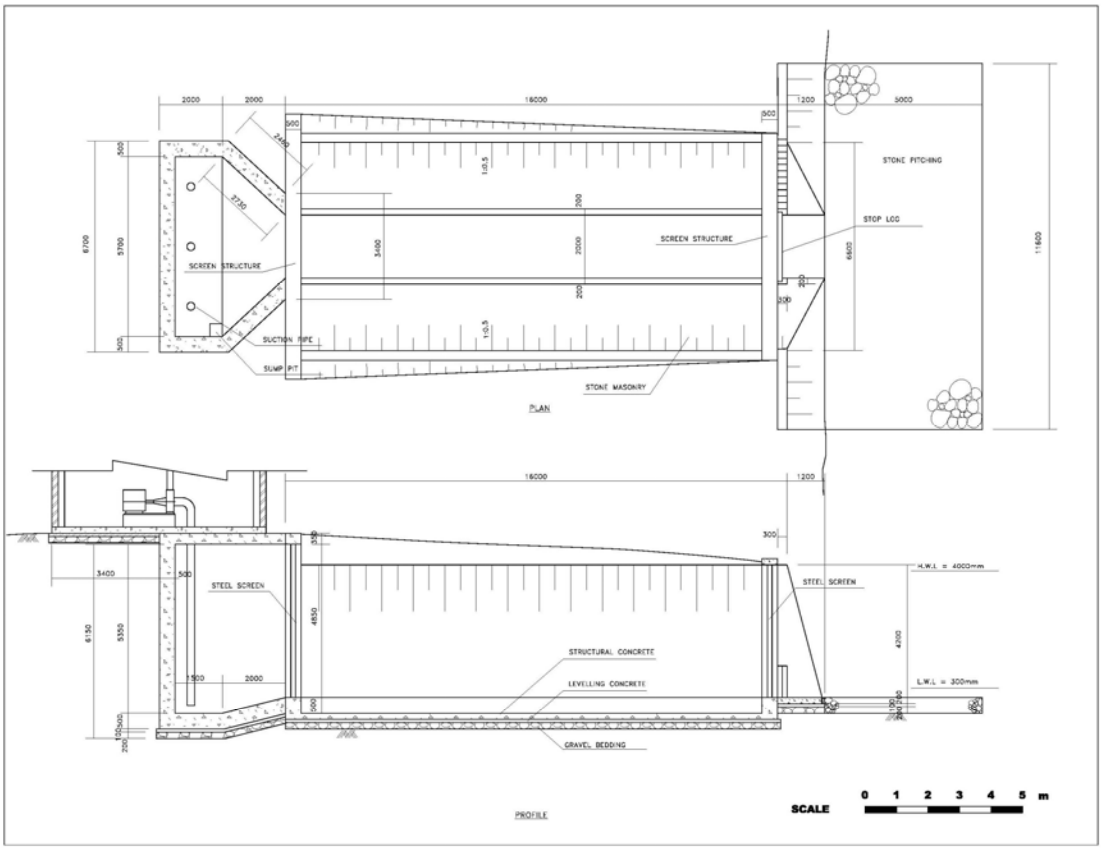


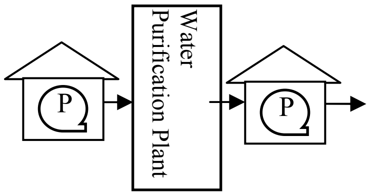
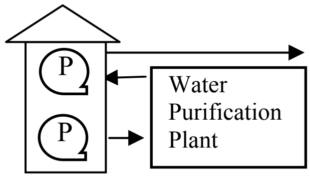
Figure 7.4: Design of Intake Facilities

7.3 Pumping station

a. Pump station plan

The Godey water supply project has two types of pump. One is intake pump which lifts water to the sedimentation tank. The other one is surface pump which lifts water to the reservoir. Two alternatives are studied for pump station arrangement (Refer to Table 7.1). The first plan is that the surface pump station is planned between the water purification plant and the town. The second plan is that the surface pump station is planned at the intake pump station. The second plan is superior to the first one in the operation stage. The second plan has less operation and maintenance costs because the number of facilities and equipment is less than the first plan. Thus, the second plan is selected in view of operation and maintenance cost, and the intake pump and surface pump are installed at the same place.

Table 7.1: Comparison of Pump Station Plan Alternatives

Item	Alternative1	Alternative2
Plan		
Transmission pipe length	4,700m	5,000m
Pump station and generation house	2 places	1 place
Generator	4 sets	3 sets
O&M Staffs	Need more staffs	Less staffs required
Spare parts, consumables	Need more materials	Less materials required

b. General design

Two pumps are planned for design water supply, 2,212m^3/day may have possibility of intermittent operation and such operation may cause heavy load for the equipment. Therefore, two pumps are designed to supply water and one additional pump is provided as stand-by. Three pumps are installed as the intake pump and surface pump. Daily pump operation period of the surface pump is set to 10 hours to follow the water supply master plan. The intake pump is set to 24 hours operation in order to activate the slow sand filter. One pump is operated for 14 hours in night time while the surface pump is not operated. It aims to maintain biofilm activity at the slow sand filter. Design flow rate is calculated as below;

Intake pump : Q_{p1}= 2,212m^3/day÷ (2numbers×10hours + 1number×14hours) ÷ 60min.
=1.08m^3/min ≈ 1.1 m^3/min

Surface pump : Q_p= 2,212m^3/day÷ 10hours ÷ 60min. ÷ 2pumps =1.84m^3/min ≈ 1.9m^3/min

Total head of each pump is calculated considering each target structure's elevation and friction loss in the pipeline. Pump specifications are summarized as follows (Table 7.2):

Table 7.2: Intake and Surface Pump Specifications

Item	Unit	Intake pump	Surface pump
Flow rate	m^3/min	1.1	1.9
Total head	m	15	59
Motor output	kW	4	25
Pump rotation No.	rpm	1500	3000
Quantity	No.	3	3

Several alternatives are studied to decide pump type. Selection criteria are considered based on the price and ease of maintenance. In case of horizontal type, additional vacuum pump is necessary to fill water between pump and suction pipe when it starts operation. Vertical type does not require a vacuum pump and it is easy to start operation. Instead of this, it is expensive and maintenance work is tougher than horizontal type. Horizontal type is more cost effective and easy maintenance, therefore it is selected. As for suction type, single suction is cheaper than double suction, therefore it is selected. The water supply plan is designed single suction horizontal volute pump. Alternative study results are summarized in Table 7.3.

Table 7.3: Alternative Study to Select the Pump Type

No.	Item	Alternative1	Alternative2
1	Pump type	Horizontal	Vertical
1.1	Cost	Cheap	Expensive
1.2	Operation	Vacuum pump	Direct start
1.3	Maintenance	Easy	Hard
2	Suction type	Single	Double
2.1	Cost	Cheap	Expensive

Cavitation analysis is studied because intake pump is suction type and it may happen. Intake pump can satisfy the following condition, cavitation will not occur.

$H_{sv} > 1.3 \times h_{sv}$

Where;

H_{sv} : Available Net Positive Suction Head (NPSH), which intake pump can be used (3.55m).

h_{sv} : NPSH, which intake pump shall be required (1.50m).

$3.55m > 1.95m = 1.3 \times 1.50m$

Besides, overhead crane is provided in the pump house to move pumps during maintenance time (refer to Figure 7.5).

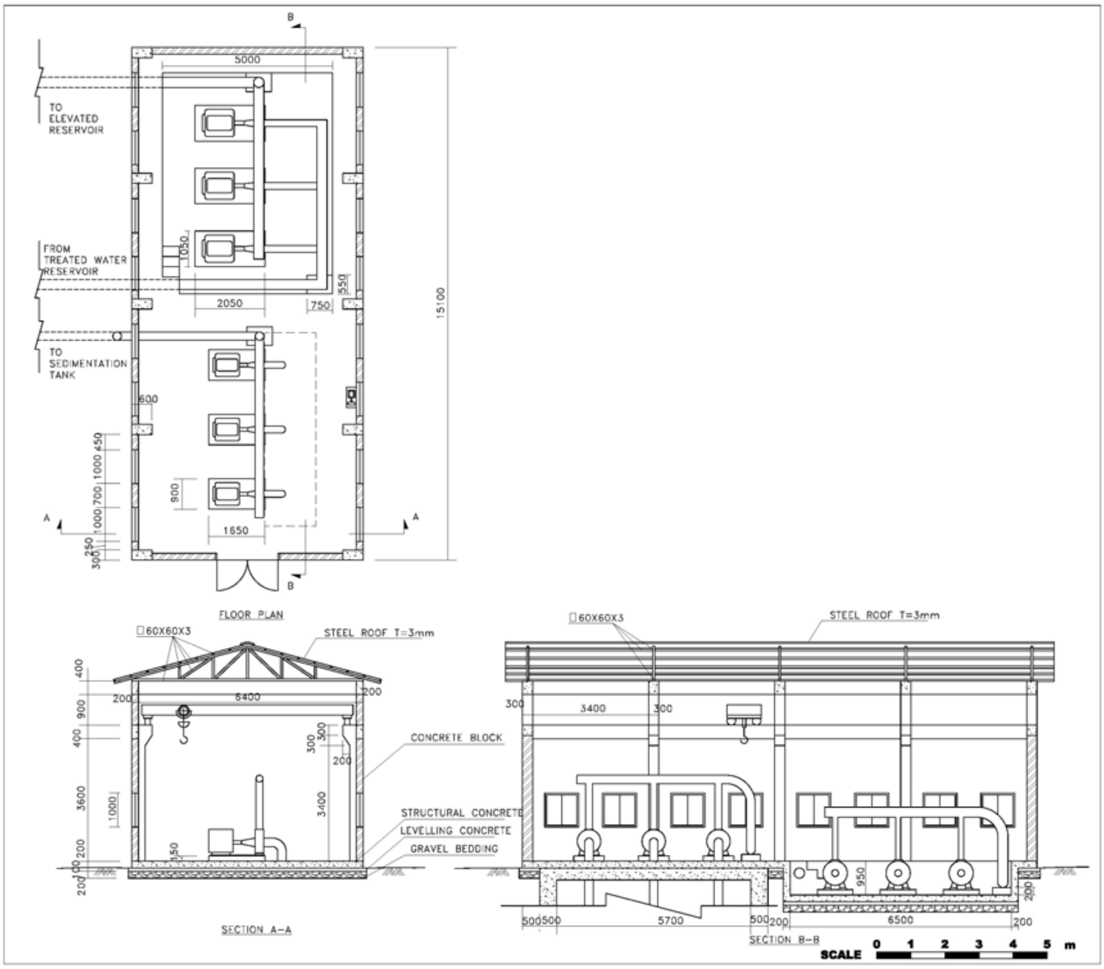


Figure 7.5: Design of Pump Station

7.4 Power supply

a. Power supply plan

Current power supply capacity is 700kW in Godey town and power supply is limited to night time. Ethiopia electrical company is proceeding with a power line project and it is under construction. Sub-station is also under construction near the proposed reservoir site. After completion of the project, electricity is supplied by the hydropower dam and Godey town can receive electricity 24 hours. According to the Ethiopia electrical company staff in Jijiga town, this on-going project needs at least 1 year up to completion as of March 2013. Godey town may receive electricity by power line in 2014 but it depends on the project progress. It is risky to rely on uncertain power source at this moment and a power supply plan is formulated accordingly. It is for this reason that a generator is used as a power source in the study. It still can be used after completion of the power line project as emergency power source during black outs or accidents. The power supply plan consists of the generator, fuel tank, and its housing.

b. General design

Following equation is applied to estimate generator output.

$$R = \frac{0.163 Q_p H}{\eta}(1+\alpha)\times 3$$

kVA = 1.2×R

Where;

R : Generator output (kW)

Q_p : Pump yield (m^3/min)

H : Total pump head (m)

η : Pump efficiency (Intake pump 0.67/ Surface pump 0.73)

α : Safety factor (0.1)

(1) One intake pump

$$R = \frac{0.163 \times 1.1 \times 15}{0.67} \times 1.1 \times 3 = 13.2 \approx 14$$

14 kW×1.2 = 16.8≈ 17 kVA

(2) One surface pump

$$R = \frac{0.163 \times 1.9 \times 59}{0.73} \times 1.1 \times 3 = 82.6 \approx 83$$

83×1.2 = 99.6 kVA≈ 100 kVA

Total output is 120 kVA ≈ 117 kVA= 17 kVA+ 100 kVA

The water supply system will operate two pumps, therefore two 120kVA generators are necessary as the power source. One generator is added as a backup, bringing the total to three generators in total.

The generator house is the same structure as the generator house of water supply construction in the pilot project in Kabribeyah. Length and width are larger than the pilot project due to necessity of installing three generators (Refer to Figure 7.6).

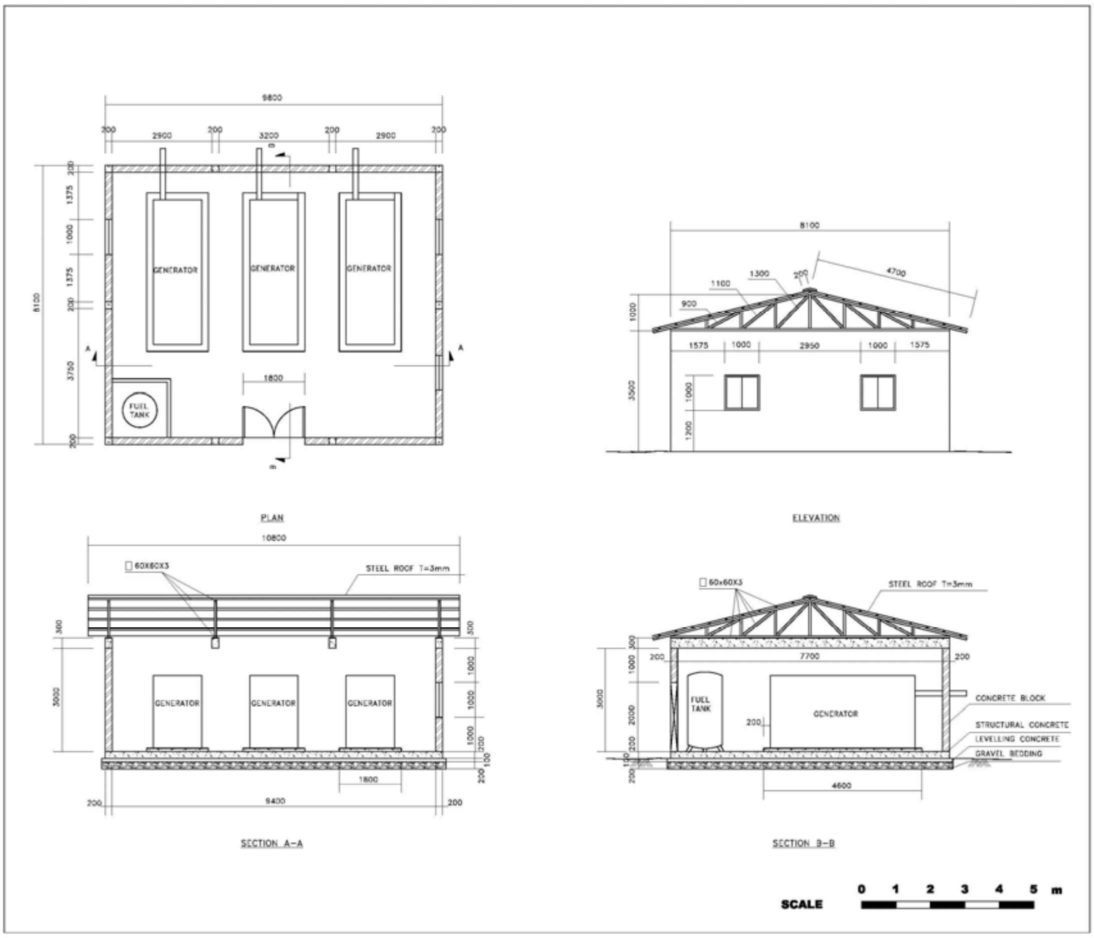


Figure 7.6: Design of Generator House

7.5 Purification plant

a. Purification facility plan

A point to consider for the purification plant planning in Godey town is the fact that the electricity supply is not stable. The existing purification plant does not rely on commercial electricity to flow purified water. As a result, they use elevation difference and flow water by gravity. The same concept is applied to the purification plant plan in the study. Electricity is not fully supplied so the water purification plant shall be planned to consume less electricity. There is a vast area that can be used for the purification plant planning. There is one hill, whose hill top is the highest point in the site. The purification plant is planned to use slope elevation difference, purify raw water, and flow by gravity.

The water purification facilities consist of sedimentation pond, rough filter, and slow sand filter and treated water reservoir.

Slow sand filter is planned to purify water quality and satisfy the condition that turbidity is below the standard value. 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 by supplying planned hourly water supply volume under the current Godey town's electricity situation. One pump is operated for night time 14 hours in order to maintain biofilm activity at the slow sand filter surface. It shall be necessary to conduct sufficient management of the slow sand filters in night time because the existing water purification facilities are only operated in day time. 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. General layout of the water purification facilities is shown in Figure 7.7.

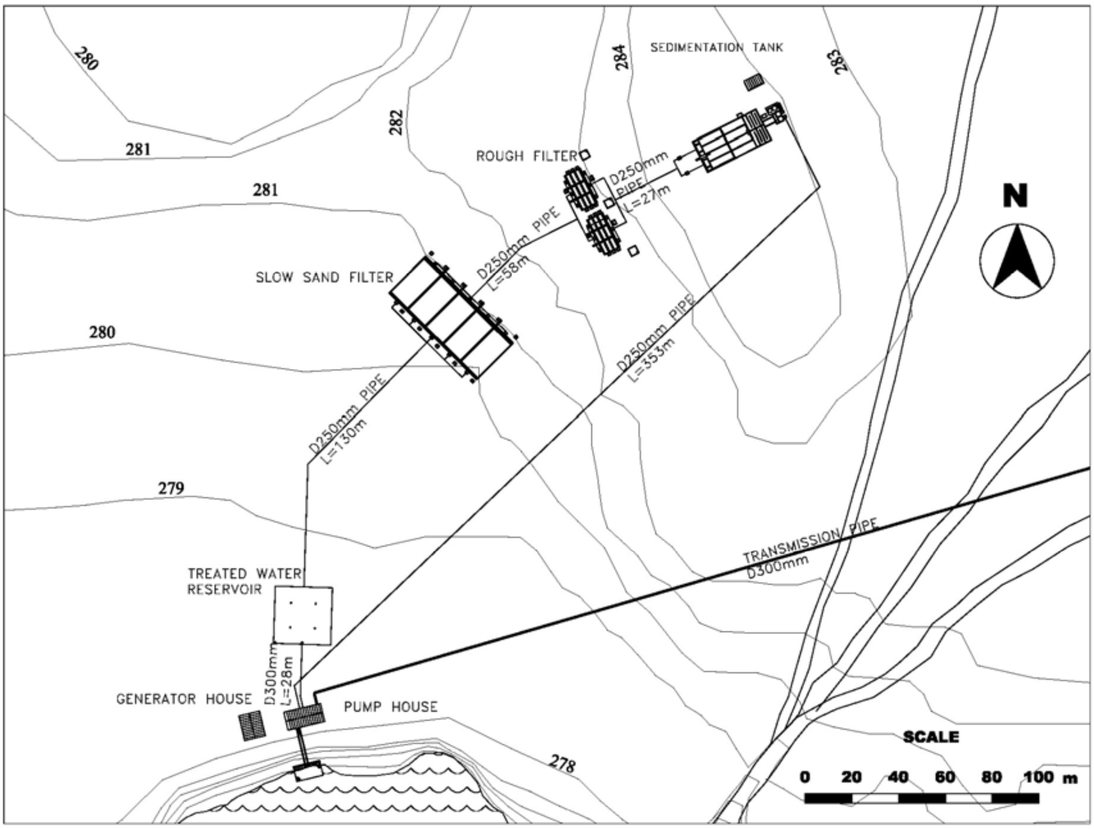


Figure 7.7: General Layout of the Water Purification Facilities

The topographic map of the water purification plant site was prepared based on the existing data. The topographic survey shall be conducted before detailed design works and it shall be necessary to confirm the actual topographic elevations. Afterward, location of planned each water purification facility shall be reviewed and it is necessary to discuss the facilities' location plan again.

b. General design

b.1 Receiving well

Water from the intake pump is poured into the receiving well (Refer to Figure 7.8). It consists of three chambers. Water pressure is released at the inlet chamber. When water flows into the outlet chamber, flow rate can be measured by the weir. At the outlet chamber, coagulation agent and alkalinity liquids are dosed. It provides 5m^3 and 3m^3 chemical dosing tanks. Aluminum sulfate and lime agent are mixed with water first and are poured into each tank.

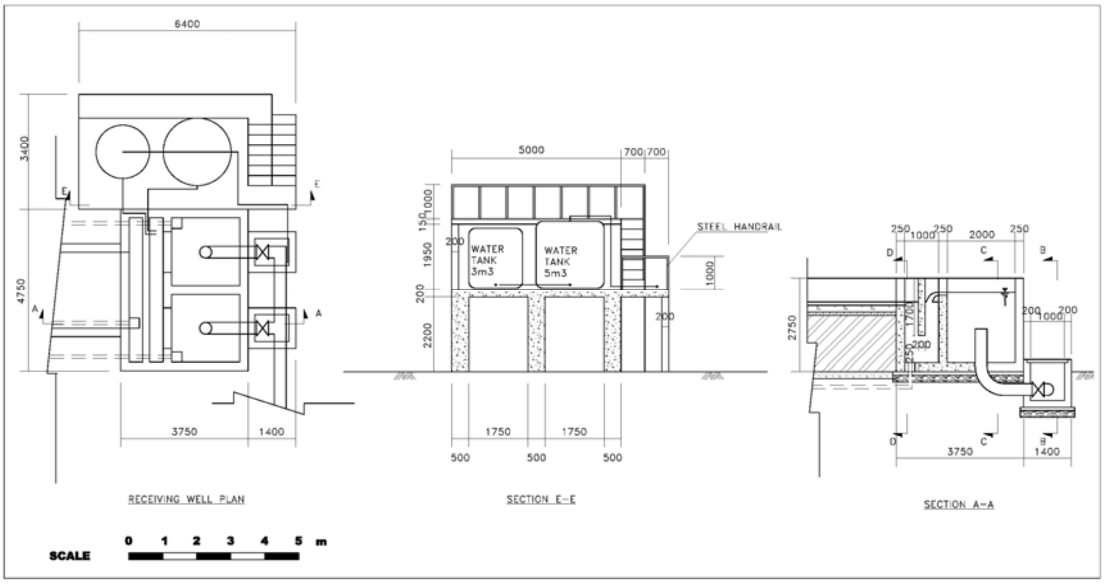


Figure 7.8: Design of Receiving Well

b.2 Flocculation

Flocculation basin is provided in order that coagulant, which is poured at the receiving well, formulates flocculation in there. Raw water is rapidly mixed with coagulant through the connection canal (length 5.0m×width 2.25m×height 0.8m) and is further mixed with coagulant at the flocculation basin. Horizontal flow flocculation basin is adopted because it does not use electricity and is easy to construct and maintain. Specifications are length 28.0m×width 1.0m×height 2.5m and retention time is around 26minutes.

b.3 Sedimentation tank

Sedimentation tank was designed to follow "Surface Water Treatment by Roughing Filters" which was published by Swiss Centre for Development Cooperation in Technology and Management. It is internationally used as design standard of roughing filter system for developing countries. Design criteria and applied figures to design sedimentation tank is summarized in Table 7.4 and details are described in the following section.

Table 7.4: Sedimentation Tank Design Criteria and Applied Figures

No.	Item	Equation	Unit	Design criteria	Applied figure
1	Length and Width ratio	L:W		3:1~8:1	3:1
2	Tank height	H	m	1.0~1.5	1.5
3	Surface loading	Q/(LW)	m/hr	0.2-1.0	0.45
4	Detention time	(LWH)/Q	hr	1.0-3.0	3.3

b.3.1 Length and width ratio

Design hourly water supply volume is 132m^3. In order to determine length and width ratio of the tank, it was assumed that tank height and surface loading were 1.0m and 0.5m/hr respectively. With the calculated area being 264m^2, the width and length ratio was chosen shown in Table 7.5.

Table 7.5: Alternative Study of Length and Width Ratio

L:W	L (m)	W (m)	LWH/Q (hr)	Selected
3:1	27	9	1.84	√
4:1	32	8	1.94	
5:1	35	7	1.86	
6:1	42	7	2.23	
7:1	42	6	1.91	
8:1	48	6	2.18	

There are not many detention time differences from 3:1 to 8:1 ratios. In this case, fewer L:W ratio means a cheaper construction cost. Thus, L:W ratio is designed to 3:1.

b.3.2 Tank height

Detention time is assumed to be 3 hours to consider maximum storage volume. Storage volume is 396m^3 for 3 hours, and length and width ratio are applied to 3:1. Maximum height is 1.5m to follow the criteria. Calculation result is shown in Table 7.6.

Table 7.6: Alternative Study of Tank Height

No.	H (m)	W (m)	L (m)	Area (m^2)	So (m/hr)	$Area_n/Area_1$	Selected
1	1.0	11	33	363	0.36	100%	
2	1.1	11	33	363	0.36	100%	
3	1.2	10	30	300	0.44	83%	
4	1.3	10	30	300	0.44	83%	
5	1.4	10	30	300	0.44	83%	
6	1.5	9	27	243	0.54	67%	√

All cases satisfy surface loading criteria. It is clear that sedimentation tank area can be reduced when tank height is deeper. The type of 1.5m in height can be granted to reduce 67% of required area to compare with 1.0m height case, therefore a height of 1.5m is selected.

b.3.3 Number of sedimentation tanks

One additional sedimentation tank is required in view of maintenance purposes, two tanks are at least required. Thus, plural sedimentation ponds are studied. Relation between the number of tanks and their performance is summarized in Table 7.7.

Table 7.7: Relation between Number of Tanks and Performance

No. of tanks	W (m)	L (m)	H (m)	So (m^2/hr.)	T (hr.)	Selected
1	7	21	1.50	0.45	3.3	√
2	5	15	1.50	0.59	2.6	
3	5	15	1.50	0.44	3.4	
4	4	12	1.50	0.54	2.8	
5	4	12	1.50	0.46	3.3	

There is no remarkable decrease in pond dimensions after decision of two tanks installation. It is less merit to have many tanks. Operation and maintenance works are easier if the number of tank is fewer. In addition, the largest scale tank is not so different from the existing tanks (25m length, 4.5m width, and 2.4m height). Thus, one sedimentation tank with 21m in length, 7m in width, and 1.5m in height is selected from Table 7.7. One additional tank is planned as a stand-by used during tank maintenance time. Two sedimentation tanks are designed in total (Figure 7.9).

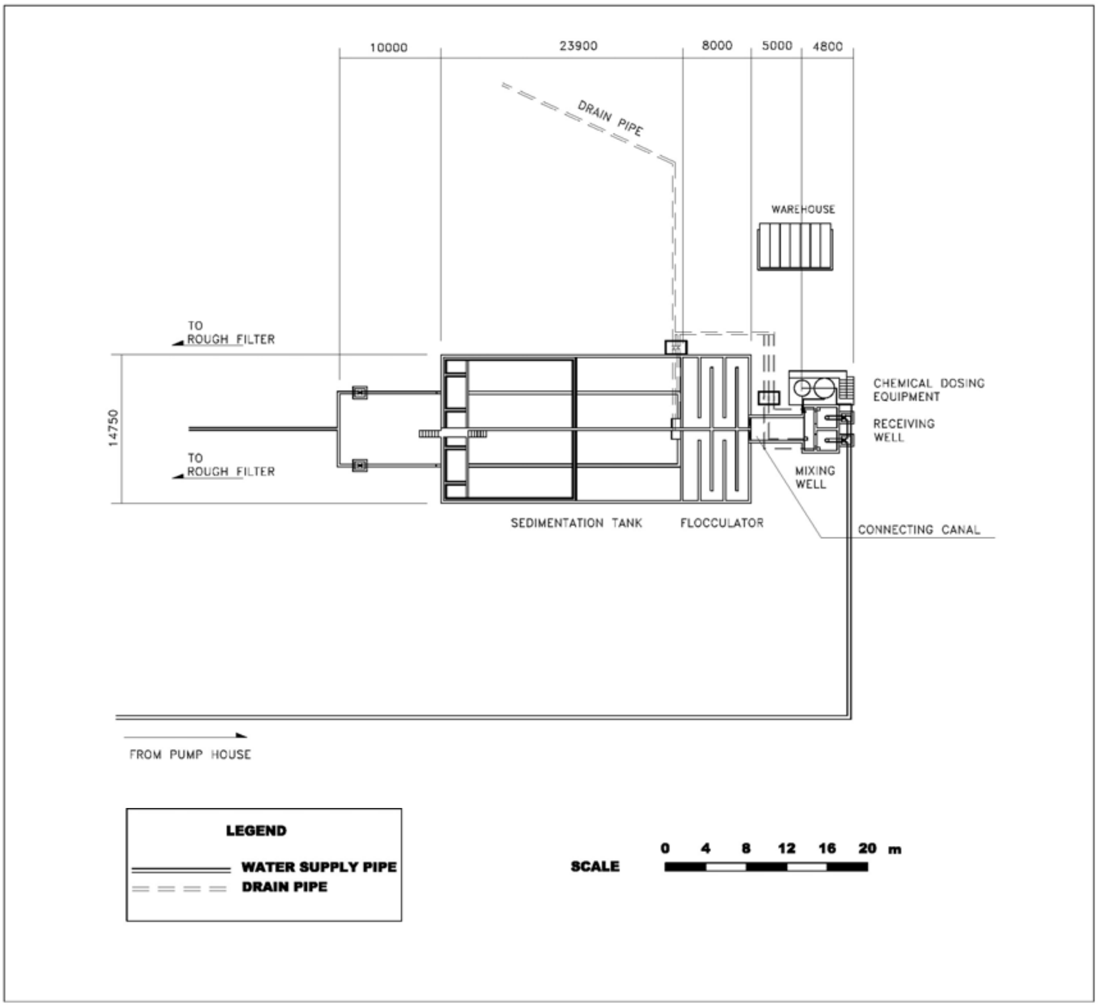


Figure 7.9: Design of Sedimentation Tank

b.4 Rough filter

b.4.1 Selection of filter type

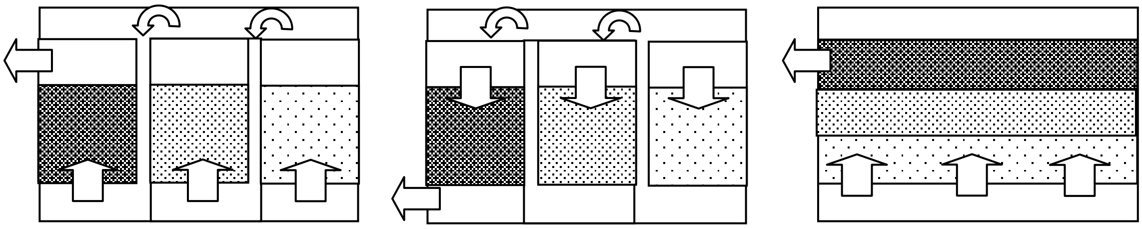
Rough filter has two types; vertical type and horizontal type. The existing rough filter is horizontal type. Both types have almost the same dimensions, alternative filter type review study is conducted to select the planned type. Study results are summarized in Table 7.8.

Table 7.8: Alternative Study of Rough Filter Selection

No.	Item	Vertical filter	Horizontal filter
1	Dimension	6m x5m x 1.0m	7m x 6m x 1.2m
2	Applied turbidity	50-150 NTU	5000-1000 NTU
3	Filtration rate	0.3~1.0m/hr	0.3~1.5m/hr
4	Required filter area	132~440m^2	88~440m^2
5	Filtered area	30.0m^2	7.2m^2
6	Required filter numbers	> 5	> 13

The difference between two types is filtering area. Vertical filter receives water from a vertical direction so that filter area is 30m^2 = 6m x 5m. Horizontal filter receives water from a horizontal direction like width and height. Then, filter area, 7.2m^2 = 6m x 1.2m, is much smaller than vertical filter and filter numbers are very huge. Though horizontal filter can purify high turbidity water, it is rather than large scale to plan 14 filters. It is for this reason that vertical filter is selected.

Vertical filter is further classified into three types. They are; 1) upflow in series, 2) downflow in series, and 3) upflow in layers. Each type image is illustrated in Figure 7.10.



1. Upflow in series   2. Downflow in series   3. Upflow in layers

Figure 7.10: Vertical Filter Types

No.1 upflow in series can have the highest turbidity removal rate. It is around 90% removal rate at the range of 150-500 NTU. The rate of No.2 also removes almost 90% of turbidity but it is around several percent less than No.1. No.3 removes turbidity with removal rate between 70~80%. Because of this reason, No.1 upflow in series type is selected as the filter type. Rough filter design is shown in Figure 7.11.

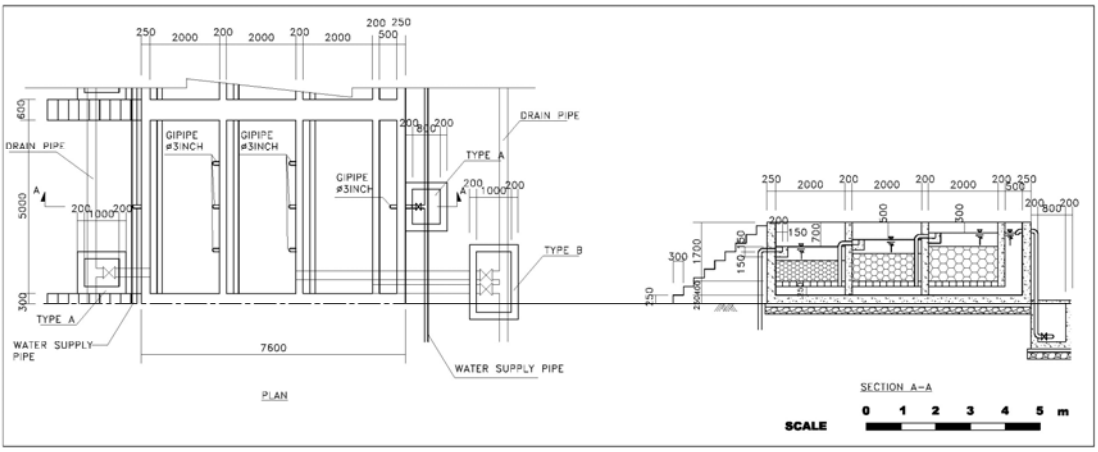


Figure 7.11: Design of Rough Filter

b.4.2 Drain system

Vertical rough filter is cleaned by using drain water. The manual, “Surface Water Treatment by Roughing Filters”, regulates the drainage rate, it ranges from 40m/hr. to 60m/hr. Drain pipe diameter is designed based on this criteria. Table 7.9 shows the relation between the drainage pipe diameter and the drainage rate from each filter. Pipe of 250mm diameter is adequate drainage rate and can secure hydraulic cleaning, therefore it is adopted. General layout of rough filter drain system is shown in Figure 7.12.

Table 7.9: Relation between Pipe Diameter and Drainage Rate

Pipe diameter	Drain time	Drainage rate
mm	Sec	m/hr
100	608	6
125	344	10
150	217	17
200	106	34
250	61	59
300	39	91

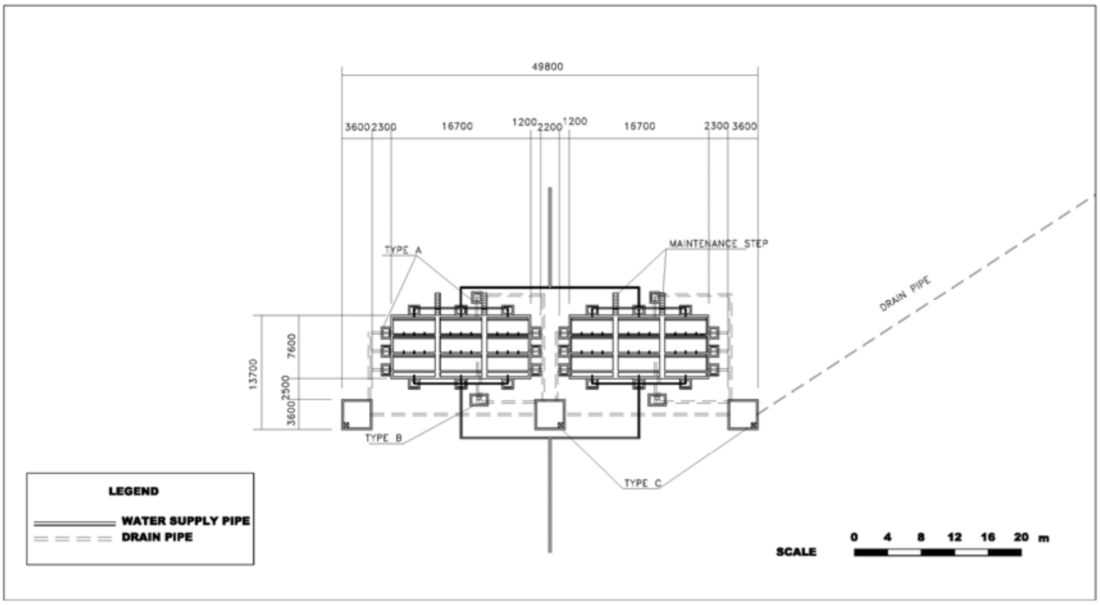


Figure 7.12: Rough Filter Layout and Drainage Plan

b.5 Slow sand filter

It is planned to fully purify turbidity, which cannot be removed at the rough filter. According to "Manual of Design for Slow Sand Filtration" issued by AWWA Research Foundation, the dimensions are $200m^2$ in maximum per filter. Larger area is easier for maintenance and cheaper construction cost. Maximum sand filter thickness is 1m. Therefore, one filter dimensions are length 20m, width 10m and thickness 1.0m. It is regulated that filter velocity range from 0.1 ~ 0.2 meter per hour. Required filter area is $660m^2 = 132m^3/hr. \div 0.2m/hr.$ and 4 filters $\approx 3.3 = 660m^2 \div 200m^2$ must be necessary. One filter is added to substitute during maintenance work. 5 slow sand filters are planned in total (Refer to Figure 7.13).

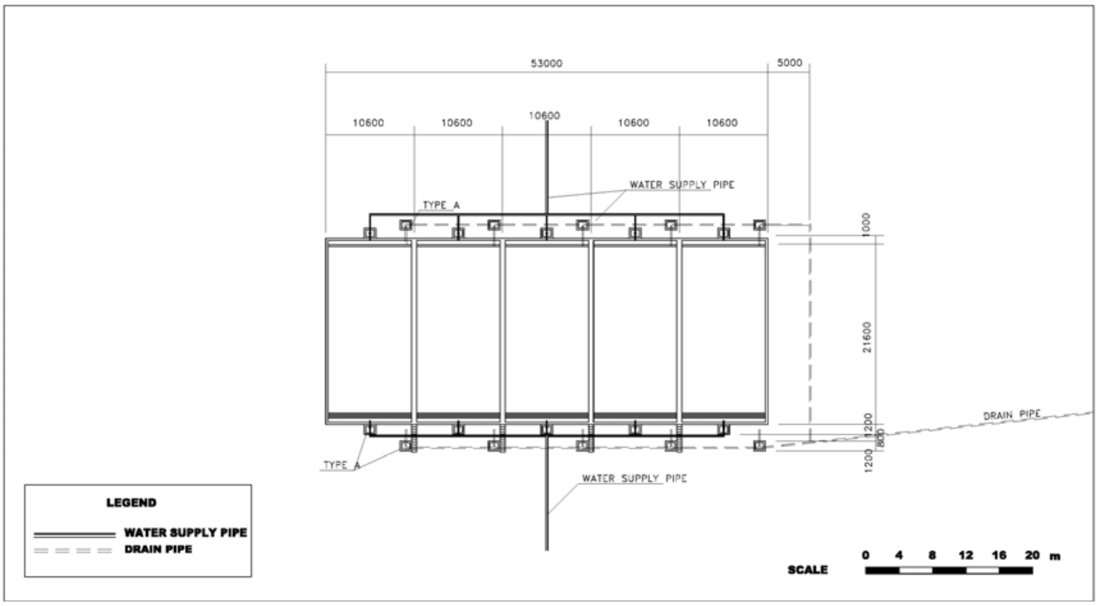


Figure 7.13: Slow Sand Filter

b.6 Treated water reservoir

It is planned to store treated water temporarily and flow to the surface pump station for their stable operation. The design water storage volume is set as night time water supply volume, namely 924m^3 (=one intake pump 1.1m^3/min x 60min x 14hours). The effective volume is set to 1,037m^3 = 24m x 24m x 1.8m to satisfy the design volume. It is in square shaped ground type. Two reservoirs are provided not to stop flowing water even though it is during cleaning work. Diaphragms are designed in order that water flow does not retain in the reservoir. Chlorination is conducted at the outlet pipe. Chlorination tank with 250L capacity is provided at the reservoir roof. Chlorine agent is mixed with water in the tank and is dripped into the reservoir (Refer to Figure 7.14).

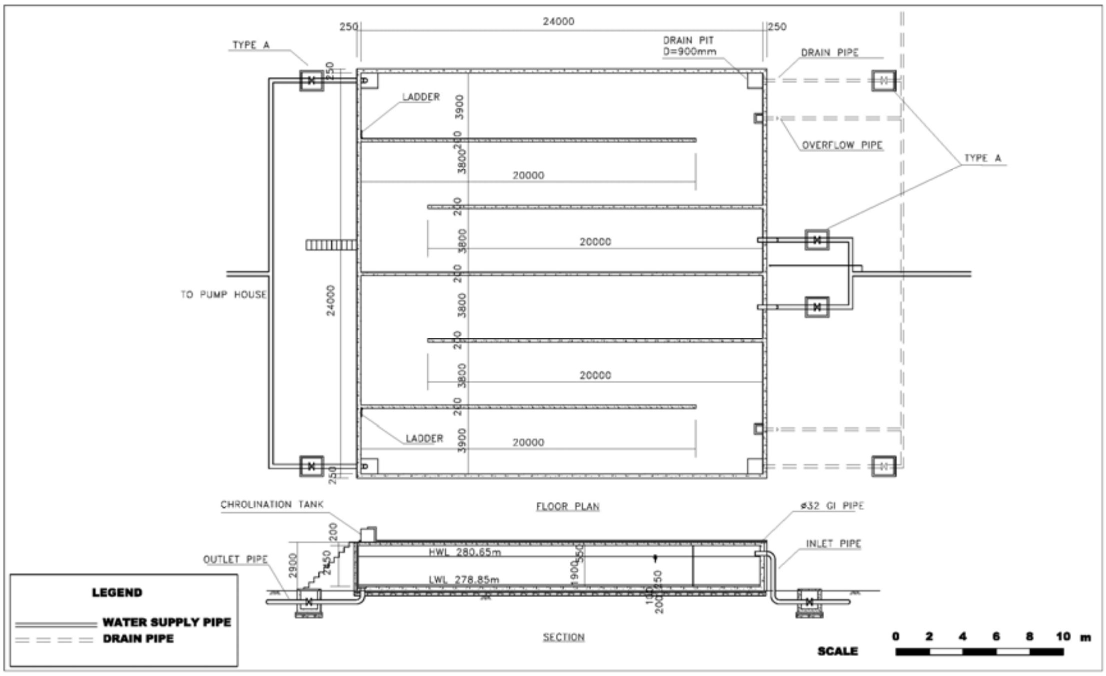


Figure 7.14: Design of Clear Water Reservoir

7.6 Transmission pipeline

a. Transmission pipeline plan

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 pipeline route is planned along the existing roads as the first priority because there is no land acquisition issue arising. Secondly, the route is planned to be as short a distance as possible. Thirdly, the route is along trunk road considering ease of construction.

The transmission pipeline extends from the surface pump station to eastern direction and passes through north side of the Christian compound. When the pipeline meets the peripheral trunk road of the town, it turns to left direction. It is installed along this road and runs the peripheral area of the town, then reaches to the reservoir. Total length is 4,998m (Refer to Figure 7.15).

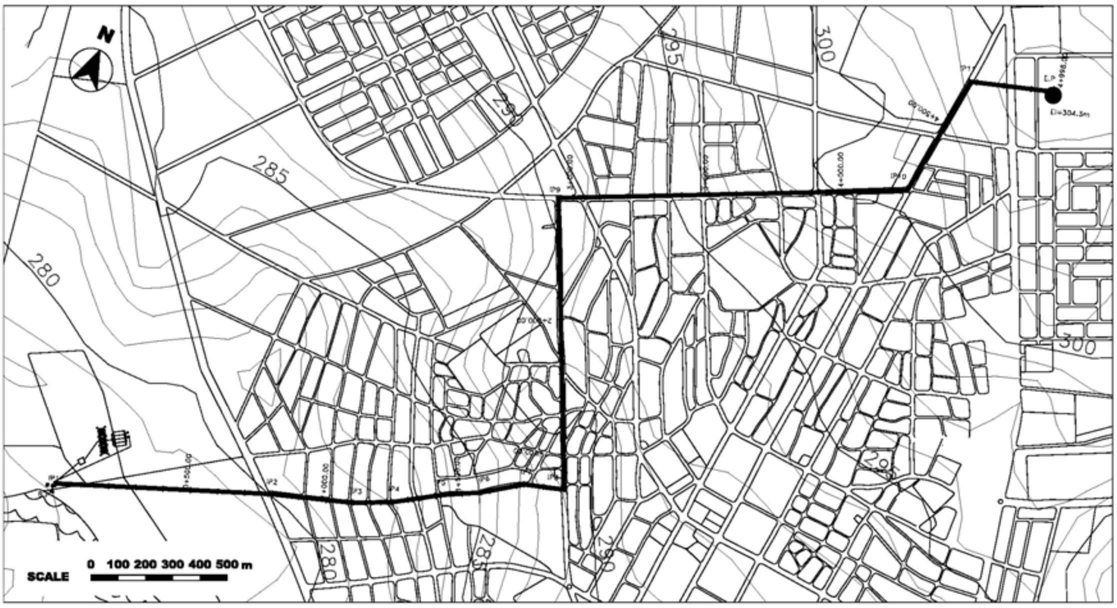


Figure 7.15: Transmission Pipeline Route

The topographic map of the transmission pipeline route was formulated based on the existing data and it was not the topographic survey result. Topographic profile was not prepared by the Study. The topographic survey shall be conducted before the detailed design work and the transmission pipeline route profile shall be confirmed. Afterward, air valve shall be arranged at high elevation point and drain valve shall be arranged at lowland.

b. General design

In order to decide the pipe diameter, hydraulic gradient is calculated applying to the William-Hazen formula.

$I = 10.666 \times C^{-1.85} \times D^{-4.85} \times Q^{1.85}$

Where;

C : Coefficient (110)
D : Pipe diameter (0.3m)
Q : Flow rate ($3.8m^3/min = 0.06m^3/sec$)
$I = 10.666 \times 110^{-1.85} \times 0.3^{-4.85} \times 0.06^{1.85} = 0.0034 \approx 0.34\%$
$H = 0.34\% \times 1000 = 3.4m$

In case that pipe diameter is 300mm, friction loss is 3.4m per 1000m. It means that total head loss is 17m in the pipeline section. If pipe of 250mm diameter is designed, total head loss is 41m. It needs tremendously huge power supply volume because lift height is more than two times. It is not appropriate to supply such huge amounts of electricity by generator in terms of cost and maintenance. Thus, pipe diameter chooses to 300mm type and friction loss shall get down to half level. Power supply volume can get down to an acceptable level.

7.7 Reservoir

a. Reservoir plan

The reservoir volume in 2020 is designed to be 800m^3 (Refer to 7.7b). The existing 3 reservoirs are 1,000m^3, 150m^3 and 60m^3 capacities respectively. Two existing reservoirs are elevated type and water levels are higher than the ground type of 1,000m^3 reservoir. It is rather difficult to operate different water level reservoirs at the same time. Therefore, two elevated type reservoir will be used for backup purposes and new reservoir in 400m^3 capacity, which half of total capacity, is planned in the water supply plan to supply water for higher elevation area.

Godey town is mostly on flat area. Though the existing reservoirs stand on top of a hill in the town, there is not much of a height difference between the reservoir and water connection. It is for this reason that the existing two reservoirs are in elevated type to secure higher water pressure at each water point. The new 400m^3 reservoir takes this function and it supplies water for higher elevation area. The existing 1,000m^3 reservoir will supply water for lower locations.

Though the new reservoir will be planned at the highest elevation point in the town, there is no clear height difference with surrounding area. Countermeasures shall be necessary to increase water pressures supplying for surrounding area. One is that the reservoir is designed to be in elevated type. The other one is to provide pump at the reservoir outlet. At this moment, no commercial power line is installed at the site. Besides, pumped water supply increases operation cost. Elevated type requires more construction cost, however, it is less operation cost and operation is easier than pumped water. Thus, the new reservoir is planned to be in elevated type (Refer to Figure 7.16).

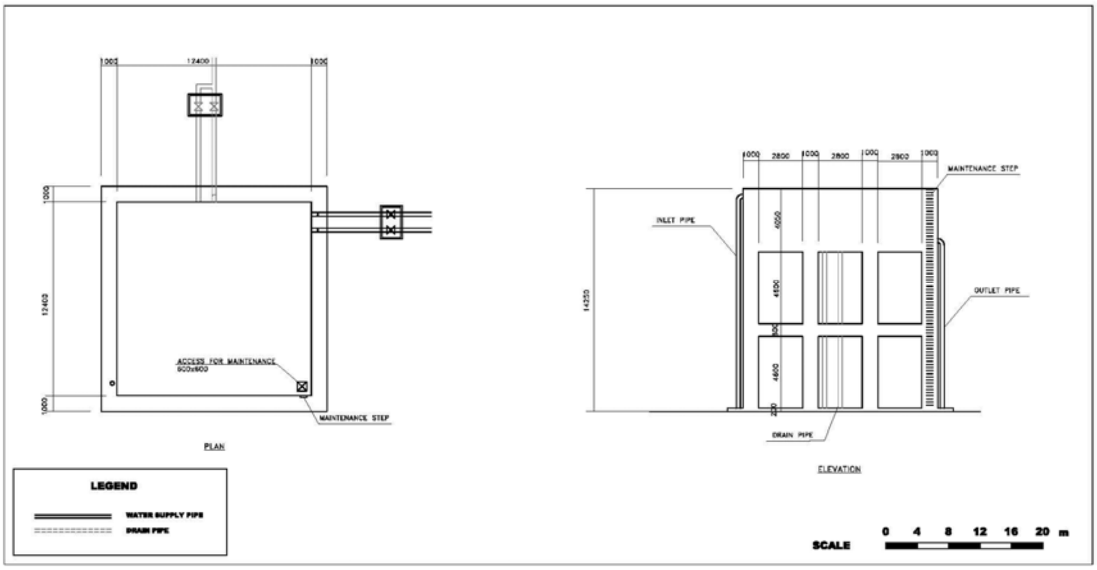


Figure 7.16: Design of Elevated Reservoir

b. General design

The reservoir volume calculation applies to the following equation, which is the same as the water supply master plan.

$V = 0.5 \times Q_d \times (1+10\%)$

Where;

Q_d : Average daily supply demand in 2020 (1,418m^3/day)

10% : Firefighting water demand

$V = 0.5 \times 1{,}418 \times (1+10\%) = 780m^3 \approx 800m^3$

The new elevated reservoir volume and height are designed to be 400m^3 and 10m. This volume is larger than normal for an elevated type. Its shape in rectangular type is selected in consideration of ease of construction.

7.8 Distribution pipeline system

a. Distribution pipeline plan

The existing distribution pipelines have been already deteriorated and do not function well. The distribution pipelines are planned to replace the existing ones and expand the distribution area. Particularly, there is no distribution pipeline system in western side of the town. The water supply plan provides distribution pipelines in this area. Besides, 5 public taps constructed by the JICA Study are located surrounding Godey town. There is no pipeline close to them. New distribution pipeline extends to each public tap and connects to them. Water can flow to each public tap after connection to the distribution pipeline.

Generally, topography in Godey town increases elevation from south to north direction. Water stored at the new reservoir is distributed to 2 directions. One is transmitted water for the existing reservoir and the other is distributed water for higher elevation area in the town. Boundary of the water supply area is set at elevation 293m. Water stored at the existing reservoir is supplied for less than 293m elevation area. Valves shall be provided at distribution pipes and distribution areas will be separated. Each distribution area will be an independent area and can secure water pressure. Distribution pipeline layout and water supply area by each reservoir is shown in Figure 7.17.

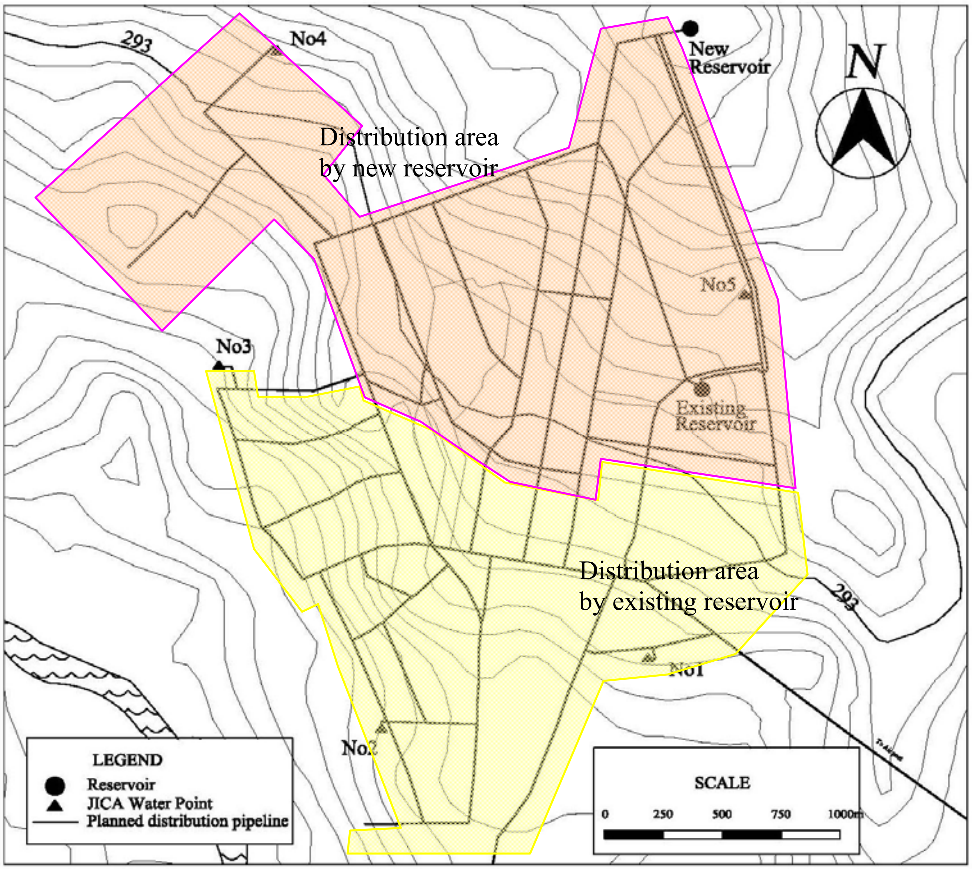


Figure 7.17: Distribution Area by Each Reservoir

Distribution pipeline system is mainly installed for the center of town. It covers limited areas of newly developing residential areas such as JICA water point No.4. If urban area expands in future, distribution pipe can easily expand to north direction. As for distribution pipe water pressure, the proposed elevated reservoir is located at the highest elevation point and secures 10m water head. North area of the reservoir is planned to be residential area in future, elevation is equal level to the reservoir. The reservoir has 10m height, water can flow by gravity to the area. Other new residential areas are lower than the reservoir, water can flow by gravity (Refer to Figure 7.18).

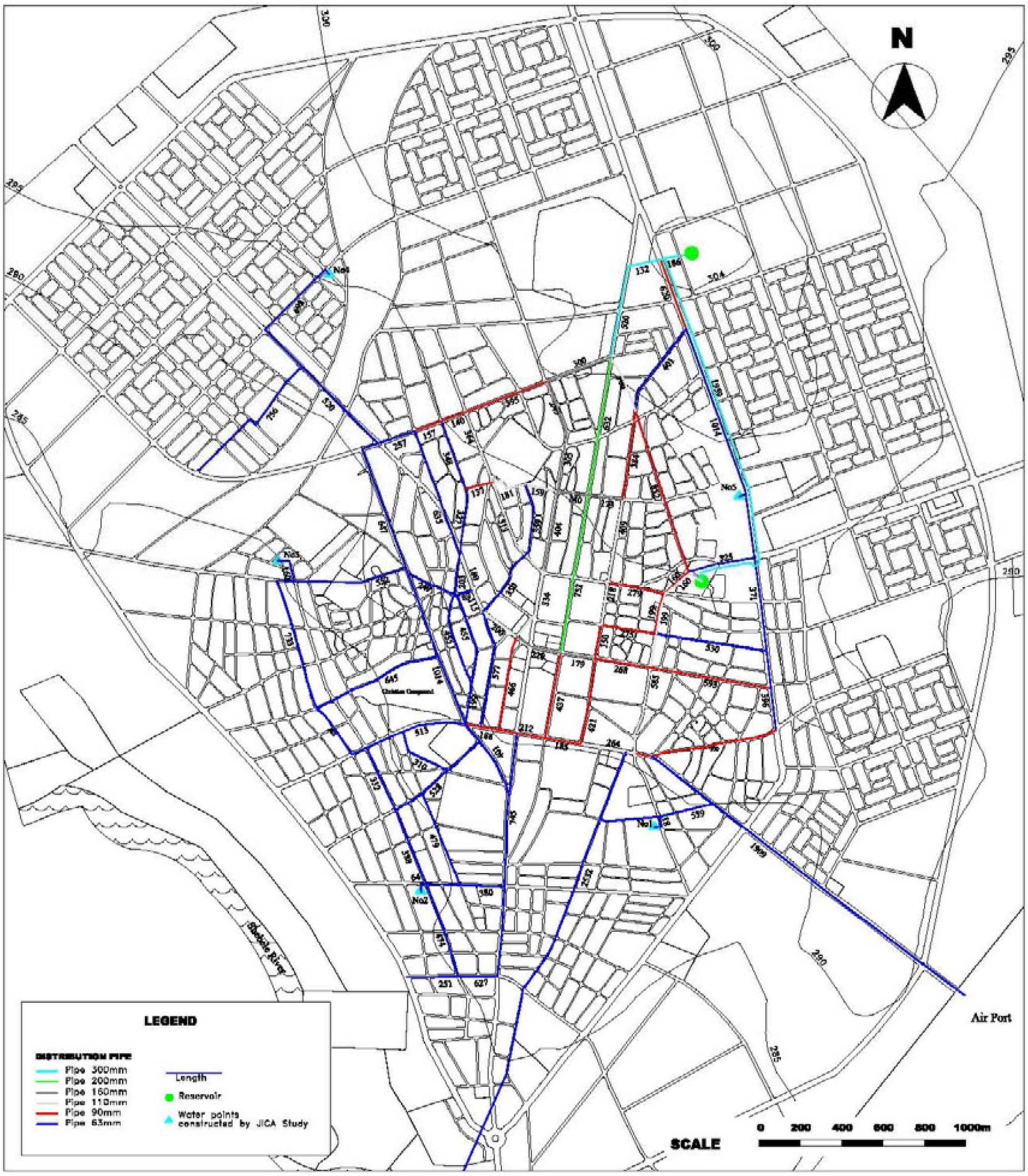


Figure 7.18: Godey Town Water Supply Distribution Pipeline Plan

b. General design

Distribution pipe is applied to uPVC pipe. Each pipeline route is along the existing road to avoid unnecessary private land acquisition. Total pipeline length is 39.3km and each of them is summarized in Table 7.10.

7.9 Water point

a. Public tap

As described in the section 5.2.1, the number of planned public tap users will be 18,479 persons. A public tap is provided for 900 persons, 21 public taps ~ 20.5 = 18,479 persons ÷ 900 persons are planned. Public tap design is modified from the pilot project, it does not provide water tank because water can reach to each public tap 24 hours from the distribution pipe. General design is shown in Figure 7.19.

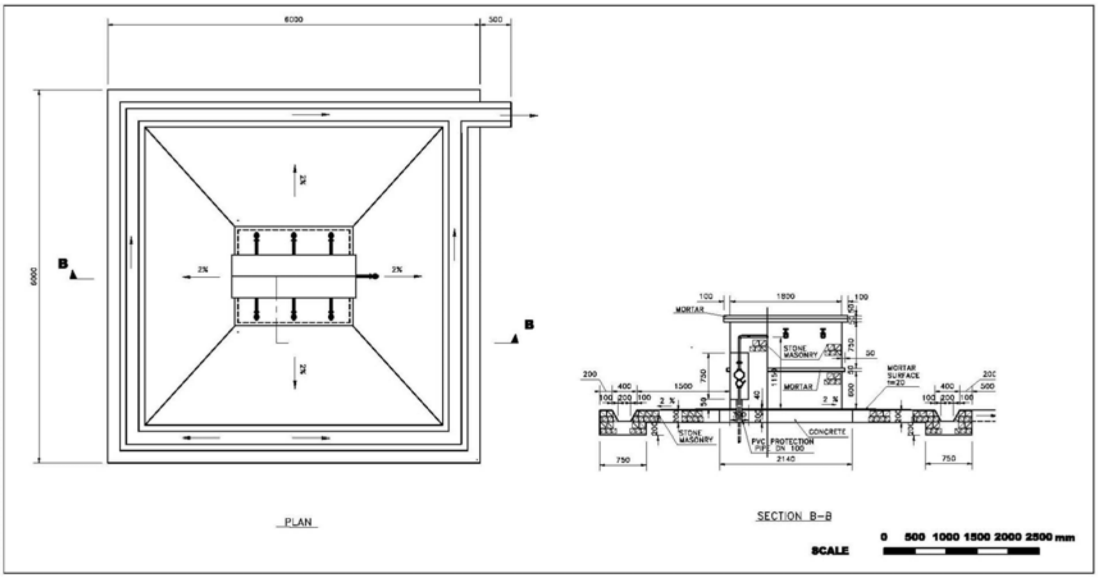


Figure 7.19: Public Tap

b. Cattle trough

Livestock water demand is calculated to 20% of drinking water demands. The number of cattle troughs is also 20% of public tap numbers and is 5 ~ 4.2 = 21×20%. Cattle trough design is the revised one applied to the pilot project. It is provided with public tap (Refer to Figure 7.20).

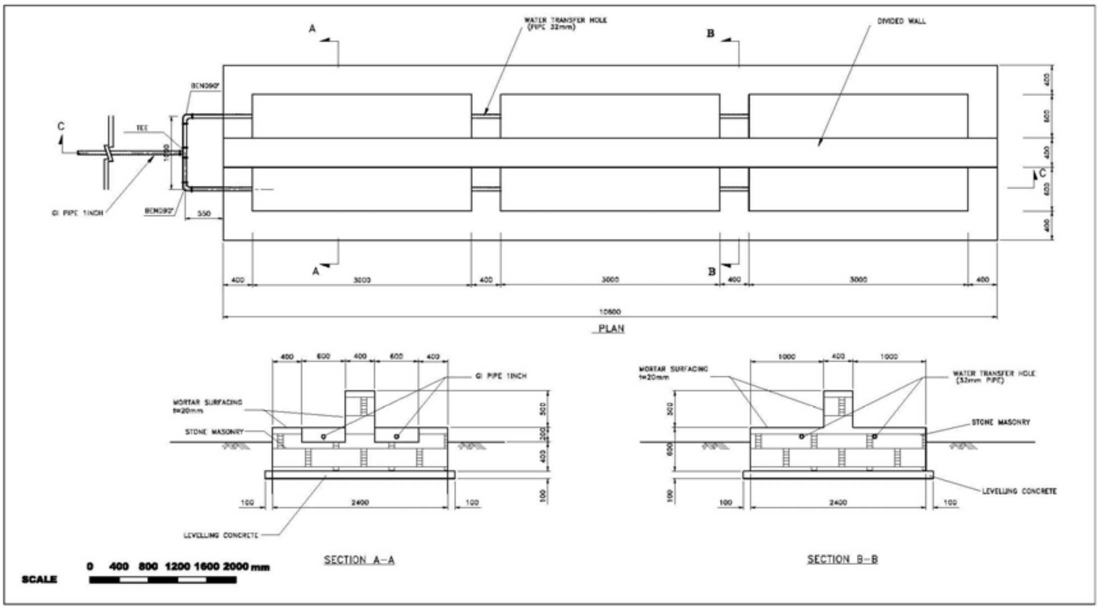


Figure 7.20: Cattle Trough

The Godey town water supply system component is summarized in Table 7.10.

Table 7.10: Major Features of Godey Town Water Supply System General Design

No.	Item	Specifications	Unit	Q'ty
1.	Intake canal	L=20m, W=2m, H=0.5m	No.	1
2.	Intake pump	Q=1.1m^3/min, H=15 m	No.	3
3.	Sedimentation tank	L=21m, W=7m, H=1.5m	No.	2
4.	Rough filter	L=6m, W=5m, H=1m	No.	6

No.	Item	Specifications	Unit	Q'ty
5.	Slow sand filter	L=20m, W=10m, H=1m	No.	5
6.	Treated water reservoir	V=1,000 m^3	No.	1
7.	Surface pump	Q=1.9m^3/min, H=59 m	No.	3
8.	Generator	120 kVA	No.	3
9.	Transmission pipeline	300 mm	m	4,998
10.	Elevated Reservoir	H=10m, V=400m^3	No.	1
11.	Distribution system			
11.1	Pipeline	63 mm	m	23,751
11.2		90 mm	m	7,218
11.3		110 mm	m	4,187
11.4		160 mm	m	1,884
11.5		200 mm	m	1,384
11.6		300 mm	m	2,797
11.7	Public tap		No.	21
11.8	Cattle trough		No.	5

Chapter 8

Cost Estimates

8 Cost Estimates

8.1 Capital cost

8.1.1 Method of cost estimation

a. Composition of capital cost

Capital cost and recurrent cost are composed of the following cost components. Construction cost (direct cost and in-direct cost) is considered as capital cost.

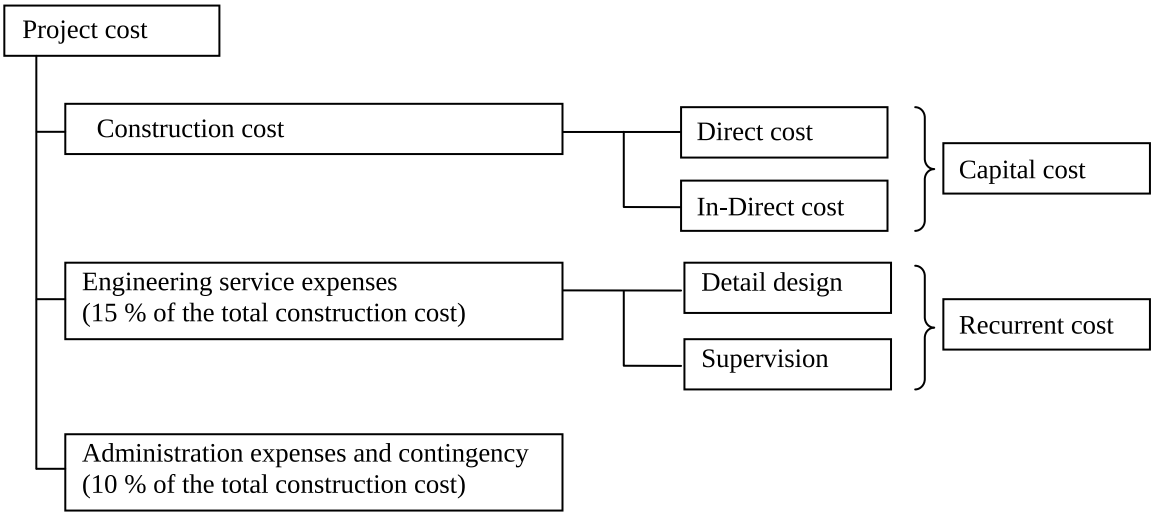


Figure 8.1: Component of the Project Cost

b. Method for estimation of capital cost

Construction cost as capital cost mainly consists of direct cost and indirect cost. Direct cost means that the cost is directly needed to construct objects. Direct cost is estimated by multiplying the quantity of each construction item calculated based on the design by the unit cost of each construction item. Then, the total direct cost is estimated by summing up the estimated cost for all the construction items.

In this study, the unit cost of each construction item was estimated based on the pilot project of water supply construction and price quotation collected from local construction companies. The unit cost of piping works differ depending on the type of the pipes. The pipes and fittings that used for the structural part of the intake, purification and transmission facilities and pipes with diameter more than D200, are considered important facilities. Therefore, pipes that have superior strength and durability such as ductile iron pipes (DIP) and stainless steel pipes were adopted for these important facilities. Unplasticized polyvinyl chloride pipes (uPVC pipe) and galvanized iron pipes (GI pipe) that are manufactured in Ethiopia, were selected as a pipe type.

Indirect cost mainly consists of the common temporary construction costs, the field office expenses and the general management cost. Indirect cost is not directly related to work performance amount of the construction objects. Indirect cost is the cost that will be used commonly for all construction work items. It was estimated based on the cost estimation standard book that is published by Japan Small-Scale Water Works Association. The calculation formula of the indirect cost is shown below.

Indirect cost = Common temporary construction cost (C) +Field office expenses (F)
+General management cost (G)

Common temporary construction cost (C) = Direct cost (D) * ratio of C
Ratio of C (%) = 485.4*D^ (-0.2231) + 1.0

Field office expenses (F) = (D+C) * ratio of F
Ratio of F (%) = 103.1*(D+T) ^ (-0.0977) + 0.5

General management cost (G) = (D+C+F) * ratio of G
Ratio of G (%) = -2.57651*Log (D+C+F) + 0.3163531

c. Conditions for the cost estimation

Conditions for the cost estimation of capital cost and recurrent cost are shown below.

- The project cost does not include value added tax (VAT) and land acquisition cost.
- The project cost is classified into Ethiopian local currency (ETB) and Foreign currency (USD) portions.
- The cost estimation is based on the prices in May, 2013.
- Price change (ETB and USD) of a period from the time of cost estimation to the commencement of designing and a period from the time of cost estimation to the tender of construction of Godey town water supply plan was taken into consideration for annual cost estimation of the project of Godey town water supply plan (the project of Godey town).
- The exchange rate of local currency is USD1.00 = 18.53 ETB as an average of control rates from November 1, 2012 to April 30, 2013.
- Engineering service and the construction are assumed to be implemented by the Ethiopia local companies.

8.1.2 Capital cost

a. Implementation schedule

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 the construction stage (implementation of the construction, trial operation of the facility, completion, supervising of the construction).

It is considered that the design stage for the project of Godey Town will take 16 months. The duration of the construction will depend on formation of construction teams. In this plan, it was assumed as follows:

- one team is assigned to intake, purification and transmission facilities construction and
- two teams are assigned for distribution facilities construction (including transmission pipeline),
- one team is arranged for public taps and cattle trough construction.

Therefore, the construction will be implemented by four (4) teams. Under this construction team formation, implementation of the construction is expected to take 26 months.

In the implementation schedule of the construction work, procurement of materials and equipment that are needed for the construction will be the critical factor to determine the period of implementation. Materials and equipment that are not manufactured in Ethiopia and not easy to procure in Ethiopian local market such as DIP and SUS pipes, submersible and surface pumps and generators must be procured from foreign countries. Therefore, it is considered to take a long time. Especially in the pipeline works of the project, the total length of pipeline is estimated to be more than 46 km. Thus, procurement of pipe materials will need time regardless of whether they are procured in Ethiopia or not. In addition to this, the total length of the main pipeline as an important component is approximately 8 km and it will be mostly DIP. DIP is not manufactured in Ethiopia. Therefore it will be necessary to procure them from foreign countries. The proposed implementation schedule considered the time required to procure these materials and equipment.

The proposed implementation schedule is shown in Table 8.1 below.

Table 8.1: Implementation Schedule of Godey Town Water Supply System

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																																											■

b. Capital cost, and capital cost for each year

Capital cost is shown in following Table 8.2.

Table 8.2: Capital Cost of Godey Town Water Supply System Plan

(Unit:USD)

Item	cost	Foreign Component	Foreign	Local
Capital cost (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**

The project of Godey town was planned to start with the design in 2015 and the tender in 2016. After the tender, the construction begins and will be completed in 2018. The project of Godey town will take 42 months from the design stage to the construction stage. The capital cost was spread over 3 years and the annual capital cost is shown in Table 8.3 below.

Table 8.3: Annual Capital Cost of Project in Godey Town

(Unit:USD)

Western calendar (year)	2016	2017	2018	Total
Capital cost (Construction cost)	2,348,000	2,348,000	2,347,000	7,043,000

c. Ratio of price change and capital cost including price change

c.1 Ratio of price change

The price change was considered in local currency (ETB) and foreign currency (USD).

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

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

Details of the price change estimation are shown in Data book.

c.2 Capital cost including price change

The cost of engineering service took into consideration of the price change period from May, 2013 (time of the cost estimation) to the estimated commencement time of the design stage. The price change in the construction was taken into consideration for the period from May, 2013 to the estimated date of tender for the construction (refer to Table 8.4).

Table 8.4: Number of Months for Price Change Consideration

Time of the cost estimation	Estimated date of commencement of design stage	Estimated date of tender for the construction
May, 2013	January, 2015	March, 2016
Number of months	20 months	34 months

The capital cost including the price change is shown in Table 8.5.

Table 8.5: Capital Cost for Each Year including Price Change

(Unit:USD)

Western calendar (year)		2016	2017	2018	Total including price change	Total not including price change
1.Capital 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

8.2 Recurrent cost

8.2.1 Method of recurrent cost

Engineering service expenses, and administration expenses and contingency are considered to be recurrent costs.

Engineering service expenses were estimated to occur uniformity at a rate of 15 % of the construction cost. The administration expenses and contingency cost were estimated to occur uniformity at 10 % of the construction cost for expenses such as procedure of contract of designing and construction work, consultation with the concerned parties, and contingency budget.

8.2.2 Recurrent cost, and recurrent cost for each year

The recurrent cost is shown in the following Table 8.6.

Table 8.6: Recurrent Cost of Godey Town Water Supply Project

(Unit:USD)

Item	cost	Foreign Component	Foreign	Local
1. Engineering service expenses (15% of construction cost, rounding up of the last three digits)				
	1,057,000	67%	708,000	349,000
2. Administration expenses and Contingency (15% of construction cost, rounding up of the last three digits)				
	705,000	67%	472,000	233,000
Recurrent cost	1,762,000		1,180,000	582,000

The project of Godey Town was planned to begin with the design in 2015 and the tender in 2016. After the tender, the construction starts, and it will be completed in 2018. The project of Godey town will take 42 months from the design stage to the construction stage. The recurrent cost was spread over four (4) years and the annual recurrent cost is shown in Table 8.7 below.

Table 8.7: Annual Recurrent Cost for the Project of Godey town

(Unit:USD)

Western calendar (year)	2015	2016	2017	2018	Total
Recurrent cost					
1. Engineering service expenses	264,000	264,000	264,000	265,000	1,057,000
2.Administration expenses and contingency	176,000	176,000	176,000	177,000	705,000
Total	440,000	440,000	440,000	442,000	1,762,000

Recurrent cost including the price change is shown in Table 8.8 below.

Table 8.8: Annual Recurrent Cost including Price Change

(Unit:USD)

Western calendar (year)	2015	2016	2017	2018	Total including price change	Total not including price change
Recurrent cost						
1.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
2.Administration expenses and contingen	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	474,000	474,000	483,000	1,905,000	1,762,000

Total project cost which consists of capital cost and recurrent cost including price change is as follows;

Table 8.9: Project Cost of Godey Town 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 contingenc	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

8.3 Operation and maintenance cost

8.3.1 Proposed systems and required O&M work and cost

a. Conditions of planning and cost estimation

The operation and maintenance plan for the proposed water supply systems of Godey Town has been prepared in consideration of following conditions as it was for the woredas and Kabribeyah town.

- Specific O&M work corresponding to the specification, size, and level of technology employed of the proposed facilities was proposed.
- To realize appropriate O&M work in future, 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 leader of the group was assigned and provision of appropriate training for the leaders was planned. Such member with sufficient qualification can probably be newly recruited from outside and their employment condition should also be improved.
- In order to supply materials and equipment necessary in operation and maintenance work, SRWDB is expected to procure such items according to the schedule and deliver them to site on time. Especially, the master plan requires the use of a large amount of chlorination chemicals to disinfect water for all the target woredas. Therefore, SRWDB should buy a large amount of the chemical in Addis Ababa and distribute them to each woreda. It was assumed as a prerequisite.

The cost of operation and maintenance was calculated in consideration of the following conditions.

- The O&M cost covers both the newly planed facilities and the existing facilities for all woredas and towns.
- The cost of O&M of the terminal water supply facilities such as public water supply points that are normally operated and maintained by WASHCO was not included.

- Staff assignment at each facility was planned in principle based on the existing operation of the same facility in order to prepare realistic plan.
- The cost is calculated as an annual average of 10 year operation. Thus, the cost that occurs every few years was distributed over the 10 years.
- The cost of replacing over-used equipment is separately calculated for corresponding years.
- The cost does not consider accidental expanses but only regular expenses.

b. Target of O&M plan and cost items

Basic information of the water supply system of Godey Town as the targets of O&M planning and O&M cost estimation along with the approaches of determining the types of work required and assignment of staff is concisely described in Table 8.10. The type of work and number of staff members required for the work are shown in more detail for each and all facilities of the proposed systems of the town (refer to Table 8.11 and Table 8.12). The cost of O&M for the system was calculated based on the data following the cost items below.

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

In the cost estimation, actual price data was used as much as possible to make the values realistic. However, the amount of chemicals, whose cost has a great impact in the total O&M cost, should be verified at the time of the training after the detailed design. Then the O&M cost should be reviewed along with the other costs and revised accordingly. The details of the cost estimation are presented in Data Book.

c. Plan and cost of O&M of the proposed water supply system in Godey Town

c.1 Work required and staff assignment

For the operators who are the major players of O&M work, the study team has proposed to newly assign a leader of operators to supervise them at each facility. These leaders are named technicians. Such members can be recruited from outside and should have at least TVET level educational background. Also, once employed, appropriate technical training should be given from the stage of construction of the facilities. The operation of the new system in Godey Town involves input of water treatment chemicals such as coagulant and pH adjusting agent that the staff is not familiar with. The daily dose of these chemicals should be determined based on a simple lab tests and the dose should be adjusted according to the flow conditions. One of the main tasks for the technician is to supervise this work. The treatment of turbid water involves a large amount of chemicals and thus, some assistant should assist the operators. Also, one laboratory technician is assigned to engage in daily checking of water quality and the lab test of water to determine the dosage of the chemicals.

The tasks required, frequency of the tasks, and assigned staff for the set of facilities constituting the water supply system that will be managed by the town water supply utility office are presented in Table 8.10. Based on this detailed O&M plan, the total number of staff required to operate the water supply system in Godey Town was determined as in Table 8.10 below. The number of current staff members assigned is also shown as a reference.

Table 8.10: Total Number of Staff Required for Operation of Planned System in Godey Town

Facility cluster	Stationed field staff					Temporary staff	
	Technician	Operator	Assistant. Operator	Lab. Technician	Guard	Day worker (man-day /year)	WD staff (man-day /year)
Intake, Pump st., Generator house, Sedimentation pond, Rough filter, Slow filter (Fac. 1-6)	5 [2]	6 [2]	3 [0]	0 [0]	18 [6]	4950 [4580]	8
Terated water reservoir (Fac. 7)		2 [0]	2 [0]	2 [0]	3 [1]	20 [216]	0
Distribution reservoir (Fac.8,9)		3 [0]	0 [0]	0 [0]	6 [0]	21 [96]	0
Back up distribution reservoir (Fac. 10)	0 [0]	0 [0]	0 [0]	0 [0]	[NA]	0 [NA]	0
Transmission and distribution pipeline system (Fac. 11)	0 [0]	0 [0]	0 [0]	0 [0]	[NA]	200 [NA]	60
Sub-total	5 [2]	11 [2]	5 [0]	2 [0]	27 [7]	5191 [4892]	68
Total	50 [15]						

Note: the numbers under the header "Facility cluster" signify the facility number in Table 8.13 to Table 8.15.
The numbers shown signify the total number of field staff to be employed under the system of working in shift.
The shaded entries are temporary staff members from water desk (WD) and not calculated in the O&M cost.
The numbers in brackets "[ ]" signify the total number of current staff employed.

Although, the basic procedure of water treatment and distribution in the system will be similar to the existing one after the completion of the project, the operation is not currently properly done and the size of the system will increase. In the O&M plan, the task of input of water treatment chemicals and removal of sludge from the sedimentation pond should be properly conducted. For this reason, the numbers of technicians and operators have been increased. Also, new positions of assistant operator and lab technician have been created to support the operator's work that is expected to be more complex and labor intensive at the same time. On the other hand, the number of day workers required increased only a little due to improved efficiency of the proposed system. The technical staff (engineers and plumbers) of Water Desk as temporary staff mainly engage in the maintenance of distribution pipelines for 68 man-day.

c.2 Estimated cost

In Godey Town, as explained in the section of water supply planning, almost the entire system will be newly constructed. However, the small existing facilities that will be continued to be used were also considered together to conduct the cost estimation. It was assumed that the existing system will be properly managed and maintained until 2020 and that the old equipment will be all replaced at the beginning of 2020, the target year of the master plan. Namely, the system was assumed all functional at the start of the year 2020. As for the personnel cost, only the stationed field staff and day workers were calculated but not the temporary staff from water desk (town water supply utility office) of the shaded columns in the table above.

The O&M cost of the system was calculated accordingly using the current price and is presented in Table 8.16. The calculated annual O&M cost is 3,929,000 Birr in 2013 price and it is equivalent to about US$ 212,000. Approximately 60% of the total O&M cost is the fuel cost, which is followed by chemical cost and personnel cost of about 20%.

Also, the cost of O&M combined with the replacement cost of equipment over 10 years from 2020 is presented in Table 8.17. The calculation considered the price increase rate of 11.3% . The price increase was assumed to apply up to the year 2020 and to be 0 % after that.

Table 8.11: Policy of O&M of the Facilities in Godey Town (1)

1 Basic conditions	Water supply amount: 2,212 m^3/day (maximum value including 30% leakage loss) Pump operation: 24 hours/day Facilities and equipment: Intake pump x 2 (driven by two 120kVA generators) Distribution pump x 2 (driven by two 120kVA generators) Sedimentation pond, Rough filter, Slow sand filter, Clear water reservoir, Elevated water tanks
2 Staff assignment	The assignment of staff was proposed based on the staff assignment at existing facilities and their work status. It also took into account the size and required work at the planned facilities as follows. Some operators should have some basic theoretical knowledge on their work and leadership skills. One person who has at least TVETC level education as a leader (technician) of operator is assigned. Technically more intricate work such as determination of chemical dosage and high level maintenance of work will be assisted by an engineer from the town water supply utility office as required. One lab technician is assigned to conduct water tests to determine appropriate dose of water treatment chemicals. The staff should avoid excessive over work and their assignment was proposed to realize average 8 hour/day work by working in shifts. The staff assignment was proposed to minimize interruption of water supply even when maintenance such as tank cleaning is conducted.
3 Generator fuel and commercial electricity	The fuel efficiency of the existing generators is reported to be 5 to 6 L/h and that of the new ones procured in the pilot project was measured to be 4 to 5L/h. Thus the value of 5L/h was adopted for the generator of same size. For others, figures (70% load) from product catalogues were used. - The operation of one intake pump is continuous 10 hours and second 24 hours - Diesel fuel is available in Godey Town
4 Water treatment chemicals	In Godey Town system, coagulant, pH adjuster, and chlorine disinfectant are used. Calcium hypochlorite is easy to handle and relatively safe and also it lasts longer in storage. Thus, calcium hypochlorite powder is used as a disinfectant. It is available in Addis Ababa. The dosage will have to be determined based on the test at site but it is assumed to be 3mg/L Aluminum sulfate powder, easy to procure in Ethiopia, is used as coagulant. The dosage will have to be determined based on the jar test at the site every day. It was however, assumed to be 100mg/L based on data from several water treatment plants including AAWSA, Ethiopia. In order to adjust pH of water after input of aluminum sulfate, lime (Calcium hydroxide) will be added. The dosage is assumed to be 40mg/L Note that sufficient training should be given to the staff who deal with the chemicals.

Table 8.12: Policy of O&M of the Facilities in Godey Town (2)

5 Spare parts for equipment	In consideration of the fact that the existing equipment mostly breaks down in around 3 years, and the maintenance capacity will also be improved, the realistic life of equipment and frequency of parts replacement was set as follows: Ground pump: 5 years, Generator: 7 years The following spare parts for generator were assumed Engine oil（every 6 months） Fuel filter（every 6 months） Oil filter（every 6 months） Air cleaner（every 6 months） Fan belt（once every 2 years） Assumed spare parts for ground pump are as follows: Gland packing (once a year) Mechanical seal (once a year) Bearing (once every 3 years)
6 Large equipment	They are replaced right after their estimated life years are reached starting from 2020. The large equipment will be procured with assistance from donors and thus free from customs tax. This cost is not included in the regular O&M but separately handled
7 Cleaning of reservoir tanks	In consideration of power supply conditions at site and difficulty in maintenance of the associated small equipment, the cleaning work should be conducted all manually. The assignment of works was determined based on the existing conditions and the size of the planned facilities. Daily workers are employed to work under the supervision of the operator. Actual facilities to be cleaned are shown in another table and the following tools may be used. Shovel, deck brush, scraper (made from iron pipe), dewatering pump, bucket, soil carrier
8 Sludge removal in slow sand filtration pond	The condition of the filter layer in the slow sand filtration pond should be maintained through adjusting in response to the surrounding environment in order to assure the best performance. Since the work is highly technical and requires experience, the work will be done under the supervision of 2 technicians who have received necessary training. The technicians will instruct the operators and day workers. The work is done all manually.
9 Other maintenance work	The short pipes and valves attached to the ground pumps are taken apart and the accumulated scale is removed carefully.

Table 8.13: Regular Operation and Maintenance Activities for Each Set of Planned Facilities in Godey Town (1)

Facility	Spec/Capacity (Dimension)	Detailed O&M tasks	Frequency (duration)	No. of Staff assigned (Work shift)	Remark
1. Intake canal	Concrete channel with 2 screens (W: 2 m, Depth: 5.5 m) L = 20 m)	1) Sludge removal	1 time / year (6 hours)	1 technician 1 operator 20 daily workers	Cleaning of the channel is only done at the peak of dry season.
		2) Screen cleaning	4 times / month (2 hours each)	1 technician 1 operator 2 daily workers	Large debris stuck in the screen is removed
Settling basin	V = 46m^3 1.5m x5.7m x 5.4m Including the receiving well	3) Sludge and garbage removal	4 times/year (4 hours each)	1 technician 1 operator 4 daily workers	The bottom of the chamber is roughly cleaned Intake filter cleaning
2. Pump house	2 intake pumps (Q =66 m^3 /h, H = 15m) x 2 pump 2 surface distribution pumps (Q =114 m^3/h, H = 59)x 2 pump	1) Pump switch on and off	2 times/day 8:00 - on 18:00 - off (15 min each)	2 Operators (4 in shift)	Design supply amount is 2212m^3/day. 24 hour continuous operation 2) Gland packing, mechanical seal, and bearing will be replaced.
		2) Pump spare parts replacement	1 time / year (1 day) x 4 pump 1 time / 3 years (1 day) x 4 pump	1 technician (5 in shift) 1 operator 2 plumbers 2 daily workers	
		3) General guarding	Every day (24 hrs)	1 guard (3 in shifts)	
3. Generator house	2 generators 120kVA x 2 generator 1 back-up generator	1) Generator operation	2 times/day 8:00 - on 18:00 - off (15 min each)	2 Operators (3 in shift)	One generator is standing by as a backup
		2) Spare parts replacement	2 times / year 1 time / year (2 hour) x 2 generators	1 technician 1 operator 1 daily workers	Engine oil, Oil filter, Air filter, Belt,
		3) General guarding	Every day (24 hrs)	1 guard (3 in shifts)	

Table 8.14: Regular Operation and Maintenance Activities for Each Set of Planned Facilities in Godey Town (2)

Facility	Spec/Capacity (Dimension)	Detailed O&M tasks	Frequency (duration)	No. of Staff assigned (Work shift)	Remark
4. Sedimentation pond	Sedimentation pond 2 ponds in parallel (21 x 7 x 1.5m) x 2 V= 220m^3 x 2 One pond for backup	1) Sludge removal	Dry: 1 time/ 6 months (2 days each) x 3 pond Rainy: 1 time/ 2 months (5 days each) x 3 ponds	1 technician (5 in shift) 1 operator (2 in shift) 15 daily workers	1 out of 2 ponds are regularly used Sludge removal is done for one pond at a time
		2) Coagulant and lime dosing	1 time / day (60 min)	1 technician (5 in shift) 1 operator 2 assistant operator (3 in shift) 1 lab-technician (2 in shift)	
		3) Store room management	Every day	2 assistant operators	Handling of chemicals
		4) General guarding	Every day (24hrs)	1 guard (3 in shifts)	Same as 3 – 3)
5. Rough filter	Q = 132 m^3/h (6 x 5 x 1 m) x 6 chambers with 1 for backup	1) Surface sludge removal	1 time / year (2 days) x 5 time	1 technician 1 operator 5 daily workers	5 out of 6 chambers are used regularly 1), 2) Cleaning is done for 1 chambers at a time
		2) Filter cleaning	1 time / 2 years (5 days) x 5 times		
		3) General guarding	Every day (24hrs)	2 guards (3 in shifts)	
6. Slow sand filtration pond	One sand filter system Q = 132 m^3/h (20 x 10 x 1 m) x 5 chambers with 1 for backup	1) Surface sludge removal, conditioning of the filter layer	6 time / year (2 days) x 5 time	2 technician 2 operator 20 daily workers	Out of 5 chambers, 4 will be regularly used. One is for backup. 1), 2) the cleaning is done for 1 chamber as a unit. This is probably the most technically difficult work in this system
		2) Filter cleaning	1 time / year (5 days) x 5 times		
		3) General guarding	Every day (24hrs)	2 guards (6 in shifts)	

Table 8.15: Regular Operation and Maintenance Activities for Each Set of Planned Facilities in Godey Town (3)

Facility	Spec/Capacity (Dimension)	Detailed O&M tasks	Frequency (duration)	No. of Staff assigned (Work shift)	Remark
7. Treated water reservoir	1 reservoir (24 x 24 x 1.8 m) V= 1,000m^3	1) Cleaning	1 time / year (6 hours)	1 technician (5 in shift) 1 operator 20 daily workers	
		2) Chlorine dosing	1 time/day (30 min)	1 operator 1 assistant operator	
		3) General guarding	Every day (24hrs)	1 guard (3 in shifts)	
8. Reservoir 1	V= 400 m^3 11.8 x 11.8 x 3 m Elevated 10 m	1) Tank cleaning	1 time / year (4 hrs)	1 operator 6 daily workers	
		2) Level check and valve operation	2 times/day (20 min each)	1 operator	
		3) General guarding	Every day (24hrs)	1 guard (3 in shift)	
9. Reservoir 2 (Existing)	V= 1,000 m^3	1) Tank cleaning	1 time/ year (4 hrs) x 1 tank	1 operator 12 daily workers	
		2) Level check and valve operation	1 time/day (15 min)	1 operator	
		3) General guarding	Every day (24hrs)	1 guard (3 in shift same as 8-3))	
10. Reservoir 3 & 4 (Existing)	2 tanks for backup V_1 = 60m^3 V_2 = 150m^3	1) Tank cleaning	1 time/ year (4 hrs) x 2 tank	1 operator 12 daily workers	These 2 tanks are used as backups
11. Pipeline system	Transmission pipe D300 (L= 4,998m) Distribution pipe D 300: 2,797m D 200: 1,384m D 160 less (L = 37km)	1) repair and replacement of pipes	1 time/ 6 months (5 day)	1 operator 2 Engineers from WD 4 plumbers from WD 20 daily worker	Repair is done based on observation and reports Engineers and plumbers from WD

Note: Water Desk = Town water supply utility office,
* The number of assigned staff members indicated signifies the number required for each facility and thus the same members may work at other facilities.
* Assigned staff and shift: the number after the staff title signifies the number of persons who work at the facility on a given day while the number in “shift” is the total number of the staff members who work in shift.

Table 8.16: O&M Cost of Water Supply System of 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 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

Table 8.17: O&M Cost and Replacement Cost for the Master Plan Water Supply Systems of Godey Town from 2020 to 2030

Unit: Birr

Year	O&M cost	Replacement cost	Total
2013	3,929,304	0	3,929,304
2020	8,313,459	0	8,313,459
2021	8,313,459	0	8,313,459
2022	8,313,459	0	8,313,459
2023	8,313,459	0	8,313,459
2024	8,313,459	0	8,313,459
2025	8,313,459	3,385,280	11,698,739
2026	8,313,459	0	8,313,459
2027	8,313,459	5,077,920	13,391,379
2028	8,313,459	0	8,313,459
2029	8,313,459	0	8,313,459
2030	8,313,459	3,385,280	11,698,739

Chapter 9

Operation and Maintenance

9 Operation and Maintenance

9.1 Condition of organizations and management

9.1.1 Godey Town water supply utility office

a. Outline and background of the office

Godey city is a new administration that was spun off from Godey Woreda around the middle of 2011. The water supply utility office was created at the same time as part of the city administration. The office is in charge of the management and O&M of Godey town water supply system. A water board made up of seven representatives from stakeholders was established as a consultation body on water supply issues in the town about eight months after the establishment of the office but it was inactive after a while. Thus the office is temporarily fully in charge of any decision making on the town's water issues. Decisions made by the office have to be ultimately approved by the city council. The head of the office was replaced in January 2013 and the members of the water board were also changed to be the following 10 members.

1. Chairperson: Godey town Mayor
2. Deputy Chairperson: Godey town manager
3. Secretary: Godey town water supply utility office
4. Member: Godey town administration finance office
5. Member: Godey town administration women's affairs
6. Member: Godey town administration health office
7. Member: Godey town administration education & capacity building office
8. Member: Godey town electric power cooperation authority
9. Member: Community elders
10. Member: Women's association

This change of the office head helped improve the environment of the office and the water supply condition as well.

b. System of bill collection

A meter reader goes around to check the meters at the end of every month. They bring the data back to office and the bills are prepared in the office. The customers, after receiving the bill, pay the bill at the office. The money collected is recorded and taken to the bank. The average monthly amount of money collected is generally 70,000 Birr. The rate is fixed at 15 Birr per 1 m^3 regardless of the total amount used or the type of customers. If the water meter is rented, the user is charged a rent of 8 Birr per month. At the public water supply points, water is provided totally free or as low as 2 Birr per 1 m^3. However, at one site which is located in a private yard, the household owner controlled the price for her own sake and refused to give water to those who could not afford the rate. As a result, only 10 households were able to get water from that point. This problem was solved by the water office after the study team pointed it out.

Collection of money depends on the voluntary conduct of the customers and thus, many people pay late or default on their payments. As a result, usually only 60% of bills are paid on time. In general, when the users default more than 2 months, the office will stop the water supply. However, this rule does not apply to some government workers who have regular incomes. Although decisive data was not obtained, it is assumed that the current recovery ratio of water bill will be around 70% if the later payers are included.

c. Budget for the office

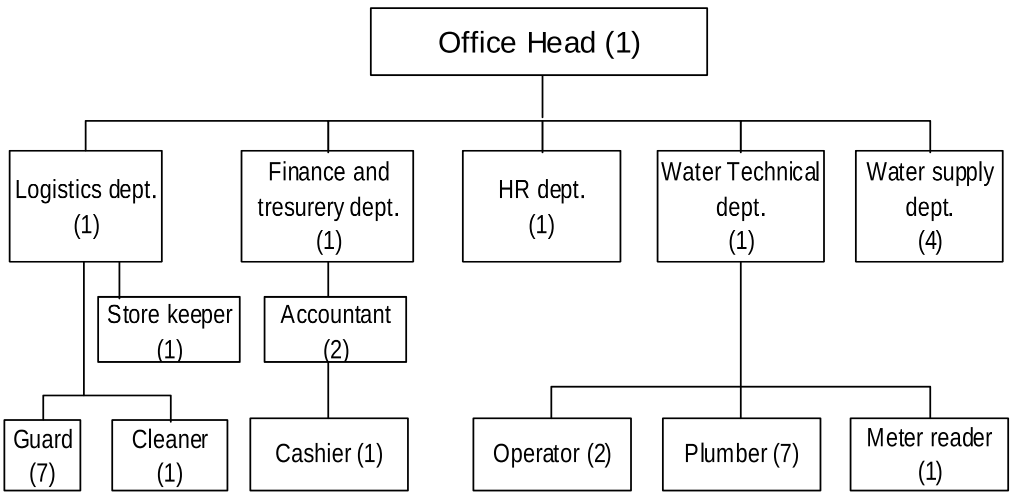
All the expenses of the office are paid from the money collected as water bills and the monthly amount is about 70,000 Birr. A special budget from the city administration for O&M and repair of facilities is to be released from July 2012. However, the budget has not yet been release at this point (November 2012) and the continuation of the budget is not promised either. The office did not have its own financial function before March 2012, and all the budget was managed by the woreda water office. At present, with its own financial function, the office keeps the data on water supplied to the customers and the collected bills in the book. As for expenses, the office compiles the items and prepares an expense report to the town administration.

d. O&M activities

As the daily O&M activities, the following tasks are conducted: 1) operation of intake pumps, 2) repair of leakage in pipelines, 3) Input of chlorine chemicals. In addition, they regularly conduct cleaning of reservoir tanks (once a year), sludge removal in the sedimentation pond (twice a month), replacement of damaged distribution pipes (as required). The regular activities at each of the component facilities of the system are listed in a table in chapter 3 in volume 3 (refer to section 3.2.6).

e. Organizational structure

The office has 31 members and 12 out of them are clerical staff members who work inside the office. The office structure is as shown in Figure 9.1. The office shares the building with woreda water office and occupies four rooms including a storage room.



Note: numbers in parenthesis indicate the number of staff members

Figure 9.1: Organizational Structure of Godey Town Water Supply Utility Office

About a half of the members have TVETC level education but actual experience is limited, especially for the young employees. The staff members are not doing what they are supposed to do daily and their morale is not high. However, the situation seems to be gradually improving after a new head took office at the beginning of 2013.

9.1.2 Condition of water fee collection and WASHCO activities in Godey Town

The system of management of water supply facilities (mainly public water taps) by the users through establishment of WASHCO is still a new idea in Somali Region.

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. However, it is the duty of the water supply utility office to prepare budget for the training and the budget, it has not been secured yet. 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 caretakers. Some caretakers decide their own water prices and that in some cases lead to a problem. A survey by the study team revealed that the existing two public water points were located in private yards and the owners of the plots were assigned as the managers (caretakers) by the town water supply utility office for that reason. These caretakers have not received any training on the management of the water point and the other conditions are the same as in Kabribeyah Town.

9.1.3 Condition of fee collection

The caretakers, current manager in charge of public water points, pay a monthly water rate of 15 Birr / 1m^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. This difference seems to be recognized as the benefit of being the care-taker, which goes against the system of WASHCO where the members are expected to be volunteers without remuneration.

Meanwhile, private households in urban areas that have their own yard taps and those that own private birkas in the outskirts of the town 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. Different rates are applied for dry and wet seasons because other sources of water become available in the wet season and the demand for water decreases.

9.2 Evaluation of O&M aspect of the project and training plan

9.2.1 Evaluation of institution and organization

The present condition of the O&M of the existing water supply system by the current town water supply utility office and WASHCOs are described above. According to this, the number of staff members who manage each facility of the system is no more than 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 the issue in staff assignment. Also the financial study pointed out that the office's indoor staff can not properly perform accounting and financial management. To cope with these problems, the proposed O&M plan of the master plan has increased the total number of the operation staff to more than three folds in order to realize proper O&M of the system. Also, improvement of the educational level of core staff through recruitment was proposed as a prerequisite. Furthermore, a new position has been proposed as leaders (titled as technician) who can make good technical decisions and can manage and instruct the team of operators.

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. To cope with the situation, the O&M plan included training modules intended for capacity development of WASHCO members and for awareness raising of the local residents. Gradual change in the awareness of water supply service is expected to occur.

9.2.2 Evaluation of technical aspect

As explained in chapter 6, 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, the office will have to handle much larger system and have to properly do the dosing of water treatment chemicals that their staff has long neglected. The task requires pouring in 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 properly adjusted in accordance with the daily turbidity level and flow rate of the system. The proposed slow filtration facility does not require energy to operate and helps to keep the O&M cost of the facility low. However, the operation of the treatment system is based on biological activities in the filter layer, which requires very intricate management of the filter layer. This is generally considered very difficult work. In order to ensure proper treatment of water by this system, it is mandatory to achieve constant removal of turbidity to a certain low level so that the quality of the inflow water to the filtration facility is stable regardless of the seasonal change in raw water quality. 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 repair when the problems happen. In short, the existing organizations can not execute the planned O&M activities properly.

In consideration of the situation above, a set of mainly technical training courses has been proposed in this study (as explained in section 3.7 of chapter 3 in volume 3) in order to make the proposed O&M plan more feasible. The training is to be started from the beginning of the project implementation stage. The training targeting Godey Town has been prepared as training modules and consists of the following ones.

Module 5: O&M of river intake system
Module 6: WASHCO training (regular)
Module 7: WASHCO follow-up training
Module 8: Improvement of residents' awareness on water and sanitation
Module 12: Operation of water treatment facilities in Godey Town
Module 13: Follow up of O&M of water treatment in Godey Town
Module 14: Maintenance of water treatment plan in Godey Town
Module 15: Water quality testing training for Godey Town
Module 17: Training on finance and accounting

The details of the training modules listed above are shown in Table 9.2 to Table 9.10. Implementation of the proposed training in accordance with the schedule shown in Figure 9.2 is the key to successful future technical management of the water supply in Godey Town.

Meanwhile the provision of the proposed training is expected to require a budget of 2,918,000 Birr to 3,285,000 Birr even if only the direct cost is considered.

9.2.3 Comprehensive evaluation

The present condition of water supply system of Godey Town and its management has been concisely tabulated in Table below and the measures to be taken in the master plan are also shown for comparison.

Table 9.1: Comparison of Present Condition and Measures in M/P

	Present condition	Measures in master plan
Water supply system	- River intake – Sedimentation – Filtering system. - Due to low water pressure, the service ratio is less than 26% of the population (only a part of the town) - The water treatment plan is not properly operated.	- The same system as the existing one but the size is 1.5 times larger. - Service is available nearly all areas of the town. - Reduction of turbidity and disinfection by proper water treatment.
Organizations of O&M	- The number of the staff members in charge of the operation is barely 15.	- Raising staff educational level through new employment - The number of staff members is increased to 50 and specialists and leaders for operator teams are newly assigned.
Technical level of O&M staff	- Technical and educational level of the staff members are too low to conduct proper management.	- Technical training targeting the operation staff of Godey Town is provided. - Also, follow up training is provided after the training.
Management by residents	- The existing management system may be an obstacle for future shift in management system. - The degree of awareness and understanding of the water supply service by the residents is low.	- Training modules targeting WASHCOs are included. - Awareness campaign for the residents are also conducted.
O&M cost	- The cost is recovered by the water fee, which is not sufficient.	- Training on accounting and finance is provided for the water supply utility office staff and WASHCO is trained for efficient fee collection to achieve higher collection ratio.

As has been explained, it is clear that the major bodies concerned with O&M of the proposed water supply facilities, town water supply utility office and WASHCO, do not have sufficient technical nor institutional capacity to properly operate and maintain the proposed water supply system at present. 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 (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.

Table 9.2: Common: O&M of River Water Intake System

1. Module	5 CM-RIS-OM: River intake system maintenance
2. Period	30 days
3. Objective	To learn about the operation and maintenance of the facilities for the river water intake system
4. Target	Technical staff members of woreda and town water office in charge of river water intake system management (3 persons) Caretakers / operators (all) Technical staff member of SRWDB (1 person)
5. Contents	Maintenance of river water intake system and operation of ground pumps driven by generators and their maintenance. - Difference in water quality due to difference in water sources (surface water and groundwater - The general function of the water supply system - Mechanism of ground pump - Regular maintenance of ground pump and practice of maintenance (packing replacement) - Mechanism of the generator - Theory of maintenance of generators (names and functions of wearing parts) - Practice of daily maintenance of generators (oil, filters replacement) - Procurement of spare parts - Procurement of fuel - Use of chlorination agent and calculation of dose - Procurement of chlorination agent - Importance of collection of water fee - Tasks of caretakers/operators and preparation of maintenance schedule - Roles and duties of woreda water office - Roles and duties of SRWDB
6. Points of consideration at implementation	- Several technical members from woreda water office should join the training - The system tends to be large and more than one operator will be needed. The selection and training of the operators will be done in the training. - The work follows that of the same system of towns but the WASHCO and water office get support from SRWDB in the case of serious problems.
7. Expected outcome	- The roles and duties of caretakers, operators, woreda water office, SRWDB in O&M of the system will be clear and they will continue the work in good collaboration. - Caretakers/operators will be able to recognize the operational condition of the equipment and be able to identify and report problems immediately.
8. Expected training provider	- Private consulting company with SRWDB or University staff (the technical staff should get prior training)
9. Materials and equipment needed	- Spare parts of generators and ground pumps - fuel for generators - chlorination chemical - general tools such as pipe wrenches - electric tools - multi-meter - O&M manuals

Table 9.3: Common: Regular WASHCO Training

1. Module	6 CM-WASH-T: WASHCO training
2. Period	10 days
3. Objective	To form WASHCO and the members learn about the operation and maintenance of the constructed new public water supply points.
4. Target	Elected WASHCO members at each public water point (7 persons/site)
5. Contents	- The training follows the WASHCO training of Somali Region (manual available). - Include the topic of money collection and accounting and financial management.
6. Points of consideration at implementation	- If possible, start the training from the stage of site selection to involve WASHCO more. - There are some minor differences in the contents of the training between WASHCOs of urban and rural areas. - WASHCOs should be combined to conduct training. - Refer to the points of consideration raised in this study.
7. Expected outcome	- WASHCO members will perform minimum maintenance of the facilities they are in charge of. - Water fees from the users will be collected properly.
8. Expected training provider	SRWDB, Town water supply utility office, Woreda water office
9. Materials and equipment needed	- WASHCO manual - flip chart - markers - notebooks and pens

Table 9.4: Common: WASHCO Follow up Training

1. Module	7 CM-WASH-FT: WASHCO training
2. Period	2 to 5 days depending on the situation
3. Objective	Provide complementary training to existing WASHCOs
4. Target	- WASHCO members who are in charge of public water taps - WASHCO members and caretakers/operators in charge of water supply system
5. Contents	Assessment of the present condition will be conducted at first. Training is in line with WASHCO training of Somali Region. - Discussion among the participants to identify problems - Discussion of solutions for the identified problems - Confirmation of daily activities based on the WASHCO manual - Provision of complementary training
6. Points of consideration at implementation	- If some members leave, find replacement in the training. - There are some minor differences in the contents of the training between WASHCOs of urban and rural areas.
7. Expected outcome	WASHCO members resume the activities or perform their duties more actively to do minimum maintenance of the facilities. Water fees from the users are also properly collected.
8. Expected training provider	SRWDB, Town water supply utility office, Woreda water office
9. Materials and equipment needed	- WASHCO manual - flip chart - markers - notebooks and pens

Table 9.5: Common: Training on Water and Sanitation Awareness Improvement for Residents

1. Module	8 CM-WS-AT: Water and sanitation awareness training
2. Period	3 days
3. Objective	- Give lecture on the water and sanitation and importance of water supply as public service to WASHCO members to disseminate the idea in the community. - Demonstrate proper use of chlorination agent to WASHCO and residents
4. Target	WASHCO members of existing and new facilities Representatives of the residents (total up to 30 people)
5. Contents	Lecture and practice - Lecture on hygienic use of water - Awareness lecture for the use of safe water (including demonstration) - Protection of water supply facilities and proper use - Knowledge of water disinfection and proper storage (boiling, priority of use) - Practice of water disinfection using chlorination agent - How to obtain chlorination agent - Approaches and methods about changing the awareness and mentality of the residents
6. Points of consideration at implementation	- Members of several WASHCOs in a woreda and leaders of the communities should be the target - It should be noted that low awareness of water and sanitation is the main obstacle in getting support to projects from residents.
7. Expected outcome	WASHCO members will explain to the community residents how to use the chlorination agent properly and how to get them. Then the use of chlorine agent will be promoted.
8. Expected training provider	SRWDB, NGO
9. Materials and equipment needed	- Flip chart - markers - notebooks and pens - chlorination agent - water and sanitation manual

Table 9.6: Godey Town: Operation of Water Treatment Facilities

1	Module	12 GD-WT: Water Treatment
2.	Period	20 days
3.	Objective	To learn about the procedure of treating highly turbid water
4.	Target	Technicians of Godey Town water supply utility office (all) Operators of Godey Town water supply utility office (all) Assistant operators of Godey Town water supply utility office (all) Lab technicians of Godey Town water supply utility office (all) Engineers from town water supply utility office (1 or 2)
5.	Contents	Lectures and practice - Basics of drinking water treatment (coagulation, sedimentation, filtration, disinfection, residual chlorine) - Confirmation of required tasks at each component facility - Method of adjusting the dosage of coagulant - Method of adjusting the dosage of pH adjusting agent - Method of adjusting the dosage of chlorination agent - Use of chemical dosing tanks - Physico-chemical properties of the chemicals to be handled - Proper handling method and storage of the chemicals - Preparation of dosing schedule and procurement budget for each chemical - Method of water quality monitoring (turbidity, residual chlorine) - Simple method of estimating water flow rate in the system - Use of calculator
6.	Points of consideration at implementation	- To make sure that the technicians and the engineer in charge of the town water supply utility office should understand the theoretical background and practical techniques as well. - Ensure that the operators and the lab technician monitor the quality of water that they treat every day. - Practice should be repeated so that they learn the work properly. - The training should be conducted immediately before the start of operation.
7.	Expected outcome	Operators properly determine the dose of the chemicals and input the chemicals to the system under the supervision of operators. The turbidity is then effectively removed at the point of sedimentation pond.
8.	Expected training provider	AAWSA, University and private consulting company (Jointly), Foreign engineer,
9.	Materials and equipment needed	- Water quality test kit - Manual for handling the chemicals - samples of the chemicals - Plastic drums of 200L - bucket - scale - rubber gloves - calculator

Table 9.7: Godey Town: Follow up of Water Treatment Plant Operation

1 Module	13 GD-WT-FUP: Water Treatment Follow up
2. Period	2 months after the training: Once a week (2 days at a time) 3 to 12 months after training: Every month (2 days at a time)
3. Objective	Follow up on the tasks the operators learned in training module GD-WT to check the application of techniques at site and to give instructions for improvement.
4. Target	Operators and technicians of town water supply utility office at work Engineers from town water supply utility office (1 or 2)
5. Contents	- Confirmation of input of chemicals and cleaning of facilities at site - Discussion and identification of problems - Instruction for improvement
6. Points of consideration at implementation	- The trainer should have ample experience because the topic at site can be variable depending on the situation of the site. - The follow up should be conducted during the operation stage.
7. Expected outcome	The operators and technicians at work will realize the problems and mistakes they are making and they will improve the situation.
8. Expected training provider	AAWSA technical staff, Foreign engineer, University and private consulting company.
9. Materials and equipment needed	- Flip charts - Markers

Table 9.8: Godey Town: Maintenance of Water Treatment Plant

1 Module	14 GD-PM: Plant maintenance
2 Period	10 days
3 Objective	To learn about the facilities and equipment used in the treatment plant
4 Target	Operators of town water supply utility office (all) Technicians of town water supply utility office (all) Engineers from town water supply utility office (1-2 persons) Engineer from SRWDB (1 person)
5 Contents	Training mainly covers the maintenance of facilities used in the treatment plan - Ground pump maintenance (spare parts replacement) - Cleaning of pipes and valves - Maintenance of generators (spare parts replacement) - Cleaning of sedimentation pond - Cleaning of filtration chambers - Sludge disposal and storage method - Cleaning of reservoir tanks - Discussion and preparation of O&M work schedule
6 Points of consideration at implementation	- Based on the O&M plan proposed in this study, in consideration of the staffing situation and detailed specifications of the constructed facilities, the participants should discuss efficient O&M work schedule and put it into practice. - The sludge generated from the sedimentation pond will be great and an appropriate disposal or storage method should be sought in consideration of the environment.
7 Expected outcome	Operators and technicians will be able to perform the regular maintenance of the system and the treatment system will be sustainably operated.
8 Expected training provider	Technical staff of SRWDB, Technical staff of AAWSA, Foreign engineers
9 Materials and equipment needed	- Shovels - scrapers (self made) - bucket - soil carrying pan - dewatering pump - small generator - hose - fuel

Table 9.9: Godey Town: Training for Water Quality Test at Site

1. Module	15 GD-WQ: Water quality
2. Period	20 days
3. Objective	To learn about the basic knowledge in water quality test employed in water treatment, and to acquire test skills
4. Target	Lab technicians of Godey town water supply utility office (all) Technicians of Godey town water supply utility office (all) Operators of Godey town water supply utility office (2)
5. Contents	Lecture and practice - Basics of water and chemical substances (property of water, acid and alkaline, oxidation and reduction, concentration, turbidity, coagulation and sedimentation, bacteria, characteristics of chlorine) - Types of coagulant and their functions (dependency on pH) - Types of chlorination agent and their functions - Method of Jar testing of coagulant - Method of testing turbidity - Method of testing residual chlorine - Method of measuring pH and EC - Simple method of measuring flow rate (no instruments used) - Use of calculator
6. Points of consideration at implementation	It is important that the technicians and the engineer in charge of the town water supply utility office also adequately understand the theory and the outline of the test procedures.
7. Expected outcome	The lab-technician will be able to obtain accurate test results every day and report it to the technicians and operators.
8. Expected training provider	Technical staff of AAWSA, Faculty of University, Foreign engineer
9. Materials and equipment needed	- Water test kit (turbidity, dried residual, residual chlorine, coli form) - color chart (quick reference to turbidity) - Jar test kit - pH meter - EC meter - scale for weighing agents

Table 9.10: Woreda Water Office: Accounting and Finance

1. Module	17 WR-ACF: Accounting and Finance
2. Period	5 days
3. Objective	To learn basic theory and skills for proper financial management of the office and to get motivation in work.
4. Target	Clerical staff of woreda water/administration office (head, accountant, cashier)
5. Contents	- Basics of accounting - Accounting for public institutions - Method of book keeping - Proper handling of cash and fund - Reporting the accounting results - Roles of accountant, cashier, and office head
6. Points of consideration at implementation	- The contents should be in line with the current system of Somali region. - Since the target staff for one woreda is small, several woredas should be combined to give training - Accounting staff may come from woreda administration
7. Expected outcome	The staff of woreda water office (woreda administration office) can properly do accounting and keep good record of the office's financial status.
8. Expected training provider	Private consulting company
9. Materials and equipment needed	- Training manual - flip chart - calculator - notebook etc.

Note: Woreda water office does not have proper staff for accounting and finance, they may come from woreda administration.

Training Module	2015				2016				2017				2018				2019				2020				after 2021	No. of training
Outline of construction																										
Godey town																										
1) SRWDB																										
01 RWB-WS	0.3												0.3											0.4		1
16 RWB-MWS		1																								1
4) Godey town																										
05 CM-RIS-OM																	1									1
06 CM-WASH-T:													9													9
07 CM-WASH-FT																				6						6
08 CM-WS-AT													6													6
12 GD-WT																1										1
13 GD-WT-FUP																	0.1	0.1	0.1	0.1					0.6	1
14 GD-PM																1										1
15 GD-WQ															1											1
17 CM-ACF				1																						1

Note: the numbers in the cells indicates the number of times of execution of training module. The dark shaded cells signify the construction work is concentrated

Figure 9.2: Proposed Schedule of Short to Mid-term Training for Capacity Development for Godey Town

Chapter 10

Environmental and Social Consideration

10 Environmental and Social Consideration

10.1 Results of environmental and social impact assessment

The negative impacts that may be caused by the proposed water supply project in Godey town are summarized in Table 10.1.

Table 10.1: Result of Scoping for the Water Supply Project 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, and be planned to develop the new water intake point freely. On the other hand, the 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.
Social Environment	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 the rural area, the burying work of a pipe crossing the road should be finished in a short time.
Natural Environment	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 contain SO_X and NO_X gases. Therefore, SRWDB should monitor ambient air quality regularly in conformity to Pollution Control -proc # 300/2002.
Natural Environment	26	Increase of noise and vibrations	**c**	**d**	Since heavy machineries will be operated during construction phase, noise and vibrations will occur; however, the duration is quite limited.
Natural Environment	30	Increase of Accidents	**c**	**d**	Traffic accidents are likely to occur due to the increase of construction vehicles at the construction phase and container trucks at the operation phase. Full control of the traffic is needed if schools and hospitals stand on the routes of transmission and distribution pipelines.

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.

10.2 Mitigation measures

The results of assessment of the water supply plan indicate that there is no serious impact ("a" rating) and middle degree impact ("b" rating) in the construction and operation stages.

Small negative impacts or no information at the present time was recognized for six items. So Table 10.2 shows the proposed mitigation measures and monitoring for key adverse impacts in Table 10.1. Also, the recommended surveys to be conducted in the implementation phase are explained in the table.

Table 10.2: 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 vibration	c	• At the following implementation phase, conduct the noise and vibration 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 crossings. Crossing locations should take into account community preferences. • To determine the routes for construction vehicles through meetings with residents. • To disseminate information on a construction plan (schedule, traffic restricted sections, 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 sections, 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).

Chapter 11

Economic and Financial Evaluation

11 Economic and Financial Evaluation

11.1 General

The cost benefit analysis has been applied to assess economic and financial viability of the water supply project in Godey town. In economic evaluation, the economic project costs and benefits are compared to calculate the economic internal return (EIRR) of the project, and in financial evaluation, recovery of the operation and maintenance costs is assessed in consideration of sustainability of the project.

11.2 Economic evaluation

11.2.1 Basic assumptions

The economic analysis has been undertaken on the basis of the following assumptions:

(1) The exchange rate of USD 1.00 = Birr 18.53, that is the average exchange rate during November 2012 and April 2013, has been applied.

(2) The base year for the calculation of costs is 2013.

(3) Only direct and tangible benefits have been quantified over the project life of 20 years (2015 - 2034) for the calculation of the economic indicators.

(4) Discount rate of 10 % has been applied as a proxy of opportunity cost of capital in Ethiopia.

(5) Transfer payments such as interest and taxes, and price escalation are not included in the calculation.

11.2.2 Economic project cost

The costs of implementation of Godey Town master plan in terms of the economic analysis "economic project costs" are composed of the construction costs and operation and maintenance (O&M) costs as mentioned below.

a. Economic project costs

The economic project costs comprise of the costs for the construction of water supply facilities, engineering services, physical contingency and administration costs. Taxes and price contingency are not included in the economic costs. Conversionof the financial prices into the economic prices have not been applied in this analysis because the proportion of the local currency portion is very small. The economic project costs thus estimated amount to 8,805,000 USD as presented in Table 11.1.

Table 11.1: Economic Project Costs of Godey Town Water Supply Project

Units: USD

Items	2015	2016	2017	2018	Total
1. Construction cost	0	2,348,000	2,348,000	2,347,000	7,043,000
2. Engineering services	264,000	264,000	264,000	265,000	1,057,000
3. Administration and Physical contingency	176,000	176,000	176,000	177,000	705,000
Base costs	440,000	2,788,000	2,788,000	2,789,000	8,805,000

b. Operation and maintenance costs

The annual operation and maintenance (O&M) costs of the proposed project are estimated at 212,050 USD at the price level of 2013, including spare parts, power supply, personnel, chemicals, consumables and others.

11.2.3 Economic benefits

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, as other benefits (e.g. improvement of quality of daily life) are considered to be difficult to quantify. The following shows the details of the calculation of the two economic benefits.

a. Benefits of time saving for fetching water

Benefits of time saving for fetching water are derived as a result of shorter distance to water sources after implementation of the project. Time savings from reduction in time spent fetching water is the difference between time for water collection “with” and “without” installation of improved water supply facilities. Time for fetching water consists of time taken to travel to site, queue and fill the container. Actual quantification was conducted based on the socio-economic survey data as follows:

Time for fetching water “without the Project” is assumed to be the same as the time spent for fetching water in the dry season, namely 3.8 hours on average per household. 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/day on average per household.

Value of time saving is measured from the average time saved multiplied by the economic labor cost. It is assumed that 50% of time saved will be used on productive activities and the remaining 50 % will have no value. 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. The value of time saved in fetching water will be evaluated to be 50 Birr (100 Birr x 50 %) per day or Birr 6.25 per hour. Consequently, time saved of 2.4 hours on average per day will have the value of 15 Birr per day per each household if an eight (8) hour work day is assumed (50 Birr x 2.4h / 8h =15 Birr). Assuming that there will be at least 300 days of productive activities in a year, the value of time saving will be Birr 4,500 per year (242.85 USD).

Benefits of time saving were assumed to arise immediately at the start of operation of the Project facilities and will increase year by year, reaching its maximum amount in 2020 (see Table 11.2).

b. Health improvement benefits

Health improvement benefits are derived as a result of an improvement in water quality and increased supply of water. The benefits can be measured from the difference of medical expenses between “with” and “without” installation of improved water supply systems.

Provision of a clean water supply will lead to the reduction in the incidence of water related diseases. In some studies conducted by UN agencies, it is assumed that provision of clean water supply will lead to 10% reduction in medical expenses every year in the target communities. Based on the results of the Socio-economic Survey in 2012, the annual medical cost is estimated at Birr 1,076 per household on average. The medical cost will be reduced by Birr 107 each year per household.

Health improvement benefits were also assumed to arise from the second year after commencement of the Project and will reach its maximum amount in 2020 (see Table 11.2).

11.2.4 Economic evaluation

In order to assess the economic validity of the project implementation, an economic analysis has been conducted on the basis of the annual costs and benefit streams as estimated in the preceding sections. The result of economic analysis of the proposed Project in terms of Economic Internal Rate of Return (EIRR) is 13.8% as presented in Table 11.2 below.

The result of economic analysis indicates that the project is economically feasible as the EIRR exceeds the opportunity cost of capital of 10%, the Net Present Value (NPV) is positive, and the Benefit Cost Ratio (B/C) exceeds 1.0.

Table 11.2: Cash Flow for Calculation of Economic Indicators

Unit: USD

Year	Incremental Net Benefit			Incremental Costs			Net Cash Flow	Discount Factor at 10%	Present Value at 10%
	Time Savings	Health	Total	Investment Cost	O & M Cost	Total Cost			
2015	0	0	0	440,000	0	440,000	-440,000	0.909	-400,000
2016	0	0	0	2,788,000	0	2,788,000	-2,788,000	0.826	-2,304,132
2017	0	0	0	2,788,000	0	2,788,000	-2,788,000	0.751	-2,094,666
2018	0	0	0	2,789,000	0	2,789,000	-2,789,000	0.683	-1,904,925
2019	1,744,287	41,478	1,785,765	0	212,051	212,051	1,573,714	0.621	977,152
2020	1,795,046	42,685	1,837,730	0	212,051	212,051	1,625,679	0.564	917,654
2021	1,795,046	42,685	1,837,731	0	212,051	212,051	1,625,680	0.513	834,231
2022	1,795,046	42,685	1,837,731	0	212,051	212,051	1,625,680	0.467	758,392
2023	1,795,046	42,685	1,837,731	0	212,051	212,051	1,625,680	0.424	689,447
2024	1,795,046	42,685	1,837,731	0	212,051	212,051	1,625,680	0.386	626,770
2025	1,795,046	42,685	1,837,731	0	212,051	212,051	1,625,680	0.350	569,791
2026	1,795,046	42,685	1,837,731	0	212,051	212,051	1,625,680	0.319	517,992
2027	1,795,046	42,685	1,837,731	0	212,051	212,051	1,625,680	0.290	470,902
2028	1,795,046	42,685	1,837,731	0	212,051	212,051	1,625,680	0.263	428,092
2029	1,795,046	42,685	1,837,731	0	212,051	212,051	1,625,680	0.239	389,175
2030	1,795,046	42,685	1,837,731	0	212,051	212,051	1,625,680	0.218	353,795
2031	1,795,046	42,685	1,837,731	0	212,051	212,051	1,625,680	0.198	321,632
2032	1,795,046	42,685	1,837,731	0	212,051	212,051	1,625,680	0.180	292,393
2033	1,795,046	42,685	1,837,731	0	212,051	212,051	1,625,680	0.164	265,812
2034	1,795,046	42,685	1,837,731	0	212,051	212,051	1,625,680	0.149	241,647
	28,669,977	681,753	29,351,729	8,805,000	3,392,816	12,197,816	0.138		1,951,154

EIRR	13.8 %
NPV	USD 2.0 million
B/C	1.2

11.3 Financial evaluation

11.3.1 Financial project cost

The financial project costs comprise of the costs for the construction of water supply facilities, engineering services, price contingency and administration costs. Cost estimation is based on the market prices as of May 2013. The conversion of financial cost to the economic cost was not conducted for the same reason as above. The base costs of the proposed project amounts to 8,805,000 USD and the total project costs including price contingency amount to 9,934,000 USD as presented in Table 11.3 below.

Table 11.3: Financial Project Costs of Godey Town Water Supply Project

Unit: USD

Item	2015	2016	2017	2018	Total
Construction cost	0	2,348,000	2,348,000	2,347,000	7,043,000
Engineering services	264,000	264,000	264,000	265,000	1,057,000
Administration and Physical contingency	176,000	176,000	176,000	177,000	705,000
Base costs *	440,000	2,788,000	2,788,000	2,789,000	8,805,000
Price contingency	34,000	366,000	366,000	363,000	1,129,000
Total	474,000	3,154,000	3,154,000	3,152,000	9,934,000

11.3.2 Results of financial evaluation

a. Cost benefit analysis

From the result of this study, the going water rate in Godey Town is 15 Birr/m^3. Thus, an average household of six members is expected to use 3.6 m^3 of water per month with an assumed 20L/capita consumption. This indicates the household will pay 35 Birr per month. With the population of Godey Town, collection of 35 Birr from each household only amounts 215,000 USD per year. This is one tenths of the annual investment amount in Table 11.2. It is obviously impossible to cover the project cost by the revenue from water bill collection. Therefore, financial cost benefit analysis in terms of Financial Internal Rate of Return (FIRR) has not been applied in this evaluation.

b. Recovery of operation and maintenance costs

On the other hand, the O&M cost that is much smaller than the project implementation cost may be recovered by the revenue from water sale. For this reason, comparison of the O&M cost and the revenue from water sale from the viewpoint of recovery of the O&M cost was conducted for the following cases of different assumed water rates.

1) The current official rate of Kabribeyah Town water supply utility office: 10 Birr (US$ 0.54)/m^3
2) The current official rate of Godey Town water supply utility office: 15 Birr (US$ 0.81)/m^3
3) The current actual terminal rate in Godey Town: 50 Birr (US$ 2.7)/m^3
4) The mid point between case 2 and 3 of 32.5 Birr (US$ 1.7)/m^3

For these four rates of water, the annual O&M cost in 2020 is US$ 448,648. This cost is based on the O&M of the new and existing facilities while the total population of Godey Town in 2020 is 36,958 (see chapter 2 in volume 2). Then the amount of money to be collected for each case was calculated on the basis of this population to compare with the O&M cost in order to determine the recovery ratio to fully cover (100%) the O&M cost. The result is shown in Table 11.4.

Table 11.4: Recovery of Operation and Maintenance Costs

	Water rate (Birr/m³)	Annual O&M cost (US$)	Annual maximum collection (US$)	Recovery ratio at 100% of coverage (%)
Case 1	10	448,648	145,598	308 %
Case 2	15	448,648	218,397	205 %
Case 3	32.5	448,648	473,194	95 %
Case 4	50	448,648	729,990	62 %

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 30.8 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 in case 4. Thus, it is sufficient to pay for the cost of water. The coverage ratio in this case is 62% and this can be raised further to reduce the water rate. Also, as mentioned in chapter 3 of volume 3, the commercial electric supply system is currently under construction. Thus, it can be used to reduce the fuel cost to a large extent in future. In the estimation by the study team, if all the pumps are operated by the commercial electric supply, the O&M cost of the system will be reduced by about 40%.

Chapter 12

Conclusions

12 Conclusions

The conclusions of this volume are described below based on the results of the survey and analysis for the feasibility study of Godey Town water supply plan.

12.1 Summary of the study results

The elevation of the town is approximately 273m-300m amsl. The Shebele River flows in the direction of WNW to east. The lowest elevation is located at a point along the Shebele River and the land surface of the town slopes southward. The population of Godey Town is 29,379 (2012) and is the largest town among the urban areas of the woredas in Shebele River basin.

The main geology of Godey Town and its surrounding areas consists of the widely distributed Korahe Gypsum strata of early Cretaceous to late Jurassic based on the existing geological map. These strata are covered by colluvial and alluvial deposits or terrace gravel layers of Quaternary along the Shebel River. The average annual rainfall is 236mm (observation period: 2004-2009) in the station of Godey Town and is 272.7mm (observation period: 1996-2012) at the station of Gode Met. The rainy season in Godey woreda is divided into two periods: from April to June as the minor rainy season and from October and December as normal rainy season. The main surface water sources of Godey Town are the water from the Shebele River. The groundwater is not a suitable water resource because of saline water quality. The Shebele River is a perennial river. Its drainage area is 127,300km^2, and the annual average amount of runoff is 25.92 mm (observation period: 1968-1971) as recorded at the Gode Met hydrological station along the Shebele River.

With regard to the population and water demand, the growth rate of population was calculated as 2.91% based on the analysis of the data of CSA and the water demand was estimated by using the urban water supply design criteria as of 2020 for the target year. The total water demand value was adopted as the design water supply value.

The existing water supply facilities were constructed in 1959, and were expanded in 1996 in accordance with the growth of the town. After that, the sand filter ponds in the water purification plant, the concrete reservoir, and some public taps were constructed. However the amount of water the system can produce is about 150m^3/day. Assuming that all the water is used for domestic purposes, this volume is equivalent to water supply amount for 7,500 persons. The existing water supply coverage ratio is about 26% even at the highest. It can be said that the existing water supply coverage ratio in Godey Town is quite low in comparison with the water supply access ratio for the entire Somali Region (74%).

Out of water quality items of Shebele River water samples, turbidity and total hardness exceed the Ethiopian standard. The issues about the present water supply facilities are insufficient water supply volume, high turbidity of raw water from the river, insufficient water pressure in the distribution pipelines, small water supply coverage area and low usage of the public taps.

The number of staff members of town water supply utility office who manage each facility of the system is about 15 in total and it is not sufficient. 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, the water points are currently being managed by caretakers. Thus the shift from the current management system towards that by WASHCO under the region's new policy is considered to have some challenges.

Regarding technical problems in the O&M of the system, the town water supply utility office has as a problem of staff with insufficient education in general. The situation makes it difficult for the office to cope with various technical challenges. The office staff has long neglected the dosing of water treatment chemicals. 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 be able to handle the repairs when the problems happen.

12.2 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 to protect against erosion by violent river 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 number of water supply facilities. The project implementation period was estimated to be 4 years from 2015 to 2018. The basic project cost is US$ 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 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 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 30.9Birr/m^3 is achieved. The calculation indicates that, for the water fee that is set at 50Birr/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.

12.3 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 10-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.