社会開発調査部報告書

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

MINISTRY OF WATER RESOURCES

No. 22

THE STUDY ON ELEVEN CENTERS WATER SUPPLY AND SANITATION IN FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

FEASIBILITY REPORT MILLE

(Volume II-II)

FEBRUARY, 1996

SANYU CONSULTANTS INC.

KYOWA ENGINEERING CONSULTANTS CO., LTD.

GOVERNMENT OF JAPAN
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)
FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
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THE STUDY
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PREFACE

This is the Feasibility Study Report for Mille presenting the results of the Study on Eleven Centers Water Supply and Sanitation (the Study) carried out in accordance with the Scope of Work agreed upon between the Government of Federal Democratic Republic of Ethiopia (GOE) through the Water Supply and Sewerage Agency (WSSA) of the Ministry of Natural Resources Development and Environmental Protection (MNRDEP), which was recently reorganized Water Supply and Sewerage Service Department (WSSD) under Ministry of Water Resources (MWR), on the one part and the Government of Japan (GOJ) through the Japan International Cooperation Agency (JICA) on the other part dated April 8, 1994.

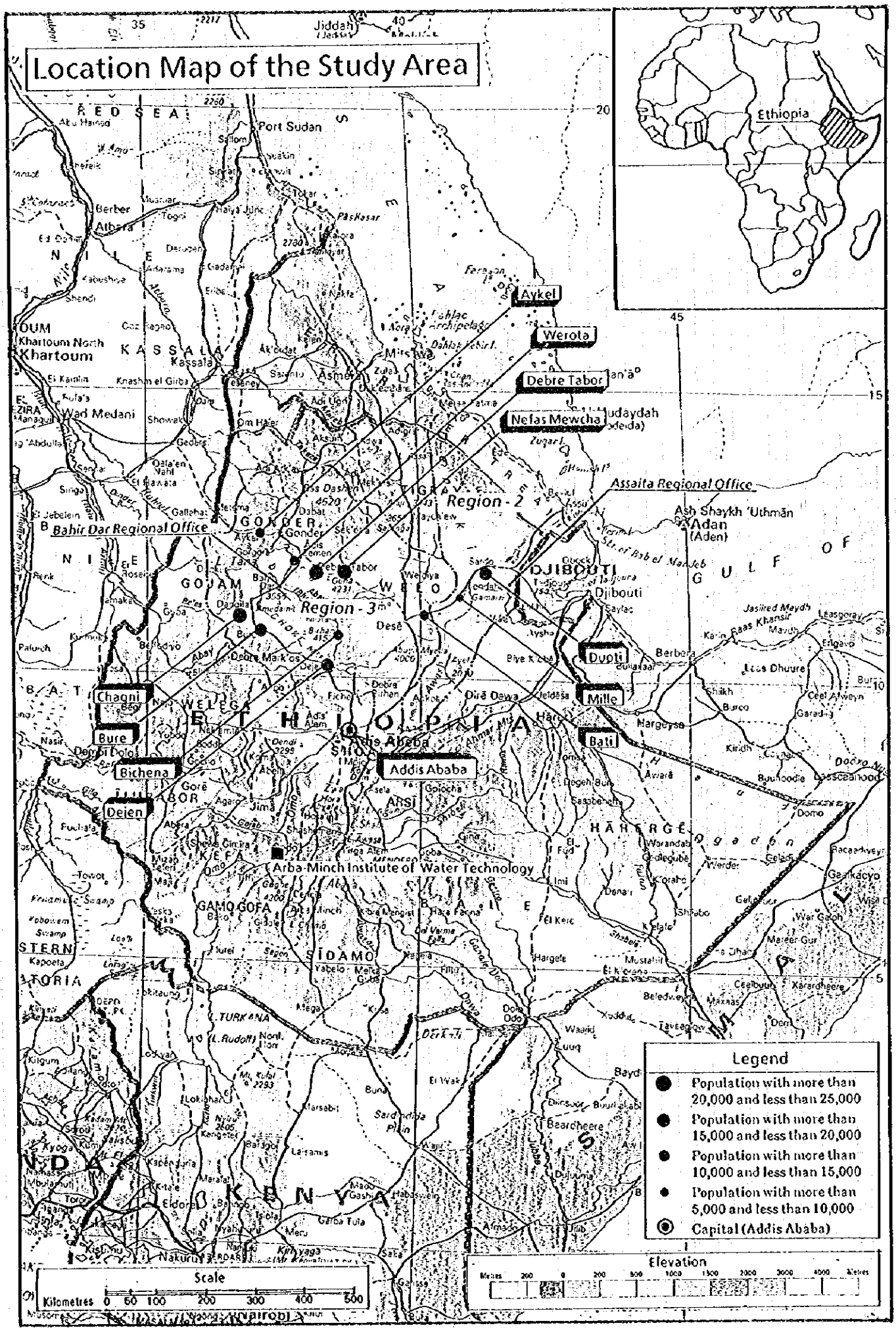
The major objectives of this Study are 1) to conduct a feasibility study on the water supply system in order to improve living condition of the population in the Study area by enhancing the level of the water supply services in terms of water quantity, water quality and its accessibility, 2) to formulate a plan for sanitary education and the diffusion of sanitary facilities in order to raise peoples' awareness on hygiene and improve environmental sanitation, which will be able to prevent the contamination of water source(s) and to secure safe water supply, and 3) to transfer technologies to the Ethiopian counterpart personnel in order to strengthen the managerial aspects of water supply services.

The Study had been conducted over a two (2) Japanese fiscal year-period from 1994/95 to 1995/96 and divided into two (2) phases. The Phase I study was conducted between December 1994 and March 1995, and Phase II was conducted between May 1995 and February 1996, for a total study period of 15 months during which three (3) times of visit to Ethiopia were made.

The survey items and major activities are meteo-hydrological survey, geo-electric prospecting (GEP) survey, water quality, water use condition, sanitary and health condition and people's awareness, social background, socio-economy, initial environmental examination (IEE), environmental impact assessment (EIA), sanitary education practice, and existing pump investigation.

With the survey and the study, this report presents the formulation of the Project of the water supply system with the implementation program, improvement plan of sanitary facilities with the diffusion program, set-up and strengthening of organization, and strengthening of operation and management.

The Study Team extends heartiest thanks to WSSD especially those assigned counterparts for their close cooperation and hard work in both office and the field, and the officers of related agencies of Japan.


Location Map of the Study Area
Ethiopia
Aykel
Werota
Debre Tabor
Nefas Mewcha
Assaita Regional Office
Bahir Dar Regional Office
Region - 2
Region - 3
Addis Ababa
Arba-Minch Institute of Water Technology
Dupti
Mille
Bati
Chagni
Bure
Bichena
Dejen
Legend
Population with more than 20,000 and less than 25,000
Population with more than 15,000 and less than 20,000
Population with more than 10,000 and less than 15,000
Population with more than 5,000 and less than 10,000
Capital (Addis Ababa)
Scale
Kilometres 0 50 100 200 300 400 500
Elevation

General Description of Current Condition in Mille

Items	Description
Administration	Afar Region, Zone 1, No. of Kebele : 1
Residents	Total population : 3,902 (57.4 persons/ha) Average family size : 4.6 persons Amhara : 69% Afar : 4% Oromo : 14% Christians : 43% (1 church) Tigre : 13% Moslems : 57% (2 mosques)
Educational Conditions	Kinder garden / Elementary& school / Junior high s. / Senior high s. No. of school 0 / 1 / 0 No. of teachers 0 / 18 / 0 No. of students 0 / 457 / 0
Medical Conditions	Hospital : - Doctor : - Health center : - Nurse : - Health clinic : 1
Economic Conditions	Hotels/restaurants : 162 Shops : 42 Cottage industry : - : Average monthly household income : 223 birr
Water SupOroms: 3%ply Condition	The source of WSS : Borehole (2) Major other sources : River Domestic consumption : 67.7 cum/day (17.8 lpcd) Other consumption : 27.9 cum/day (total 95.6) Water service coverage : 97% House connection : 83.4 lpcd (5%, 1.25 birr/cum) Yard connection : 38.9 lpcd (12%, 1.25 birr/cum) Neighbors : 23.0 lpcd (18%, 1.25(3.1) birr/cum) Public fountain : 6.8 lpcd (62%, 1.25(3.2) birr/cum)
Sanitary C Oroms: 3%ondition	Septic toilet : - /100HH Dry pit toilet : 44/100HH Community toilet : - /100HH Open field : 56/100HH Toilet condition : Ill-maintained and constructed, they prefer open field mainly due to smell. Sullage disposal site : No allocated and vacuum track is required. Drainage facilities : No existed except along main road.
People's Health Awareness and Needs	Group awareness : 5% Diarrhea awareness : 60% ORS awareness : 30% Sanitary behaviors score : 962/1600 (60%) Needs : Adequate water, Employment
Remarks	1. Water charge in bracket is actually paid. 2. HH means "household". 3. ORS means Oral Rehydration Solution. 4. Mille is suffering from unemployment due to close Mille plantation. 5. Faecal coliforms found in samples from connections and household containers.

Project Description of Mille

Items	Description
Project Title	Eleven Centers Water Supply and Sanitation
Executing Agency	Water Supply and Sewerage Service Department(WSSD)
Objectives	To supply domestic water which meets people's demand and to improve sanitary condition in the center.
Population Projected	In 1995: 3,902 (8.0%) — 2000: 5,733 (7.5%) — 2005: 8,230 (7.0%) — 2010: 11,543
Water Demand Projected in cum/day	In 1995*: Domestic 68, Non Domestic 28, Losses 34, Total 130 2000: Domestic 162, Non Domestic 79, Losses 27, Total 268 2005: Domestic 268, Non Domestic 129, Losses 57, Total 472 2010: Domestic 519, Non Domestic 206, Losses 128, Total 853
Dimensions of Water Supply System	Target Service Coverage: 100% (97% at present) Target Year of 2005 Deep Wells : 2 (152m) Rising Main : ϕ100 (3.54 km), ϕ75 (0.50 km) Booster of Rising : — No. Reservoir : 140m^3(70×2) Distribution : ϕ150(7,040m), ϕ75(520m), ϕ50(1,560m) Booster of Dist'n : ϕ150mm, Q=0.5m^3/min, H=12.5m, 2set Target Year of 2010 Deep Wells : 1 (104m) Rising Main : ϕ75(0.95km)
Water Tariff Structure & Accounting System	Introduction of Progressive Water Tariff** HC: 3.03 birr/m^3, YC: 1.80 birr/m^3, PF: 0.89 birr/m^3 Introduction of Double Accounting System
Plan of Sanitary Facilities Improvement	Construction of 2 public toilets and facilitation of other type toilets. Provision of toilet emptying system. Maintenance of main drainage and construction of supplemental drainages. Facilitation of waste water disposal pit and dry solid waste disposal system.
Plan of Sanitary Education and Implementation Program	Utilization of sanitary education manual and video. Application of sanitary education priorities(see report). Set-up of Sanitary/Health Committee. Assignment of Community Participation Promoter.
Organization Set-up	Strengthening of Planning & Project Department of MWR and relationship among central, regional and town. WSS to be composed of Administration, Financial, Technical and Sanitary Service, and manpower to be 19 in 2005 and 25 in 2010.
Remarks	* Actual Consumption ** Water Tariff for industry and institution is same as HCs'.

Composition of the Report

Report
- Executive Summary
- Main Report (Volume I)
- Feasibility Report (Volume II-I to II-XI)
- Appendixes (Volume III-I to III-XI)

Others
- Operation and Maintenance Manual
- Sanitary Education Manual
- Sanitary Education Video (titled Simple Steps... for Better Health)

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ABBREVIATIONS

[ORGANIZATION]

AfDB or ADB	-	African Development Bank
AfDF or ADF	-	African Development Fund
AWTI	-	Arba-Minch Water Technology Institute
CIDA	-	Canadian International Development Agency
CPPS	-	Community Participation Promotion Services
CSA	-	Central Statistical Authority
EELPA	-	Ethiopian Electric Light and Power Authority
EIGS	-	Ethiopian Institute for Geological Survey
EMA	-	Ethiopian Mapping Authority
EPD	-	Environmental Protection Department
GOE or TGE	-	Transitional Government of Ethiopia
GOJ	-	Government of Japan
IBRD	-	International Bank for Reconstruction Development (The World Bank)
JICA	-	Japan International Cooperation Agency
KFW	-	Kreditanstalt fur Wiederaufbau
MEDP	-	Ministry of Economic Development Planning
MEEC	-	Ministry of External Economic Cooperation
MNRDEP	-	Ministry of Natural Resources Development and Environmental Protection
MOA	-	Ministry of Agriculture
MOH	-	Ministry of Health
MPI	-	Master Plan Institute
MPWUDH	-	Ministry of Public Works and Urban Development and Housing
MWR	-	Ministry of Water Resources
NMA	-	National Meteorological Authority
NMSA	-	National Meteorological Service Agency
NGO	-	Non-Governmental Organization
NRDPEPB	-	Natural Resources Development & Environmental Protection Bureau
PWUDB	-	Public Works and Urban Development Bureau
REA	-	Regional Education Authority
REWA	-	Revolutional Ethiopian Women Association
RRC	-	Relief and Rehabilitation Commission
UN	-	United Nations
UNDP	-	United Nations Development Program
UNICEF	-	United Nations Children's Fund
TADE	-	Tendaho Agricultural Development Enterprise
WAB	-	Women's Affairs Bureau
WHO	-	World Health Organization
WRDA	-	Water Resources Development Authority
WSS	-	Water Supply Service
WSSA	-	Water Supply and Sewerage Agency
WSSD	-	Water Supply and Sewerage Service Department (former WSSA)
WWCE	-	Water Works Construction Enterprise
WWDE	-	Water Well Drilling Enterprise

[OTHERS]

BOP	- Balance of Payment
CPP	- Community Participation Promoters
DCI	- Ductile Cast Iron
Dia	- Diameter
DWL	- Dynamic Water Level
EB	- Ethiopian Birr (Birr or birr)
E.C.	- Ethiopian Calender
ERRP	- Ethiopian Relief and Rehabilitation Programme
EIA	- Environmental Impact Assessment
EIRR	- Economic Internal Rate of Return
FIRR	- Financial Internal Rate of Return
FRP	- Fiberglass Reinforced Plastic
GDP	- Gross Domestic Product
GNP	- Gross National Product
GS	- Galvanized Steel
HC	- Household Connection
IEE	- Initial Environmental Examination
lpcd	- liters per capita per day
l/s	- liters per second
m.asl	- meters above mean sea level
mg/l	- milligram per liter
ND or DN	- nominal diameter
NP or PN	- nominal pressure
O & M	- Operation and Maintenance
pa	- per annum
PC	- Private Connection
PF or P.F.	- Public Fountain
pm	- per month
PCM	- Project Cycle Management
PDM	- Project Design Matrix
PVC	- polyvinyl chloride
SWL	- Static Water Level
TB	- Tuberculosis
TOR	- Terms of Reference
USD	- United States Dollar
VES	- Vertical Electric Sounding
WID	- Women in Development
YC	- Yard Connection

Exchange Rate

1 US Dollar = 6.3 Birr

1 US Dollar = 94.5 Yen

1 Birr = 15.0 Yen

GLOSSARY

Belg	- Short & moderate rain in spring, autumn or winter
Birr, Br	- Ethiopian currency unit
Debo	- Small association in rural area to work collectively in farm
Eder	- Community organization for social occasions & social problems
Kebele	- Smallest unit of administration
Keremt	- long & heavy rain in summer
Kilil	- Region (a group of zones)
Shet	- Stream
Wenz	- River
Woreda	- An administrative sub-district (also referred to as Wereda)
Zone	- A group of Weredas

Note: There is, as yet, no standardized spelling of Ethiopian words written in Roman Letters and based on English phonetics. Consequently, different spellings of the same word may be encountered in the report, particularly on the EMA maps.

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Chapter 1 Introduction

1.1 Background

Most of the Ethiopian population do not have adequate and safe access to potable water supplies or sanitation facilities, leaving people vulnerable to water-borne and sanitation-related infectious diseases.

In 1994, only 26 % of the total population and 18 % of the rural population were estimated to have access to potable water. Consequently, the majority of the population is exposed to polluted water and thus to water-borne diseases. It is also estimated that less than 12 % of the total population uses latrines. An estimated 1 % only of the rural population have access to adequate refuse disposal systems.

Surveys of morbidity patterns and levels have pointed the consequence to the effects of poor water supply and hygiene practice, and unsanitary excreta disposal. Addressing health problems through water supply and sanitation activities is evident.

In Mille, water service coverage is 98 %, however the water consumption per capita per day is extremely low with the amount of 17.8 lpcd. Although water quality of the sources is acceptable with reference to WHO drinking water guideline in terms of physico-chemical aspects, many faecal coliforms have been detected in samples collected from connections and household containers. This means the contamination is expected in such ways of through cross-connections, leaking and back-siphonage associated with aged facilities.

Toilet coverage stays at low level of 44 %. Those toilets are mostly ill-maintained and poorly designed/constructed in terms of ventilation and emptying, thus the majority of the population dispose off their body waste in open field. Also, sullage disposal sites are not prepared, making difficult to dispose of emptied ones. Drainage facilities are not well constructed except ones along main road, constructed by road authority. And, even the drainage along main road is not well maintained, accompanying blockade by garbage or refuse disposal.

In view of the above situation, the Government of Ethiopia (GOE) put priority on the Eleven Centers Water Supply and Sanitation among 230 rural centers listed in the National Development Plan (ERRP 1993-95). Mille is the one, located in Afar Region, among the Eleven Centers along with Dupti, Bati, Nefas Mewcha, Debre Tabor, Werota, Aykel, Chagni, Bure, Bichena and Dejen as shown on the attached Location Map.

1.2 Overall Progress of the Study

The Team arrived in Ethiopia on January 5, 1995 and submitted the Inception Report to Water Supply and Sewerage Service Department (WSSD). Both parties had discussed and confirmed the plan of approach, plan of operation, schedule of the Study, undertakings of the both parties and other related matters. Following the confirmation, the Team immediately commenced the Phase I survey/study.

The Team had collected and reviewed the existing data and information related to the Study. After reviewing the data and information gathered, reconnaissance survey covering all Eleven Centers had been carried out throughout the month of January by the Team members and their counterparts. The survey was conducted to recognize the overall situation of the centers, give common understandings among the members, and identify the centers to be studied in Phase I and Phase II respectively. Mille was selected for the detailed survey during Phase I. The survey items and major activities are described below:

Meteorological and hydrological survey had been conducted through the aerial photographs, topographical maps, related rainfall/river discharge data collected, and further field observation in order to understand the drainage and recharge systems of the Study area.

For the geological part, geo-electric prospecting (GEP) survey had been conducted to identify the hydrogeological condition to be required for designing water supply systems. The 15 points at each center had been prospected with a maximum depth of 150 meters.

Water quality of the existing water sources and surface water had been examined in terms of physico-chemical characteristics. The analysis items and procedure were made in accordance with WHO drinking water quality guidelines. Also water samples had been undertaken for bacteriological tests, which were collected from the water sources, public fountains, private connections and household containers in order to identify the place of contamination.

Topographic survey had been made along the existing water supply transmission lines and distribution lines through the reservoirs. Also, proposed water supply distribution lines, which start at prospective water source(s) identified by GEP, had been surveyed.

Survey on water use condition had been conducted by filling-out questionnaire form(s) at 100 households as well as schools, institutions, industries, hotels and restaurants in each center. A census for water consumption had also been carried out in all areas being supplied with piped water. These surveys have clarified the water supply quantity and service rate as well as people's demand for water both in quantitative and qualitative aspects.

Survey of sanitary and health condition had been also carried out together with the above water use condition survey. Interviews had been conducted at the above 100 households, and sanitary facilities such as the type of toilet, condition of facility and utilization, treatment of dejecta/excretion and situation of solid wastes disposal had been observed.

Survey of social background aims at minimizing the possible negative effects which may be expected on the society and the people. The survey had been carried out by the same 100-household-interviews, questioning key informants such as Wereda, Kebele, school teachers, health workers and other community leaders, and meetings with various focused groups.

Socio-economic survey had been conducted with 100-household-interviews as well as questioning key organizations and institutions. This survey clarifies household level economy and financial condition of those organizations/institutions, contributing to introduction of affordable water tariff system and sound account of WSS.

Initial environmental examination (IEE) had been carried out on all Eleven Centers during reconnaissance and Phase I surveys. As a result of IEE conducted in Phase I, detailed environmental survey had been carried out during Phase II survey in accordance with the terms of reference made on IEE. Based on the result of IEE and the detailed environmental survey, environmental impact assessment (EIA) for each center had been made in parallel with the project formulation.

Besides the surveys mentioned above, a sanitary education video titled "Simple Steps.....for Better Health" was firstly produced in this water & health sector of Ethiopia with different languages as Amharic, Afar and English.

With the completion of those surveys mentioned above, comprehensive evaluation and understanding of problems had been made based on the present situation. Then, concept and basic strategy of the Project had been formulated at the end of field survey in Phase II, and presented in the Interim Report.

After returning to Japan, the Team started Home Work in Japan to finalize the project formulation based on the concept mentioned in the Interim Report and agreed by WSSD through discussions. Those outcomes are presented in this report together with operation and maintenance manual and sanitary education manual.

Chapter 2 Natural Condition

2.1 Meteorology and Hydrology

Mille is located at the fringe of basalt mesa dissected by faults. Mille river is a tributary of Awash river, which flows along the course controlled by the faults.

Mille has a meteorological station of NMSA and a river gauging station of WRDA. However, the river gauging station is not functional at present. Mille river at Mille has a catchment area of 4,350 km^2, extending to Dessie and Weldiya areas in the high land. See Figure 2.1.1 for the locations and the watershed around Mille.

Table 2.1.1 shows the long term monthly mean values of precipitation, potential evapotranspiration and air temperature obtained from NMSA.

Table 2.1.1 Long Term Monthly Mean Values of Precipitation, Potential Evapotranspiration and Air Temperature

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P (mm)	11.6	7.8	21.9	60.0	18.3	0.8	65.8	77.6	30.2	6.3	0.0	0.0	290.3
ETo (mm)	200	191	194	199	202	201	200	201	205	212	215	207	2,427
A.Temp. (°C)	26.3	26.9	29.1	30.9	32.8	35.6	33.5	31.7	32.5	29.0	26.7	26.1	30.1

The distribution of the monthly precipitation through a year shows two weakly pronounced rainy seasons, one in April and the other in July and August. The monthly potential evapotranspiration is very high but does not vary much ranging from 191 mm in February to 215 mm in November. The monthly mean air temperature ranges from 26.1°C in December to 35.6°C in June, exceeding 30°C from April to September.

The monthly mean runoff of Mille river at Mille varies from 0.7 mm of precipitation in June to 24.2 mm of precipitation in August as shown in Table 2.1.2.

In order to assess the ground water recharge in Mille river basin, the water balance sheet is prepared as shown in Table 2.1.2. The basin wide meteorological elements such as precipitation and potential evapotranspiration are obtained by Thiesen Polygon method using the data of Mille and Bati. The weights for those meteorological stations are 0.18 and 0.82 respectively. The meteorological data of Mille and Bati is shown in Appendices.

Table 2.1.2 Water Balance Sheet of the Ground Water Recharge Area, Mille River Basin

Unit : mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	42.7	59.1	55.5	77.0	45.7	7.9	165.1	179.8	85.1	27.5	0.1	35.2	496.9
Q	1.6	3.1	5.5	6.9	4.1	0.7	7.9	24.2	5.5	3.4	2.1	1.3	66.3
P-Q	41.1	56.0	50.0	70.1	41.6	7.2	157.2	155.6	79.6	24.1	*	33.9	430.6
ETo	145.9	145.1	148.9	149.8	152.0	151.8	151.6	152.6	149.2	148.9	146.9	146.3	1,789.0
ETcrop	102.1	101.6	104.2	104.9	106.4	106.3	106.1	106.8	104.4	104.2	102.8	102.4	1,252.0
ETa	41.1	56.0	50.0	70.1	41.6	7.2	106.1	106.8	79.6	24.1	-	33.9	614.0
ΔS	0	0	0	0	0	0	51.1	48.8	0	0	-	0	99.9

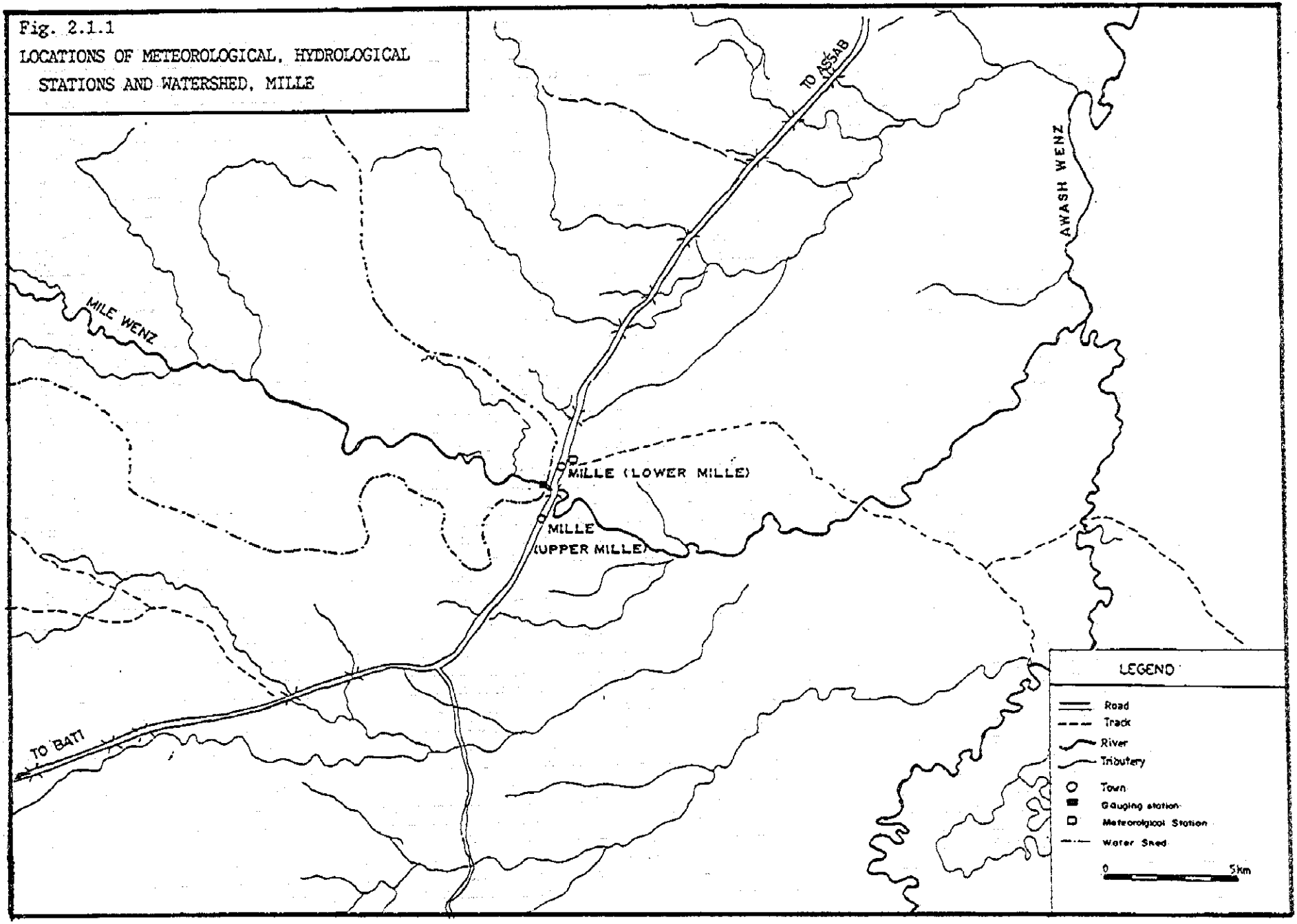
Note: P = Precipitation
Q = Runoff
ETo = Potential Evapotranspiration
ETcrop = Reference Crop Evapotranspiration
ETa = Actual Evapotranspiration
ΔS = Recharge
* = Distorted Data
- = Not Calculated due to Distorted Data

The crop factor for reference crop evapotranspiration is assumed at 0.7. Table 2.1.2 shows the ground water recharge takes place only in July and August. The quantity of the recharge can be calculated for the whole area, since there is no significantly large impervious layers in the basin:

$$0.0999 \times 4{,}350 \times 10^6 = 434.6 \times 10^6 \text{ m}^3/\text{year}$$

The aquifer is replenished with this quantity in an average year.

Fig. 2.1.1
LOCATIONS OF METEOROLOGICAL, HYDROLOGICAL STATIONS AND WATERSHED, MILLE



2.2 Hydrogeology

2.2.1 Geology

Mille is situated at the flunks of a volcanic mountain ridge that is crossed by Mille river. The Mille area is characterized by two unit formations. The hills and mountain ranges are formed by complex volcanoes of andesite-trachyte rhyolite composition which are fissured basaltic lava having deep brownish color and broken into blocks. This might be due to the high degree of physical weathering activated by the high solar radiation. In the east of the town, it is extended by a vast plain area which is covered by an alluvial and aeolian deposits. The alluvial deposit lies following the Mille river course.

As the result of aerial photograph interpretation, major lineations trending to NW-SE are observed at the south end of the Upper Mille and the north end of the Lower Mille. Minor lineations of NNE-SSW and ENE-WSW are crossing at the areas between Upper and Lower Mille and the riverside terrace area along the upstream of Mille river. Existing boreholes are situated following the NNE-SSW lineation just like being aligned, which is formed by the scarp of basaltic lava outcrop along the Addis Ababa - Aseb Road.

2.2.2 Hydrogeology

(1) Groundwater

There are three boreholes drilled in the Mille area but one borehole was abandoned. The two productive boreholes are situated on both sides of Mille river. There are only insufficient data about the borehole hydraulics but the lithological data of the three boreholes is available.

According to our field measurement, the yields were 3.6 l/s (BH1) and 2.8 l/s (BH2), though they are reported at 1.0 and 2.0 l/s on the data obtained from WWCE Kombolcha office. The ground water aquifer and the important recharging unit which is either from Mille river of from the Wello highlands should rely on fracture zones. The lithology of this area is fully basaltic nature. The eastward of the town, where the flat plain extends, are dominated by the sediments which might be important aquifers if they are thick enough and are not in a position to drain towards the Awash. The borehole information shows that the SWL is 30 m below ground surface and the thickness of the sediments is less than 15 m. This information is a good confirmation that the saturated ground water in the basaltic formation is not drained out.

(2) Other Water Source

In most parts of the rift escarpment and the tip flank towards the rift floor, some high discharge springs are generally observed. Mille river is formed in such a geography from the wello highlands, but there is no spring source nearby the town.

Mille river is the only surface water to the close vicinity of the town. The river discharge decreases in downstream due to the high evaporation and the seepage to thick alluvium.

According to verbal information, the river gets completely dry up during the extended dry season.

Table 2.2.1 Boreholes in Mille

BOREHOLE No.	LOCATION	DEPTH (m)	YIELD (l/s)	YEAR DRILLED	SWL (m)	SLOT POSITION	REMARK
WSS No.1	U.Mille	80	3.6 (#1)	1983	16	36.5 - 80m	productive
WSS No.2	L.Mille	62	2.8 (#2)	1978	22	56 - 62m	productive
WSS No.3	L.Mille	34	-	?	-	-	abandoned (#3)

Note: #1- Yield is observed by field measurement. WWDE data is 1.0 l/s.
#2- Yield is observed by field measurement. WWDE data is 2.0 l/s.
#3- This borehole was abandoned due to casing and circulation problem.

Chapter 3 Present Social, Water Supply and Sanitation Condition

3.1 Result of Water Quality Analysis

Water quality analysis has been made in both physico-chemical and bacteriological aspects, using calorimetric, volumetric analysis and filtration technique methods respectively. In the operational procedure and application of guideline value, "WHO Guidelines for Drinking-Water Quality 1993" has been referred to. The results are shown in Appendix-2 "Result of Water Quality Test" of Appendixes (Volume III).

3.1.1 Physico-chemical aspects

There are two (2) WSS sources which supply the water to Upper and Lower Mille respectively, both of which are boreholes. Those analyzed physico-chemical constituents are within the acceptable range according to the WHO drinking water guideline values.

There is a perennial river named Mille River flowing from north-west to south-east in between Lower and Upper Mile, and finally into Awash River. Some people go to the river for laundry and bathing specially during dry season in which the river water is not very turbid. However there is almost no town resident who fetches the river water for the purpose of drinking except during water supply system failure, although nomad people living surrounding area of the town often fetch the water as drinking purpose. A sample was collected from the Mille River, and the analyzed physico-chemical constituents are within the acceptable range set by the WHO drinking water guideline except turbidity and color. The river water could be potable water with filtration and disinfection scheme, however it is not recommendable for drinking because groundwater in this area is expected to be the most reliable and economical water source.

3.1.2 Bacteriological Aspects

Nineteen (19) samples, source of which is the two (2) Boreholes No.1 and No.2, had been undertaken for faecal coliform test. The results indicate that all samples are contaminated with faecal coliforms. The borehole No.1 and No.2 have shown one (1) and (3) coliforms per 100 ml respectively. It is considered that bacteria infiltration into the water supply pipes could be easily taken place because the system is not pressured continuously. Therefore water outlets such as public fountain and private connection indicate more contamination with the number of three (3) to too-many-to-count of faecal coliforms. Also, containers in household have shown large amount of contamination with too-many-to-count faecal coliforms in most cases.

The result above indicates that potable water from the source appears to be severely contaminated through poor sanitary condition or presence of leakage/infiltration of the distribution scheme and mostly improper handling of the household containers with poor awareness of sanitation of the consumers.

3.2 Current Water Consumption and Demand

3.2.1 Current Water Production and Consumption

Based on the data of the production and the billed consumption given by the staff stationed in Mille. In order to compare each data, the data from December, 1993 E.C.to November, 1994 E.C.(12 months) were selected and summarized in Table 3.2.1.

The large scale consumers such as commerce connection and governmental connection are included in individual connections. The water, fetched from the hydrant, is generally supplied for ETCA and custom office, so that it can be said that about 80 % of the total consumption is by individual connection. Annual consumption and production are given as blow.

Annual production	45,425 m^3
Annual consumption	31,751 m^3
Losses	about 30 %

In spite of hot season, the monthly consumption in July and August was low as compared to June. This was because the breakdown of the generator was taken place in July and August in 1994.

It is assumed that unauthorized connections, inaccuracies in metering, wrong recording of hydrant, and leakage from the old pipes and fittings as the unaccounted factor are included.

3.2.2 Water Users

According to the water consumption census conducted by the Team and the billed consumption data obtained at WSS office, it was found that the population served by the water supply was approximately 3,800. This figure is accounted for 97% of the total population of the Center. The water users can be divided into domestic, institutional, commercial and industrial consumption. Domestic consumption is subdivided into the ones of house connection, yard connection, public fountains and those who bought or borrowed water from neighbors (vendors). Table 3.2.2 shows the results of the data processing.

Table 3.2.2 Water Consumption and Demand

Categories	No. of Customers	Population served		Day Consumption		Day Demand	
		Population	(%)	(m^3)	(LPCD)	(m^3)	(LPCD)
Domestic	955	3,795	(100.0)	67.7	(17.8)	154.8	(40.8)
House Connection	1	200	(5.3)	16.7	(83.4)	16.7	(83.4)
Yard Connection	77	470	(12.4)	18.3	(38.9)	28.2	(60.0)
Public Fountain	643	2,419	(63.7)	16.5	(6.8)	47.4	(32.0)
Neighbors	234	706	(18.6)	16.2	(23.0)	32.5	(46.0)
Institutional	12			9.1		18.6	
Commercial	169			11.1		25.4	
Industrial	2			2.8		2.8	
Total	1,138	3,795		95.6		201.6	

Usually, the water users such as domestic, institutional, commercial and industrial vary in mode house connection to public fountain. Livestock project was considered as a house connection and a customer of domestic consumption, because there were about 200 residents in the compound and they used water for domestic purposes and gardening.

Yard connections are mixed with the domestic users and business users. Among yard connection users, 77 yard connection customers were domestic users. Its consumption is estimated at 18.3.

10 customers such as Freight Transport Cooperation, custom control station, Telecommunication, Kebele office, Mille district administration office are institutional customers, and the 2 customers Ephrem W/semaiat Garage and custom control station (new building) are considered as industrial. The major commercial customers are hotels (lodgings), restaurants and bars.

Concerning public fountain users, there were more than 50 houses engaged in businesses such as coffee bar, eatery, laundry, brewery and even water vendors in the vicinity of the PF at Sheh Yiman. The scale of their businesses was so small that the consumption for their businesses was considered negligible to the total consumption. All the consumption from the PF was, therefore, considered as domestic.

Those who borrowed and bought water from the neighbors were counted at 234 houses with the population of 706. Their domestic consumption 23.0 lpcd was obtained by the census survey and checked with the consumption records of those who gave water. There were more than 48 houses which engaged in small businesses. It was considered that the consumption for their businesses was negligible to the total consumption.

There were 2 hydrant users namely ETCA and Red Cross. ETCA camp sites at Lower Mille and has 130 workers. Their consumption was domestic, however, sorted as institutional consumption because they were stationed temporarily. Red cross distributed water to the villages near Mille, so that their consumption was excluded from the consumption of Mille.

3.2.3 Current Water Demand

The day demand of domestic categories was calculated in lpcd and given in Table 3.2.2. However, the day demand by each categories have exceeded the WSSAs guideline, and it is expected that the day demand more than WSSAs guideline will vary to upper modes. Thus, the demand rate in the guideline is adopted for the water demand projection.

In addition to above, the factor of natural condition is taking into account.

Table 3.2.1 Water production and Consumption in Mille

Consumption (m3)

	IC	PF1	PF2	PF3	PF4	PF5	PF6	Sub Total	Hydrant	Grand Total
Jul-93	2,910	166	93	144	37	279	99	818	2,302	6,030
Aug-93	2,125	144	156	219	32	312	89	952	2,302	5,379
Sep-93	1,873	25	30	55	9	195	50	364	166	2,403
Oct-93	1,656	100	131	117	22	400	103	873	2,774	5,303
Nov-93	1,570	97	151	180	45	400	40	913	2,774	5,257
Dec-93	1,428	89	182	121	30	195	40	657	786	2,871
Jan-94	1,404	33	63	107	75	165	30	473	630	2,507
Feb-94	1,541	52	90	143	162	155	44	646	1,485	3,672
Mar-94	1,609	96	75	110	38	142	23	484	0	2,093
Apr-94	1,846	48	149	70	21	84	25	397	0	2,243
May-94	1,811	61	100	136	45	171	56	569	936	3,316
Jun-94	1,811	31	46	76	20	63	29	265	936	3,012
Jul-94	1,691	51	79	161	51	265	40	647	0	2,338
Aug-94	1,608	34	45	154	46	170	28	477	0	2,085
Sep-94	1,379	90	139	144	33	313	83	802	0	2,181
Oct-94	2,059	87	155	142	45	158	42	629	126	2,814
Nov-94	2,022	86	82	121	33	132	31	485	112	2,619
Dec-94	2,087	58	68	104	30	99	25	384	126	2,597
Jan-95	2,184	65	92	114	37	158	46	512	154	2,850
Feb-95	2,173	58	102	68	28	100	16	372	126	2,671
Mar-95	1,853	58	68	104	30	99	25	384	196	2,433
Apr-95	1,853	80	127	89	22	118	41	477	168	2,498
May-95	2,254	47	49	66	10	68	14	254	182	2,690
Jun-95	2,254	123	119	164	28	172	33	639	120	3,013
Total	45,001							13,473	16,401	74,875
Average										3,120
Maximum										6,030

Production (m3)

Well		
Lower	Upper	Total
1,883	2,356	4,239
1,948	1,534	3,482
2,257	1,572	3,829
2,072	1,369	3,441
2,344	1,543	3,887
2,432	1,707	4,139
2,700	1,583	4,283
2,369	603	2,972
3,016	18	3,034
2,615	1,740	4,355
2,474	1,689	4,163
2,178	1,423	3,601
2,137	1,546	3,683
1,069	1,496	2,565
786	1,446	2,232
2,677	1,464	4,141
1,864	1,388	3,252
2,135	1,498	3,633
1,847	1,797	3,644
40,803	27,772	68,575
		3,609

Unaccounted Losses

m3	(%)
1,368	32
975	28
157	4
1,348	39
1,644	42
823	20
1,271	30
634	21
949	31
2,174	50
1,349	32
982	27
1,086	29
-285	-11
-439	-20
1,708	41
754	23
943	26
631	17
18,072	26

* Recorded in Ethiopian Calendar IC:Individual Connection PF:Public Fountain

*Unaccounted loss is sumed up from Dec. '93 to Jan. '95

3.3 Water Supply Facilities Condition

3.3.1 General

A little technical data on existing system was available, so that the field survey was carried out on the basis of the visual observations and measurements including test pit, discussions with the personnel and operators stationed in the sites.

Mille town is classified as satellite town of Asayta, according to the water supply service office in Asayta. The town is divided into two parts: Upper Mille and Lower Mille. There is an independent existing water supply system in each part of the town. Each system basically has piped water supply system with a borehole as the water source. The power for the water supply is served by the on-site generators because no hydroelectric supply is available in this town.

The existing water supply system has consisted of one borehole, distribution (transmission) pipeline and one reservoir for each part of the town separately. The schematic existing water supply system is shown in Figure 3.3.1.

3.3.2 Upper Mille

(1) Water Source

The existing borehole with a depth of 80 m was constructed at about 200 m south of the river Mille in 1982. The groundwater is pumped by the submersible pump, Japanese-made with the capacity of 3.3 l/s and the total head of 250 m.

The submersible pump is driven by the on-site generator, Italian-made. No technical data on this generator is available. The submersible pump is generally operated twice a day: 3 to 6 hours in the morning and 1 to 3 hours in the afternoon.

The borehole head is fitted with a check valve, a gate valve and a flow meter, and the actual pumping rate is quantified at rate of 3.6 l/s.

In addition, there is a hydrant facility beside the borehole. Mainly, ETCA utilizes this hydrant to supply water for his camp.

(2) Transmission and Distribution Facilities

The water pumped is delivered to the reservoir with the capacity of 25m3, through the transmission pipeline. This pipeline has two functions of transmission and distribution, with the valve operation. However, the water is directly distributed between the borehole and reservoir so that the valve installed at the outlet and inlet of the reservoir has been fully opened.

The pipeline network is dead-end distribution system with a galvanized steel pipes. The diameter of the main pipes is ranging from DN 15 to DN 65. The length of pipeline is summarized as follows:

Table 3.3.1 Existing Pipeline Data

Dia. (mm)	Length (m)	Material
15	18	G.S.
20	1102	-do-
25	94	-do-
40	523	-do-
65	1167	-do-

The reservoir, constructed on the top of hill, is made of steel plate, and without its cover. It was observed that the water level of the reservoir was about 70 cm during the time the pump was in operation.

(3) Service Level

With regards to the service level of water supply, there are two modes: individual connection and public fountain. There is, reportedly, no strict demarcation between house connection and yard connection with the WSS.

There are 31 individual connections including governmental and private use and 3 public fountains. All the public fountains are operational, and they are opened twice a day in the morning and afternoon.

3.3.3 Lower Mille

(1) Water Source

The existing borehole with a depth of 62 m is located at about 100 m northeast of the bridge. As well as Upper Mille, groundwater is pumped by the submersible pump, Japanese-made with the capacity of 1.5l/s and the total head of 140m.

The submersible pump is driven by the on-site generator. This generator is English-made with the capacity of 11KVA, manufactured in 1988. The submersible pump is usually operated twice a day as well as Upper Mille.

The borehole head is fitted with a check valve, a gate valve and a flow meter, and the flow meter showed that the actual pumping rate is around 2.8l/s.

(2) Transmission and Distribution Facilities

The component of the transmission and distribution facilities is same as Upper Mille.

The pipeline system has two functions: transmission and distribution, as well as Upper Mille. The diameter of the pipeline is ranging from DN 15 to DN 65. The length of pipeline is summarized as follows:

Table 3.3.2 Existing Pipeline Data

Dia. (mm)	Length (m)	Material
15	101	G.S.
20	64	-do-
25	38	-do-
40	319	-do-
65	1144	-do-

The reservoir, constructed on the top of hill, has the capacity of 25 m^3. It is made of steel plate, and without its cover. It was also observed that the water level of the reservoir was almost empty during the time the pump was in operation.

(3) Service Level

The existing service level is same as Upper Mille. There are 61 individual connections including governmental and private use and 4 public fountains. All the fountains are operational. The operation hour of public fountain is same as Upper Mille.

Some private houses are built on the service pipes for the public fountain.

3.3.4 O & M

The water supply facilities is under the control of WSS in Asayta. There is no service office in Mille. No regular check-up for water supply facilities is made in Mille town. In case of the breakdown of the facilities, the technician will be dispatched from the Asayta office in response to the request.

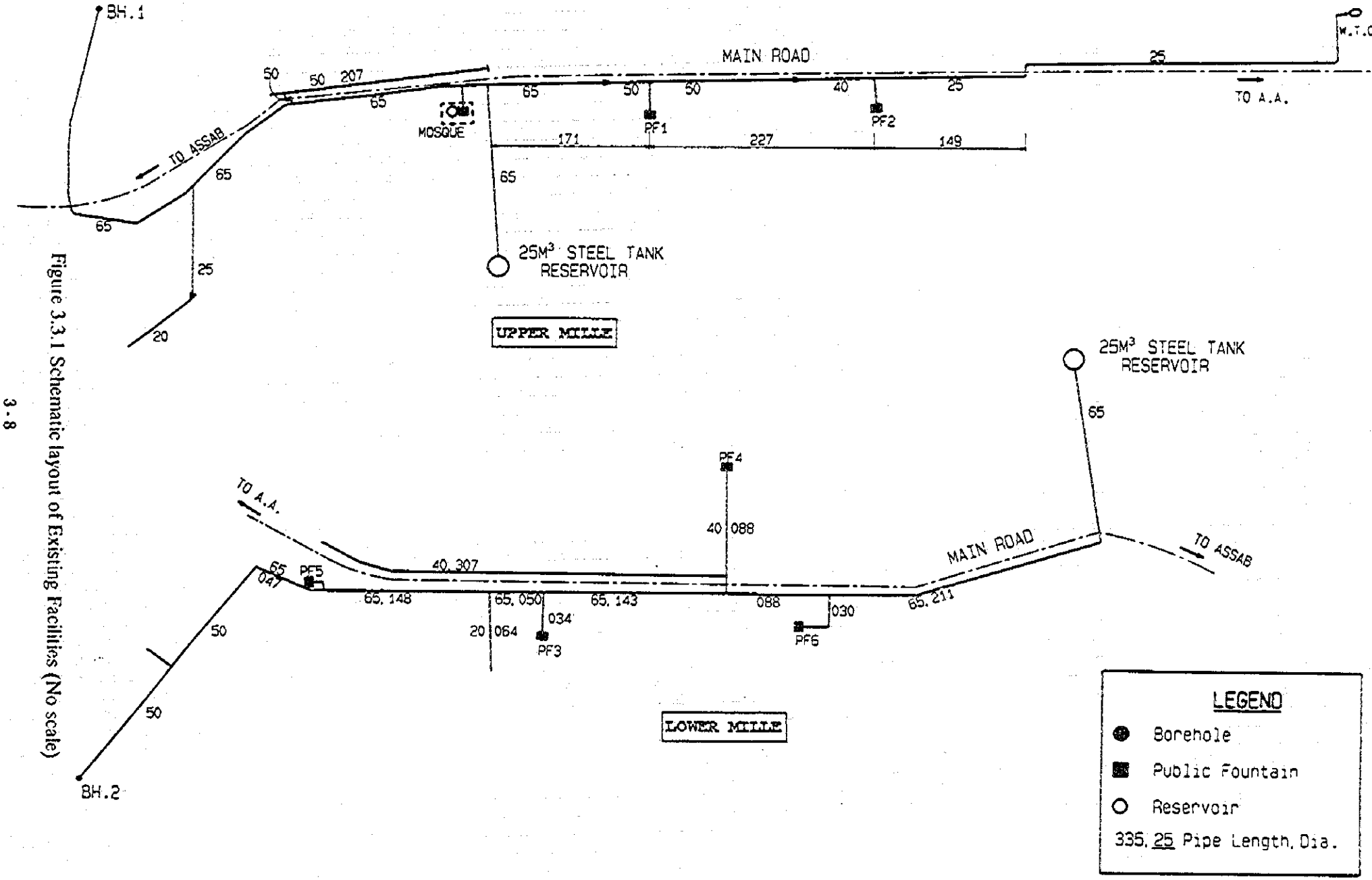


Figure 3.3.1 Schematic layout of Existing Facilities (No scale)

3.4 Sanitary Facilities Condition

3.4.1 Toilet Facilities

The 1984 Population and Housing Census has not covered Mille; and no survey was made regarding households. The Team carried out 100 households survey, and the result reveals that 56 households out of 100 do not have any type of toilet facilities, and the dwellers use open-field for excreta disposal. The remaining 44 households, the survey shows, have dry pit latrine for disposing their body wastes.

3.4.2 Other Sanitary Facilities

The survey of the 100 households in Mille has shown the following results pertaining to refuse disposal.

Table 3.4.1 Survey of 100 Households regarding dry Solid Waste Disposal

Category	Number
• Households that throw dry solid wastes anywhere	69
• Households that dump in open pit	8
• Households that dump in covered pit	0
• Households that collect refuse and burn	23
Total Household Surveyed	100

As it can be seen from the tabulation that 77 households out of 100 dump their dry solid wastes in open; and only 23 households burn.

When considering disposal of sullage, the survey shows that 94 households out of 100 dump anywhere; while only 6 households dispose in pits creating very high environmental pollution and serious health hazards.

3.5 Organization and Management

It is advised to refer to Tables 1 and 2 of Appendix-5 when you read this section.

Mille is one of the satellite towns of Asayta WSS so far as water supply is concerned.

Therefore, the personnel engaged in water supply activities for the town are organizationally under the manager of Asayta WSS and most of them are workers on contract or temporary basis.

The number of personnel for the satellite water supply service of Mille is 11 and its breakdown by position/function is shown below.

Table 3.5.1 Number of Personnel and Positions/Functions

Positions/Functions	Gender		Type of Employment		
	M	F	Permanent	Contract	Temporary
1. Administration					
Guards	3	0	0	0	3
2. Finance					
Water sellers	0	5	1	1	3
3. Technical					
Motor operators	2	0	0	2	0
Plumber	1	0	0	1	0
Sub-total	3	0	0	3	0
Total	6	5	1	4	6

The number of workers on temporary basis is 6. Assuming their average work days per year is a half of permanent/contract workers, one can say that the total number of personnel is in reality 8.

Because of absence of water meter no solid data are available regarding the production and consumption of water. However, based on the water price annual water consumption in 1993/1994 is estimated at something like 29,232 m^3. Leakage ratio is not known. But, supposing that it is 15%, then annual water production in 1993/1994 works out to 34,391 m^3. When it is divided by the recalculated number of personnel, one gets 4,299 m^3, which is an estimated annual production of water per employee.

This labor productivity indicator of the town is one of the highest among the 11 towns. It may suggest that the number of personnel is at a reasonable level. The monthly remuneration per worker is 96 birr. It is by far the lowest. It follows from the above that one can cite a curtailment of workforce and personnel cost as an advantage of satellite water supply operations.

The female workers are 6 in number. It means the females occupy 54.5% of the total personnel. The average share of females in water supply workers of the 11 towns is 27%. In this meaning female participation in the water supply service of Mille is very high.

3.6 Financial Condition of WSS

It is advised to refer to Tables 1 and 2 in Appendix-5 when you read this section.

The price of water per m^3 is 1.25 birr for all clients. The same tariff is applied in Bichena. In Dupti it is 1.5 birr for connection owners and 1.25 birr for public fountain users. In all the other towns concerned except Aykel the price of water per m^3 is 1 birr for all clients. In Aykel where only water from public fountains is available its price is 5 birr per m^3.

Consumption of water in the last fiscal year (Jul. 1993 to Jun. 1994) is calculated at something like 29,232 m^3. The daily water consumption as divided by population comes to 20.5 liter. This is by far the highest among the 11 towns. Water production is not known because there is no water meter.

Income for the last year was 48,818 birr. Major sources of income were yard connections customers (42.1%), hydrant users (38.6%) and public fountains users (14.6%). Income per m^3 of water consumed works out to 1.67 birr, which is at a medium level. Bill collection rate is 79.1%, which is the second lowest, next to 67.8% in Debre Tabor.

Expenditures for the same year were 38,182 birr. Major items of expenditures were fuel (51.4%), salary (33.1%) and per diem (7.2%). The income-expenditure ratio comes to 127.9%. It means that water supply activity in Mille was financially in a good shape as in Werota and Aykel. Water supply activity in only these three towns is solvent among the towns concerned. The income from hydrant users appears to have been one of major contributing factors.

The number of personnel is 11. It is the second smallest among the 11 towns, next to 10 for Dupti. Annual income per worker is 4,438 birr, which is one of the highest. Expenditures per worker is 3,471 birr, which is one of the lowest. Average monthly income of WSS employees is 96 birr. It is the second lowest among the 11 towns, next to 70 birr in Aykel.

It follows from the above that a comparatively ample supply of water, a comparatively high water rate, low cost (personnel and fuel) combinedly contributed to good financial performances. If managerial discipline is added, even better performances can be expected.

3.7 Social Background and People's Awareness

3.7.1 Population and social composition

The population of Mille was estimated to be around 3,902 at the time of the field survey. According to the responses of the household survey the majority of the inhabitants were Amhara (69%), Tigre (15%) and Oromo (11%) with only 4% Afar. Mille was basically a "highlanders" settlement surrounded by Afar. The town was divided into two portions, Upper Mille and Lower Mille, with Upper Mille being more populous. In Mille there were 60% male headed households and about 40% Christians according to the household survey. There were fewer female headed Muslim households than Christian female headed households in the lowes income groups (i.e. with monthly incomes below 100 Birr). Both types of female headed households had greater proportions in this income bracket than male headed households.

There had been a recent handing over of administrative power to the Afar at Woreda level. This change of responsibilities and authority was gradually being adjusted to. Rural Afar were being encouraged to settle in the town. The Kebele was dominated still by highlanders and the Kebele chairman had natural leadership qualities and was well liked by

the community. Most of the commercial activities were being undertaken by the highlanders. The town depends mainly upon the road for trade including hotels. There was a large livestock company which had been a major employer particularly since the Mille plantation closed down in 1992. At the time of the field survey the major priority need in Mille was identified as employment.

3.7.2 Sanitary conditions

The impression of the sanitation practices of the Mille population were very poor at the time of the field survey, however the household questionnaire reveals a different picture. Almost all of the group meetings reported that they practiced open defecation in the area immediately surrounding the town and that in the dry season the excreta was blown in the wind and in the rainy season it washed into the Mille river. In both conditions excreta would pose a hazard to health. However the population seemed mainly unaware of this health risk and there was an open opposition to controlled defecation practices. Latrines were considered odorous and unpleasant. However the household survey revealed a different picture, suggesting better than average sanitary behavior practices and similar levels of diarrhoeal disease awareness. This discrepancy in results is the most serious of the Eleven Centers and may be due to the slightly different field survey methodology used during this period. The household survey suggested that low income households and PF Users have the lowest access to latrines out of all of the groups analyzed in Mille.

3.7.3 Water situation

The piped water supply system covered Upper and Lower Mille, however Upper Mille has most of the PCs. The rest of Upper and Lower Mille relied on PFs. Only one PF operated in the morning and the afternoon. The other four operated every other day or third day for two hours in the morning only. PCs were served with a minimum of five hours supply daily. PF users had to revert to buying water at inflated prices from PC Vendors or taking water directly from the Mille river. On occasions the water system would break down and repairs to the system had sometimes taken weeks or even months.

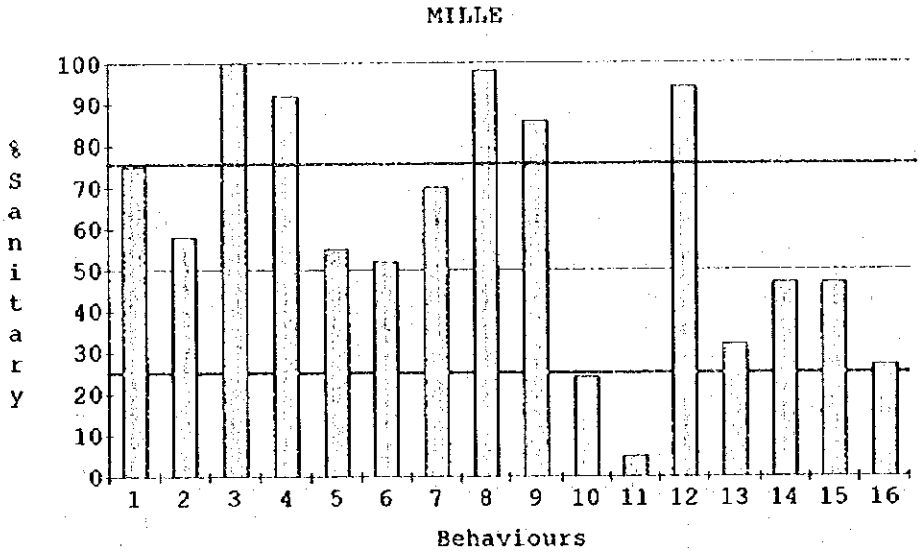
The PF Users identified the need for five additional PFs which would give them longer service time, reduced queues and reduced distance to walk for collection of water. The community felt that each additional PF could be managed by a small committee of water users (already nominated). The water seller would then be appointed by this committee. The salary of the water seller could be partly met by WSS and partly through slightly increased water charges. Locations of the additional PFs were also agreed upon. The community requested that they be involved in any further decisions about the water supply system.

Compared with other towns in the Study, Mille was very different with respect to gender roles over the cartage of water. Although women were still the largest collectors of water, men (older men included) were the next largest group of water collectors. Girls and then boys also collected and carried water. This was a most unusual phenomena in Ethiopia.

3.7.4 Health Indicators

Mille had a Health Center covering the town and surrounding countryside. According to the Health Center, the prevalent diseases occurring in Mille during 1994/5 were identified as malaria, dysentery, TB and sexually transmitted diseases. Malaria was considered to be the major problem. The Health Center was providing some health education to the community, but as the community was unaware of this activity, it was probably ineffective.

The indicator sanitary behaviors taken from the household survey have been recorded in Figure 3.7.1.



No.	SANITARY BEHAVIOURS	%Sanitary
1	Access to piped water	75
2	Use piped water supply always	58
3	Covered water container	100
4	Water scoop kept off the floor	92
5	Handwashing with soap after defecating	55
6	" after handling childrens stools*	52
7	Covering cooked food during storage	70
8	Not eating raw unwashed fruit and vegetables	98
9	Kitchen utensils stored off the floor	86
10	Rubbish burried or burned	24
11	Wastewater disposed in pit/drain/veg. garden	5
12	No animals kept in the house	94
13	Home not infested with flies	32
14	Latrine in use by household	47
15	Latrine in use by all household members	47
16	Infant's excreta disposed of in latrine*	27
TOTAL SCORE FOR SANITARY BEHAVIOURS		962

*As proportion of households with young children

Figure 3.7.1 Indicator Sanitary Behaviours

The summary chart indicates areas where sanitary behavior improvements were required. The highest priority areas were burning or burial of solid waste and sanitary disposal of waste water. The medium-high priority areas were fly control, access and use of latrines by households and sanitary disposal of children's excreta. The medium-low priority areas were access/drinking of piped water always, handwashing with soap after defecation and after handling children's stools and covering cooked food during storage.

There was little variation in the score with gender of household heads, with ethnic groups or land ownership. There were some differences between religion and between household income groups. The access to water remained similar for all groups but the level of access to latrines seemed to vary with income. Those with a monthly income of less than 100 Birr and PF Users had less access to latrines than higher income groups. Christians were more likely to wash their hands with soap than Muslims. PC Users had the best access to water and sanitation facilities and had the best sanitary behaviors compared with all other groups analyzed.

3.7.5 Education

There was one elementary school (up to 8th grade) in Mille, with 420 students. There was a high ratio of girls at the school, with 1.5 girls to each boy. There were no water facilities at the school and although there were two latrines, students preferred not to use them.

3.7.6 Religious institutions

These institutions were not approached during the field survey.

3.8 Socio-Economy

It is advised to refer to Tables 3 and 4 in Appendix-5 when you read this section.

3.8.1 Administrative Conditions

There are 17 governmental organizations excluding schools dealing with general administration, finance, education, health, water supply and sanitation, communications, police, justice, water resources development, agriculture, road maintenance and municipal affairs.

It is especially to be noted in this regard that there is North Eastern (or Third) Livestock Project Office. The project was started in 1986 by the government to settle Afar population. French and German financial assistance is forthcoming to provide water for domestic use and for livestock.

The number of government employees is 336. It is the second smallest, next to 322 in Werota among the 11 towns. The number of them per 1,000 population works out to 86, which is the highest. Their average monthly salaries are 311 birr, which is on the low side.

This town has one Kebele.

3.8.2 Population

The population of the town is estimated at 3,902 based on the JICA census. It is the smallest among the 11 towns concerned. Ethnically, Amhara has the largest share of population with 69.2%, followed by Oromo with 13.5%, Tigre with 12.5%, Afar with 3.8% and Gurage with 1.0%. Religion-wise, Moslem population accounts for 57% and Christian population 43%. There are 2 mosques and 1 church.

This town is ethnically varied with Amhara at the top in number. Also, it is an Islamic center.

The average family size is 4.6 persons. This is the second smallest among the 11 towns, next to 4.5 in Dupti. The area of the town is estimated at 68 ha by JICA, which is the smallest. The population density is calculated at 57.4 persons/ha. It is the second highest, following 73.1 persons/ha in Bichena.

3.8.3 Educational Conditions

There is one elementary school with up to 8th grade only. One more elementary school is now under construction. The total number of pupils is 420. The number of pupils per 100 population is calculated at 14, which is the lowest among the 11 towns.

Literacy ratio and primary school enrollment ratio were 62% and 53% respectively according to the 1984 population census. The literacy ratio is one of the lowest and the enrollment ratio is the lowest along with that for Bati.

The existing educational conditions in the town can be said to be poor compared with those in other towns.

3.8.4 Medical Conditions

There is 1 health clinic and 2 private pharmacies. The total number of medical personnel in the health clinic comes to 4, which is the smallest among the 11 towns. It means that there is one medical personnel for every 1,000 population. It is on the low side.

It appears that the people of the town should be given better access to medical personnel and facilities.

The types of diseases people suffer most are water-borne diseases such as intestinal parasite, skin infection and malaria, and respiratory tract infections such as bronchitis, pneumonia and T.B. It seems that it has something to do with the shortage of piped water and climatic conditions in the town. The number of top ten disease cases treated in the Health Clinic in 1993/94 was 1,611.

The estimated total number of cases treated last year in the health clinic was divided by the estimated service population. It came to 12.4%, which is the second lowest, next to 11.1% in Dejen.

Under 5 mortality rate and life expectancy were 154/1000 and 53 years respectively according to the 1984 population census. They are both at the medium level.

Ratio of households more or less using septic tanks and pit latrines is 45%. This is the second lowest, following 39% in Aykel among the 11 towns. Bichena has the same ratio as Mille in this regard.

It follows from the above that sanitary awareness of the people is one of the lowest, although it does not necessarily mean that they suffer from diseases more than people in other towns.

3.8.5 Economic Conditions

The number of hotels and restaurants is 162 (79.4%) and that of shops 42 (20.6%), adding up to 204. This total number of commercial establishments is the smallest among the 11 towns. The total number per 1,000 population comes to 52, which is on the high side. The number of hotels and restaurants per 1,000 population is 42, which is by far the highest.

Mille is characterized as a commercial town with many hotels and restaurants catering for transit passengers.

Major occupations in the town are commerce, day laborers and government employees. There is no cottage industry, nor agricultural activities. Major marketable items are vegetables, fruit, crops such as maize, barley and wheat, animals such as sheep and goat, and others. There is no major market day in a week.

Average monthly household income is 223 birr. This is one of the lowest among the 11 towns.

3.9 Town Planning and Development

The master plan for town planning has not been formulated, and there is no plan to formulate the master plan according to the officials in Regional office of Region 2. It is expected that the existing town will extent along the main road, and especially, the Upper Mille will extent towards east.

The electric power is now supplied to the Center by the off-site generator by EELPA, and there is no allocation for water supply. There is no plan to supply hydroelectric power to the Center for future. Existing water supply facilities is operated by the on-site generators Thus, the future water supply facilities at the target year of 2005 and 2010 will be also operated by the on-site generators.

Chapter 4 Plan of Water Supply System

4.1 Water Demand Projection

4.1.1 Population Projection

The population of Mille was 1,169 in 1984 according to the results of the 1984 Population Census. The census is the first one the Ethiopian government has ever took. No population figures are available for Mille before 1984.

Since 1984 Central Statistical Authority (CSA) published its own estimates of population. According to them population of the town in 1992 was 1,738. Also, the JICA Study Team has the Cartographic Census population figures of the town for 1994, which are 2,716. The census was conducted by CSA using its own staff. CSA told the team that the figures are the most dependable.

On the other hand, the team conducted its own census of Mille population on the site. As a result it was found that it is 3,902.

Officials at Mille say that the workers at the plantation returned to their birth place after the socialist government took power some four years ago. It contributed to a sharp increase of population at Mille. Also Upper Mille was added to Lower Mille during the last decade. It gave rise to an abrupt increase of the population and at the same time it will cause a population growth in future. Mille has a comparatively ample supply of water among the 11 towns. Besides, its business is thriving as its location is such that many truck drivers spend a night there.

Eventually the JICA census figures were adopted as the 1995 population of the town. As the average annual population growth rate 1995 to 2000 8.0% was adopted based on the average annual population growth rate 1984 to 1994, which is 8.80%. The more a projection is long-term, the more the incertainty increases regarding the projection. Therefore, one should be more cautious and conservative for a longer-term projection. In line with this reasoning the average annual population growth rates 2000 to 2005 and 2005 to 2010 were projected to be 7.5% and 7% respectively.

As a result the projected population of the town for 2000, 2005 and 2010 works out to 5,733, 8,230 and 11,543 respectively (Refer to Table 4.1.1).

Table 4.1.1 Population of Mille

1. Past Population

1984 Population Census	1994 Estimates by WSSA	Average Annual Growth Rate 1984 to 1994
1,169	2,716	8.80%

2. Population Projection

1995	2000	Average Annual Growth Rate 1995 to 2000
3,902	5,733	8.0%
2000	2005	Average Annual Growth Rate 2000 to 2005
5,733	8,230	7.5%
2005	2010	Average Annual Growth Rate 2005 to 2010
8,230	11,543	7.0%

4.1.2 Water Demand Projection

(1) Domestic Water Demand

a) Population Projection by Service Modes

Based on the current population data by service modes, the population at the target years by modes is projected and estimated in the Table 4.1.2.

The house connection and yard connection are estimated, based on the ratio of the households who are payable for the mode-wise water charge. Target ratio of the sum of house connection and yard connection at the year of 2010 is 73%, and 23% of these ratio is house connection.

The ratio of the population served by the piped water at the target year of 2010 is 100%, considering the current ratio.

Table 4.1.2 Population Forecast by Service Modes

	Population (%)							
	1995		2000		2005		2010	
House Connection	200	(5.1)	447	(7.8)	1,078	(13.1)	2,424	(21.0)
Yard Connection	1,176	30.1	1,932	33.7	3,374	41.0	6,002	52.0
Public Fountain	2,419	62.0	3,354	58.5	3,778	45.9	3,117	27.0
Sub total	3,795	97.2	5,733	100.0	8,230	100.0	11,543	100.0
TSU	107	2.8	0	0.0	0	0.0	0	0.0
Total	3,902	100.0	5,733	100.0	8,230	100.0	11,543	100.0

b) Projection of Domestic Water Demand

Water demand figure by service modes formulated by WSSA is applied for the projection, i.e, House Connection 60 lpcd, Yard Connection 35 lpcd, Public Fountain 15 lpcd. In addition, these figures multiply by 1.1, considering the natural condition (annual mean rainfall is less than 900 mm).

It will be possible to supply the above ratio, providing that the construction for first stage is completed in the year of 2000. Thus, water consumption ratio will increase according to the completion of next stage. Based on these conditions, the domestic water demands at the years of 2000, 2005 and 2010 are obtained as follows:

Table 4.1.3 Total & Average Domestic Water Demand

	m^3/day (lpcd)							
	1995		2000		2005		2010	
House Connection	16.7	(83.4)	29.5	(66)	76.5	(71)	186.6	(77)
Yard Connection	34.5	(29.3)	75.3	(39)	141.7	(42)	270.1	(45)
Public Fountain	16.4	(6.8)	57.0	(17)	68.0	(18)	62.3	(20)
Total	67.6		161.9		286.3		519.1	
Average	22.5	(17.8)	54.0	(28)	95.4	(35)	173.0	(45)

(2) Non Domestic Water Demand

a) Current Non Domestic Water Demand

As a result of field survey, the following current non domestic water demand is obtained.

Table 4.1.4 Current Non Domestic Water Demand

Item	Unit	Nos.	Demand (m^3/day)	Remarks
School	5 l/person	420	2.1	
Hospital	20 l/staff	10	0.2	
Hotel	100 l/bed	420	42.0	6 beds/place × 70 places = 420 beds
Bar...	200 l/bar	5	1.0	
Mosque	5 l/visitor	400	2.0	200 visitors/place × 2 places = 400
Offices	5 l/person	40	0.2	
Total			47.5	

b) Non Domestic Water Demand in Target Years

The public and institutional water demand increase in a geometric ratio of population growth, and the commercial water demand increases in a geometric ratio of population growth plus 3%. Non domestic water demands in the target years are estimated as follows:

Table 4.1.5 Total Non Domestic Water Demand in Target Years

Item	Demand (m^3/day)				Remarks
	1995	2000	2005	2010	
School	2.1	3.1	4.5	6.3	Population growth rate
Hospital	0.2	0.3	0.4	0.6	-do-
Hotel	42.0	70.8	116.6	187.8	Population growth rate +3%
Bar, Tea shop	1.0	1.7	2.8	4.5	-do-
Mosques	2.0	2.9	4.2	5.9	Population growth rate
Offices	0.2	0.3	0.4	0.6	-do-
Total	48	79	129	206	

(3) Total Water Demand

Total water demand at the target years including the accounted losses (29%) are estimated as follows:

Table 4.1.6 Total Water Demand in Target Years (m^3/day)

	1995*	2000	2005	2010
Domestic	68	162	286	519
Non Domestic	28	79	129	206
Losses	34	27	57	128
Total	130	268	472	853

* Actual consumption

(4) Maximum Day Demand and Peak Day Demand

Taking the seasonal difference into account, the factor 1.5 is adopted for the projection of maximum day demand. Furthermore, the factor 2.0 is adopted for the projection of peak day demand. The maximum day demand and peak day demand at the target years are obtained as follows:

Table 4.1.7 Maximum Day Demand Peak Day Demand

Item	Factor	1995	2000	2005	2010
Average Water Demand (m^3/day)		130	268	472	853
Maximum Day Demand (m^3/day)	1.5	195	402	708	1,280
Peak Day Demand (m^3/hour)	2.0	16	34	59	107

4.2 Water Resources Development

4.2.1 Evaluation of Water Resources

Mille has annual precipitation of 290.3 mm but no ground water recharge occurs in an average year, which means all the precipitation evaporates. However, Mill has Mille river flowing in the middle of the town, which divides the town into two parts, Upper Mille and

Lower Mille. Mille river is a large perennial river having a watershed area of 4,350 km^2 at Mille. The area precipitation is estimated at 496.9 mm/year and the area ground water recharge is 99.9 mm/year in an average year. The use of the river for water supply is not recommended at this stage because the O & M cost of treatment facilities is not affordable with this small town.

In Mille, ground water development is feasible. The WSS has two operational wells located at both side of the river, BH No.1 for Upper Mille and BH No.2 for Lower Mille. The yields of the wells are reported at 3.6 l/s and 2.8 l/s respectively.

The geology has basaltic nature in which basaltic lava outcrops in the area. In the eastern plain, basalts underlie below aeilan deposits and river deposits and along the river course they underlie below river deposits. The major aquifers of the wells are highly weathered and fractured rocks, gravel, sand and volcanic ash according to the geological logs. Since the wells are located along a linearment according to the aerial photograph interpretation, it is expected that the rocks are fractured and weathered along the linearments as favorable as for ground water exploitation.

Geoelectrical survey was conducted at 15 points as shown in Drawing including the existing borehole sites. In general, the apparent resistivity curves have bumpy shapes reflecting the degree of fracturing, weathering and saturation. The specific resitivities of weathered and fractured rocks vary largely from 2 to 50 ohm-m. The results of VES interpretation are shown in Appendices.

Considering the lineation and the result of VES interpretation, borehole sites are selected at VES Station No.5, No.9 and No.14 totally three (3) sites. Station No.5 and No.9 are located in Lower Mille and Station No.14 is in Upper Mille.

4.2.2 Strategy of Water Resources Development

The characteristics of the major aquifers of the operational wells and the proposed well sites are shown in Table 4.2.1.

Table 4.2.1 Characteristics of Aquifers

Well No.	Locations	Depths of Major Aquifers (GL-m)	Lithology of the Aquifers	Total Thickness of the Aquifers (m)	Permeabilities (m/day)	Remarks
1	VES St.1	38 - 46	Hard Rock	42	1.5	WSS BH No.1
		46 - 48	Decomposed Rock			
		48 - 50	Red Ash			
		50 - 80	Hard Rock			
2	VES St.2	50 - 62	Gravel and Sand	12	4	WSS BH No.2
3	VES St.14	32 - 70※	Weathered and Fractured Basalt	19	1	New Well
4	VES St.5	16 - 70※	Weathered and Fractured Basalt	27	1	-Ditto-
5	VES St.9	25 - 103※	Weathered and Fractured Basalt	39	1	-Ditto-

Note: ※ = The aquifer bottom is probably deeper than the figure.

The depths of the major aquifers of WSS wells are obtained from the geological logs. The others are detected by the geoelectrical survey. Excluding the operational wells, the thickness of major aquifers is reduced into half because a part of basalts are highly weathered and may become claylsh. The permeabilities of major aquifers with WSS wells are estimated assuming 60% of the yields is optimal. For the new well sites, the permeabilities are assumed at 1 m/day according to the design criteria. The optimal yields of the wells are estimated with the formula listed in the design criteria with a drawdown of 20m and diameters of wells to be 200 mm. The optimal yields of the wells are shown in Table 4.2.2.

Table 4.2.2 Optimal Yields and Water Levels of the Wells

Well No.	Dia. of Well (m)	Optimal Yield (m^3/day)	Static Water Level (GL-m)	Dynamic Water Level (GL-m)	Remarks
1	0.15	191	16	36	WSS BH No.1
2	0.15	145	20	40	WSS BH No.2
3	0.20	230	25	45	New Well for Year 2005
4	0.20	327	25	45	-Ditto-
5	0.20	472	16	36	New Well for Year 2010

The optimal yields of Well No.1 to Well No.4 totaling to 893 m^3/day cover the demands of year 2005. The total yield of all the wells will cover the demand of year 2010.

It is recommended to drill two (2) wells i.e. Well No.3 and Well No.4 before year 2005 because both Mille can have one well each for the individual water supply systems.

4.2.3 Design of Water Source Facilities

The new deep wells are designed as follows.

(1) Casing

Fiber Reinforced Plastic (FRP) pipe is adopted considering its elasticity for the case that the drilled borehole is not straight.

The diameter of casing is decided at 200 mm, taking into consideration the outer diameter of submersible pump (standard 80 - 140 mm) and the allowance. The length of the pipe is six (6) m per piece.

(2) Screen

Corresponding with the casing, FRP screen is adopted. The opening ratio is 12% and the length is four (4) m per piece. The total screen length is longer than the calculated by the following formula.

$$Ls = \frac{\alpha \cdot Q}{10 \cdot A \cdot N \cdot V}$$

where Ls: Length of screen (m)
Q: Pumping rate (l/s) (assumed equal to the optimal yield)
A: Surface area of screen 0.66 m^2/m
N: Opening ratio 0.12
V: Inflow velocity 0.5 cm/s (assumed)
α: Safety factor 3

The dimensions of the wells are summarized as shown in Table 4.2.3.

Table 4.2.3 Dimensions of Wells

Well No.		3	4	5
Pumping Rate	(m^3/day)	230	327	472
	(l/s)	(2.7)	(3.8)	(5.5)
Diameter of Well	(mm)	200	200	200
Casing Length	(m)	48	36	48
Screen Length	(m)	28	40	56
Well Depth	(m)	76	76	104
Drilling Diameter	(mm)	300	300	300

4.3 Plan of Water Supply System

The water supply system proposed for the center of Mille would be implemented in two phases: first phase (target year 2005) and second phase (target year 2010).

The water supply system, which is composed of intake facilities, rising mains and distribution facilities, is proposed in the first phase to meet the water demand. The first phase is proposed of intake facilities, transmission facilities and distribution facilities.

The water supply system, which is composed of additional intake facilities, transmission facilities and distribution facilities, is planned in the second phase to meet the water demand at the target year of 2010.

4.3.1 Water Supply System in 2005

There are now two water supply systems in the center of Mille: upper Mille and lower Mille. Water supply system at target year of 2005 is also divided into two systems as well.

(1) Boreholes

There are three potential sites for borehole as stated in chapter 4.2. Among these proposed sites, two boreholes will be drilled in the first phase. The groundwater pumped up is transferred to the new reservoir directly. The existing two boreholes are planned to be incorporated into new systems production boreholes. The production rate planned is summarized as follows.

a) Upper Mille

W1 (Existing well)	191 m^3/day
W3 (proposed)	230 m^3/day
Total	521 m^3/day

b) Lower Mille

W2 (Existing well)	145 m^3/day
W4 (proposed)	327 m^3/day
Total	472 m^3/day

(2) Borehole Pumps

Each borehole will be equipped with a submersible motor pump. The characteristics of the pumps to be installed are assumed as follows:

W1, W2 Q = 0.13 m^3/min., H = 80 m, Pump Dia = 100 mm, P = 3 kW
W3, W4 Q = 0.25 m^3/min., H = 70~100 m, Pump Dia = 140 mm, P = 5 kW

(3) Rising Mains

Rising mains will range from 75 mm to 100 mm with total 4,040 m and transfer water to the new reservoir.

(4) Reservoir

The capacity of the reservoirs is required to meet the water demand at the year of 2005, and the required capacity for each is 140 m^3 including reserve for fire fighting.

(5) Distribution Network

The distribution network is designed for the peak hour demand and fire fighting case, according to the design criteria.

The layout of the network follows the existing roads. The pipe with Dia. 75 mm is adopted as the minimum dia., and the pipe with dia. 50 mm is automatically adopted for the small distribution zone. Existing galvanized steel pipes will be replaced, if necessary.

The layout of distribution network for the target year of 2005 is prepared and attached in the Drawings. The main pipelines planned are shown as follows:

Table 4.3.1 Distribution pipelines

DN (mm)	Length (m)
150	7,040
75	520
50	1,650

(6) Disinfection

Disinfection will be performed by the injection system directly into the outlet of the reservoirs, which are planned to be built in Upper and Lower Mille. Total daily consumption of chemical will be estimated at about 0.7 kg and necessary more than 0.11 PPM at the end of distribution pipe.

(7) On-site Generator

In order to operate the water supply system, the generator with capacity of about 3 sets of 20 KVA will be installed.

(8) Administration Building

In order to manage daily basis waterworks such as operation works, bill collecting, a building is required to be built by the year of 2005. The building is preferable to be built in the center of the town, and it has a store room.

4.3.2 Water Supply System in 2010

(1) Borehole

No.5 site is proposed in the second phase to meet the water demand at the year of 2010. The rising main connected to the upper Mille's systems. The production rate planned is summarized as follows.

W5 (proposed) 472 m^3/day

(2) Borehole Pumps

The borehole of No.5 will be equipped with a submersible motor pump. The characteristics of the pumps to be installed are assumed as follows:

W5 (proposed) Q = 0.30 m^3/min., H = 112 m

(3) Distribution Network

The layout of distribution network for the target year of 2010 is not prepared in this Study. It is because a master plan of town planning is not formulated yet. It is preferable to design a layout plan after formulation of the master plan.

(4) Disinfection

Total daily consumption of chemical at the stage of year 2010 will be estimated at about 1.2 kg and necessary more than 0.11 PPM at the end of distribution pipe.

4.4 Implementation Schedule and Cost Estimation

4.4.1 Executing and Responsible Agencies

The executive agency of this Project is to be the Water Resources Bureau of Afar National Regional Government, while the Ministry of Water Resources is to be responsible to coordinate and facilitate the implementation of the Project.

WSSD is to be responsible for the close coordination with the agencies concerned on the project approval, finance and project implementation. The Project would be required to be of great importance in the coordination of activities among the departments in the Ministry and between the central and regional offices concerned.

Prior to the implementation of the Project, the Project Manager is to be appointed under WSSD, who rests with the day-to-day works. Under the manager, aiming at the smooth implementation, coordination be maintained among such departments/services as Planning & Project, Administration & Finance, Contract Administration, Design and WSSD. The Project Manager be also required to keep close relationship with regional and town offices concerned.

4.4.2 Construction Schedule

The construction works for pipeline and reservoir related to water supply works have been carried out mostly by manual labor in Ethiopia. However, it would be recommended to introduce certain number of construction machines in order to speed up the construction works.

As this Project requires urgent intermediation to counteract the current deteriorating water supply condition, the aforementioned measures shall be employed for the purpose of keeping-up smooth execution of the construction works.

The construction schedule is divided into two stages; namely, 1) preparation of finance including the foreign currency portion and detail design accompanied with tender document, and 2) implementation of the Project. The schedule is proposed in the following, taking into consideration the above two stages and the construction amount.

First stage : Preparation in 1996
Second stage : Implementation after 1996 with reference to the priority among Eleven Centers

4.4.3 Project Construction Cost

The Project cost is estimated with both local currency and foreign currency. The unit price is estimated with reference to the standard unit price specified in Guideline for Preparation of Project, WSSA, July 1991. The unit price in this Project is price-escalated from the guideline prices based on the inflation rate shown in Economic Sensus between 1991 and 1995. WSSD's overhead, design and supervision fees and physical contingency are estimated according to the guideline.

In respect of foreign currency portion, the cost is required for the preparation of construction equipment and machinery, and procurement of such equipment and material as pump and pipe. Also, fuel, cement and other local materials made of imported row material are partly counted into foreign currency portion.

Engineering staff will be required for the detail design work and the implementation of the Project, since the Project is relatively large in the scale comparing to those existing water supply system. Consultant will also be employed by WSSD, MWR and be responsible for the all necessary work to be required and cooperate together with the WSSD's engineers.

Total project costs regarding water supply in years of 2005 and 2010 are summarized in Table 4.4.1.

Table 4.4.1 Total Project Cost of Water Supply in Thousand Birr

Year	F.C.	L.C.	Total
2005	6,663	4,407	11,070
2010			8,022

Note: Transportation Cost for Construction Equipment, Vehicles and Office Equipment are not included.

In this Study, sanitary improvement was also designed and required costs are summarized in Table 4.4.2. The costs are composed of 1) toilet facilities to be constructed in schools, medical institutions and public, 2) vacuum track, 3) refuse disposal track, 4) sludge dumping site, 5) refuse disposing site and 6) refuse collecting bins. Household sanitary facilities such as toilet (including community type) and waste water disposal pit shall be managed by the individuals or otherwise subsidized. Although drainage facilities are important, those are to be managed by Municipality and community participation in coordination with WSS. Therefore, the cost does not include the drainage facilities.

Table 4.4.2 Total Project Cost of Sanitary Facilities in Thousand Birr

Year	Cost
2005	1,313
2010	443

4.5 Financial Analysis

4.5.1 Financial Plan

(1) Estimation of Revenues

(a) Determination of Water Tariff

It was decided that there will be three water prices. One will be applied to house connection owners and non-domestic clients. The second and the last will be applied to yard connection users and public fountain users respectively.

The water tariff was so constructed that house connection owners and non-domestic clients will cross-subsidize yard connection and public fountain users, and yard connection users will, in turn, cross-subsidize public fountain users.

The tariff was determined in such a way that house connection owners, yard connection users and public fountain users will pay 4%, 4% and 2% of their income for water respectively in the target year of 2010.

Eventually, it is recommended that the following tariff will be applied from 1999 onward:

Clients	Water Price (birr/m^3)
1. House Connection Owners and Non-Domestic Clients	3.03
2. Yard Connection Users	1.80
3. Public Fountain Users	0.89

Important information concerned such as average monthly household income, share of households, water consumption per household per month, payment for water supply per household per month and ratio of water payment to income by type of clients and by the target year is shown in Table 4.5.1.

(b) Projection of Revenues

The major income source of water supply services is as every one knows revenue from water charge.

It is calculated by (No. of households by year by type of clients) × (annual water consumption per household by year by type of clients) × (water price by type of clients) × (bill collection rate).

The number of households was estimated based on the service population projection in the other chapter.

Annual water consumption was estimated based on the water demand projection in the other chapter.

Water price is already mentioned above.

The bill collection rate in the future was assumed as 95%.

There is the second revenue source. It is the revenue from technical service charge. This is the installation charge of connections. They say that the charge is 40% of the material and transportation cost actually incurred.

The revenue is calculated by (No. of connections to be newly installed by year) × (average technical service charge per connection).

The number of connections to be newly installed every year is estimated based on the projected number of house/yard connection owners.

According to the field surveys conducted by JICA, the average technical service charge per connection worked out to 195 birr although the charge varies depending on the diameter and length of the pipe, distance, etc.

The third revenue source is the the revenue from meter rent. For every new connection installed a water meter will be rented. The rental fee is 1 birr per month.

There are other revenues such as those from material sales, contract fee, connection fee, road crossing, etc. They are assumed to be 2% of the sum total of the preceding three revenues.

Projected revenues by source are shown in Table 4.5.2.

(2) Estimation of Cost

There are two types of cost. One is capital cost and the other is operation and maintenance (O & M) cost. Capital cost is required to construct and replace water supply facilities. O & M cost is an recurrent cost daily required for the proper functioning of water supply facilities.

(a) O & M Cost

Seven types of O & M cost can be identified.

The first is electricity cost. In Mille, however, it is projected that electricity will not be available for pumps in future.

The second is fuel cost. It is estimated that 122 birr, 216 birr and 391 birr will be daily required in 2000, 2005 and 2010 respectively.

The third is disinfection cost. It is estimated that 5 birr, 8 birr and 13 birr will be daily required in 2000, 2005 and 2010 respectively.

The fourth cost is personnel cost. It is estimated that 15, 19 and 25 employees will be required for WSS in 2000, 2005 and 2010 respectively. It is recommended that the average monthly remuneration per employee will be 481 birr. It was worked out based on the standard salaries the authorities are now proposing for each type/position of personnel comprizing WSS.

The fifth is installation cost of connections. It is projected that 29, 59 and 114 connections will be annually newly installed from 1999 to 2004, from 2005 to 2009 and from 2010 onward respectively. Installation cost per connection is estimated at 488 birr on average.

The sixth is the purchase cost of water meters. For each connection to be newly installed one water meter will be required. The purchase price of a water meter widely varies depending on the diameter of the pipe and the country from which it was imported. It was assumed that it will be 276 birr based on the bulk purchase price of Indian imports.

The last is other cost including office supplies, uniform, per diem and travel, postage & telephone, transport, maintenance of office, motor house, etc. , insurance, cleaning items, etc. It was assumed that the cost will be 10% of the six preceding cost combined.

(b) Capital Cost

Capital cost can be classified into initial cost and replacement cost. The former is required at the time of initial investment and the latter at the time of investment for replacement.

So far as the Project is concerned, replacement cost will be required every 15 years for water purification units only. The average life of other equipment and facilities is assumed to be 30 years, which is the assumed life of the Project.

The summary of the estimated initial cost is as follows:

(Unit : thousand birr)

Item	Foreign Components	Local Components	Total
1. Phase 1			
1) Construction Cost	5,057	2,694	7,751
2) Engineering Cost (12% of 1))	930		930
3) Contingency (5% of 1) + 2))	299	135	434
Sub-Total	6,286	2,829	9,115
4) Buildings		1,123	1,123
5) WSSD's Management Cost (2% of 1) + 2) + 3) + 4))		205	205
Sub-Total		1,328	1,328
Total	6,286	4,157	10,443
6) Water Purification Units (included in total)	10	15	25
2. Phase 2			
1) Construction Cost			4,669
2) Engineering Cost (10% of 1))			467
3) Contingency (10% of 1) + 2))			513
Total			5,649
Grand-Total			16,062

The Phase 1 Project will start in 1996 and end in 1998, while the Phase 2 Project will start in 2007 and end in 2009. The first year of project implementation is for detail design, and the second and third years are for the construction of facilities. The progress of construction work was assumed to be 50% for 1997/2008 and the remaining 50% for 1998/2009.

4.5.2 Financial Analysis

Financial statements (income statement and fund statement) were projected for 30 years starting in 1996.

In doing so, the following conditions were assumed:

1. External Loan for Initial Cost

Ratio of Loan	:	100%
Grace Period	:	10 years
Repayment Period	:	30 years
Interest Rate	:	1%

2. Governmental Subsidy to WSS

   90% of Initial Cost

It is to be noted that the cost related to the construction of accommodation facilities as well as WSSD's management is not included in the above initial cost. Such cost will be borne by the Ethiopian government and WSS will pay it back on the same repayment terms as in the case of external loan.

Also, it was assumed that the existing corporate tax system will be applied, including 40% tax rate on the before-tax income in case the income is over 50 thousand birr.

Further, inflation was not considered.

The results are shown in Table 4.5.3.

As it shows, WSS will be financially sound and stable in terms of earnings as well as solvency in years to come except initial years, if all the above mentioned conditions, estimates and assumptions are met.

As representative managerial indicators, the weighted averages of the ratio of revenues to expenditures and the ratio of working capital to revenues for the 30 years from 1996 to 2025 work out to the following:

Revenues/Expenditures = 130.3%
Working Capital/Revenues = 30.0%

Generally, it will be all right if the ratio of revenues to expenditures is equal to or more than 100%, or preferably 110%. Also, it will be all right if the ratio of working capital to revenues is equal to or more than 10%.

It is to be noted that the above values exceed the required levels by a substantial margin.

Table 4.5.1 Water Price and Ratio of Water Payment to Income

Item	1995	2000	2005	2010
1. Average Monthly Household Income (birr)				
1) House Connection Owners	897	852	850	804
2) Yard Connection Users	327	339	305	280
3) Public Fountain Users	128	129	140	122
2. Share of Households (%)				
1) House Connection Owners	5.1	7.8	13.1	21.0
2) Yard Connection Users	30.1	33.7	41.0	52.0
3) Public Fountain Users	62.0	58.5	45.9	27.0
3. Water Consumption/Household/Month (m^3)				
1) House Connection Owners	11.5	9.1	9.8	10.6
2) Yard Connection Users	4.0	5.4	5.8	6.2
3) Public Fountain Users	0.9	2.3	2.5	2.8
4. Water Price (birr/m^3)				
1) House Connection Owners	1.25	3.03	3.03	3.03
2) Yard Connection Users	1.25	1.80	1.80	1.80
3) Public Fountain Users	1.25	0.89	0.89	0.89
5. Payment for Water Supply/Household/Month (birr)				
1) House Connection Owners	14.4	27.6	29.7	32.2
2) Yard Connection Users	5.0	9.7	10.4	11.2
3) Public Fountain Users	1.1	2.1	2.2	2.5
6. Ratio of Water Payment to Income (%)				
1) House Connection Owners	1.6	3.2	3.5	4.0
2) Yard Connection Users	1.5	2.9	3.4	4.0
3) Public Fountain Users	0.9	1.6	1.6	2.0

Source: JICA

Table 4.5.2 Planning of Revenues

(Unit: birr)

Year	H./Y. Connec.	Public Founta.	Non-Domest.	Techni. Servic.	Meter Rent	Other Revenue	Total
1996	26,256	7,321	14,359	1,502	-	799	50,236
1997	27,044	7,540	14,790	1,502	-	822	51,698
1998	27,855	7,767	15,233	1,502	-	846	53,203
1999	49,147	10,559	50,599	5,588	3,734	3,338	122,966
2000	77,993	17,591	83,002	5,588	4,078	3,765	192,016
2001	96,158	18,270	93,508	11,550	4,789	4,485	228,759
2002	114,322	18,949	104,015	11,550	5,500	5,087	259,422
2003	132,487	19,627	114,521	11,550	6,211	5,688	290,084
2004	150,652	20,306	125,028	11,550	6,921	6,289	320,746
2005	168,817	20,985	135,534	11,550	7,632	6,890	351,408
2006	207,981	20,633	151,714	22,141	8,995	8,229	419,693
2007	247,144	20,282	167,894	22,141	10,357	9,356	477,174
2008	286,308	19,930	184,074	22,141	11,720	10,483	534,656
2009	325,471	19,578	200,254	22,141	13,082	11,611	592,137
2010	364,635	19,226	216,434	22,141	14,445	12,738	649,618
2011	364,635	19,226	216,434	0	14,445	12,295	627,035
2012	364,635	19,226	216,434	0	14,445	12,295	627,035
2013	364,635	19,226	216,434	0	14,445	12,295	627,035
2014	364,635	19,226	216,434	0	14,445	12,295	627,035
2015	364,635	19,226	216,434	0	14,445	12,295	627,035
2016	364,635	19,226	216,434	0	14,445	12,295	627,035
2017	364,635	19,226	216,434	0	14,445	12,295	627,035
2018	364,635	19,226	216,434	0	14,445	12,295	627,035
2019	364,635	19,226	216,434	0	14,445	12,295	627,035
2020	364,635	19,226	216,434	0	14,445	12,295	627,035
2021	364,635	19,226	216,434	0	14,445	12,295	627,035
2022	364,635	19,226	216,434	0	14,445	12,295	627,035
2023	364,635	19,226	216,434	0	14,445	12,295	627,035
2024	364,635	19,226	216,434	0	14,445	12,295	627,035
2025	364,635	19,226	216,434	0	14,445	12,295	627,035

Note: H./Y. Connec. = House/Yard Connection
Public Founta. = Public Fountain
Non-Domest. = Non-Domestic
Techni. Servic. = Technical Service
'-' = included in 'Other Revenue', if any

Table 4.5.3(1) Financial Statement

(Unit: thousand birr)

No.	1	2	3	4	5	6	7	8	9	10
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Income Statement										
Revenue	50	52	53	123	192	229	259	290	321	351
Operation and Maintenance	39	41	42	157	171	209	222	235	247	260
Depreciation	0	32	65	65	65	65	65	65	65	65
Payment of Interest	0	0	0	0	0	0	0	0	0	0
Expenditure	39	73	106	222	236	274	286	299	312	325
Profit before Tax	11	-21	-53	-99	-44	-45	-27	-9	9	27
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	11	-21	-53	-99	-44	-45	-27	-9	9	27
Funds Statement										
Profit after Tax	11	-21	-53	-99	-44	-45	-27	-9	9	27
Loans	98	1071	1071	0	0	0	0	0	0	0
Subsidies	879	3662	3662	0	0	0	0	0	0	0
Depreciation	0	32	65	65	65	65	65	65	65	65
Sources	987	4744	4745	-34	21	20	38	56	73	91
Capital Works	976	4069	4069	0	0	0	0	0	0	0
Payment of Principal	0	0	0	0	0	0	0	0	0	0
Working Capital	11	675	675	-34	21	20	38	56	73	91
Applications	987	4744	4745	-34	21	20	38	56	73	91
Loan Liabilities	99	1181	2275	2297	2320	2344	2367	2391	2415	2439
Cash Balance	22	697	1372	1338	1359	1379	1416	1472	1545	1636

Source: JICA

Table 4.5.3(2) Financial Statement

(Unit: thousand birr)

No.	11	12	13	14	15	16	17	18	19	20
Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Income Statement										
Revenue	420	477	535	592	650	627	627	627	627	627
Operation and Maintenance	328	351	373	395	417	321	321	321	321	321
Depreciation	65	65	73	82	82	82	82	82	82	82
Payment of Interest	1	13	24	23	22	21	20	18	17	16
Expenditure	394	428	470	499	520	423	422	421	420	419
Profit before Tax	25	49	65	93	129	204	205	206	207	209
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	25	49	65	93	129	204	205	206	207	209
Funds Statement										
Profit after Tax	25	49	65	93	129	204	205	206	207	209
Loans	0	51	257	257	0	0	0	0	0	0
Subsidies	0	462	2311	2311	0	0	0	0	0	0
Depreciation	65	65	73	82	82	82	82	82	82	82
Sources	90	628	2706	2742	211	286	287	288	289	290
Capital Works	0	514	2568	2568	0	0	13	13	0	0
Payment of Principal	5	59	113	114	115	116	118	119	120	121
Working Capital	85	55	25	60	96	169	157	157	169	169
Applications	90	628	2706	2742	211	286	287	288	289	290
Loan Liabilities	2457	2462	2609	2757	2648	2537	2425	2313	2199	2084
Cash Balance	1722	1777	1802	1862	1958	2127	2284	2441	2610	2779

Source: JICA

Table 4.5.3(3) Financial Statement

(Unit: thousand birr)

No.	21	22	23	24	25	26	27	28	29	30
Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Income Statement										
Revenue	627	627	627	627	627	627	627	627	627	627
Operation and Maintenance	321	321	321	321	321	321	321	321	321	321
Depreciation	82	82	82	82	82	82	82	82	82	82
Payment of Interest	15	14	16	17	16	14	12	11	9	8
Expenditure	417	417	418	420	418	417	415	413	412	410
Profit before Tax	210	210	209	207	209	210	212	214	215	217
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	210	210	209	207	209	210	212	214	215	217
Funds Statement										
Profit after Tax	210	210	209	207	209	210	212	214	215	217
Loans	0	0	0	0	0	0	0	0	0	0
Subsidies	0	0	0	0	0	0	0	0	0	0
Depreciation	82	82	82	82	82	82	82	82	82	82
Sources	291	292	291	289	291	292	294	295	297	299
Capital Works	0	0	0	0	0	0	0	0	0	0
Payment of Principal	122	126	140	155	156	158	159	161	162	164
Working Capital	169	166	150	135	135	135	135	135	135	135
Applications	291	292	291	289	291	292	294	295	297	299
Loan Liabilities	1967	1847	1709	1555	1399	1241	1082	921	758	594
Cash Balance	2948	3114	3264	3399	3533	3668	3803	3937	4072	4206

Source: JICA

Chapter 5 Improvement of Health and Sanitation

5.1 Plan for Sanitary Facilities

The sanitation situation in Mille is very bad. The critical shortage of water supply in the town plays a considerable role in aggravating the sanitation situation. Therefore, any plan of improving the sanitary facilities should go hand-in-hand with the improvement of water supply. The waste water production in liters per capita per day was estimated using the water demand data for each type of water supply service.

Table 5.1.1 Water Demand in lpcd and Waste Water Production in lpcd for Mille

Item	HC			YC			PF		
	1995	2005	2010	1995	2005	2010	1995	2005	2010
• Water demand (lpcd)	83.4	71	77	29.3	42	45	6.8	18	20
• Waste water generation rate (%)	81	77	78	66	70	70	60	63	64
• Waste water production (lpcd)	67	55	60	19	29	31	4	11	13

Form the water demand and waste water production as indicated in Table 5.1.1, conventional sewerage system cannot be introduced in Mille even by the year 2010.

Therefore, the sanitary technologies envisaged for Mille are on-site technologies such as drainage and waste water disposal pit.

5.1.1 Plan of Toilet Facilities

The sanitary technologies planned for Mille are grouped into four major categories.

- Improved Traditional Pit Latrines
- VIP Latrines
- Compost Toilets
- Flush Toilets

These technologies are related to the types of water supply services of house connections (HC), yard Connections (YC) and public fountain (PF). The proposed toilet facilities are considered for residential or domestic households as well as for non-domestic households taking the water supply services of HC, YC and PF into account.

Table 5.1.2 Proposed Sanitation System in Relation to Types of Water Supply Services for Domestic Households

Types of Water Supply Services	Proposed Sanitary System for Domestic Households
1. Traditional Water Sources + Public Fountain (PF)	• Improved traditional pit latrine • VIP latrine, single-pit or double-pit • Soakaway pit for sullage
2. Yard Connection (YC)	• VIP latrine, single-or double-pit • Compost latrine • Pour-flush toilet with simple water seal and on-site pit • Pour-flush latrine + soakaway pit • Soakaway pit for sullage
3. House Connection (HC)	• Pour-flush toilet + soakaway pit • Cistern-flush toilet + soakaway pit • Pour-flush or cistern-flush toilet + septic tank • Soakaway pit for sludge

In each category, the first sanitary technology proposed is generally the cheapest and the simplest. Those that can afford more can have the subsequent ones depending on their choices and paying capacity.

For communities, schools, bus, terminals, market areas, health facilities, government offices, hotels, restaurants, bakeries, pastries, bars, tej and tella drinking houses etc. the sanitation technologies proposed are indicated in Table 5.1.3.

Table 5.1.3 Proposed Sanitation Technologies for Communities and Non-domestic Households

Category	Proposed Sanitation System
1. Communities	• VIP community latrine with washbasin
2. Schools & training centers	• VIP collective toilet with washbasin
3. Market & bus terminals	• VIP public toilet with washbasin or shower
4. Government institutions	• VIP latrine with washbasin • Cistern-flush toilet + soakaway pit • Cistern-flush toilet + septic tank
5. Commercials	• VIP latrine with washbasin • Pour-flush or cistern-flush toilet + soakaway pit • Pour-flush or cistern-flush toilet + septic tank
6. Hotels, restaurants, drinking place, etc.	• Collective VIP latrine with washbasin • Pour-flush toilet with washbasin + soakaway pit • Cistern-flush toilet with washbasin + septic tank • Soakaway pit for sullage
7. Hospitals, health centers, clinics	• Collective VIP latrine with washbasin • Pour-flush toilet with washbasin + soakaway pit • Cistern-flush toilet with washbasin + septic tank • Soakaway pit for sullage

5.1.2 Plan of Sullage, Dry Solid Waste and Drainage

(1) Sullage

Sullage is the waste water which does not contain excreta but comes out from each household. Sullage always contains some pathogens though the concentration is much lower than that in sewage. In Mille, sullage is presently being dumped in front of the households or along the streets. This poses a health risk if it is allowed to continue to be dumped everywhere.

The plan considers sullage soakaway pits of various sizes depending on the size and type of households for its disposal. The sullage soakaway pits need to be properly lined with stone, adobe, and other local materials with open joints for the major parts of the depth leaving about 30 cm from the top for pointed lining. If the waste water or sullage is too much for the soakaway pits to handle, then drainage field channels should be used.

(2) Dry Solid Waste

The dumping of dry solid wastes everywhere has created environmental pollution and water contamination in Mille which should not be allowed to continue in order to improve the sanitation situation in the town. Since Mille has three main parts, the proposed refuse disposal sites have taken this into consideration; and envisaged one for Lower Mille, one for Upper Mille and a third one for Mille 3.

(3) Drainage

Sullage soakaway pits are planned for disposal of sullage from domestics well as non-domestic households. Sometimes the waste water may be too much for the soakaway pits to handle or the soaking capability of the pit may be too low creating excess waste water to be drained. When this condition arises, "drain field channels" have to be used, the size being directed by size of excess waste water.

Though rainfall in Mille is very low, when it comes it creates storm drainage problems unless adequate facilities are problems. The main road that passes through Mille has adequate side and cross drainage facilities provided; but they are not regularly maintained and blockages often occurs. The first plan in undertaking drainage improvement is to open-up all closed or blocked drainage facilities that are available.

Local people in Lower Mille have reported formation of stagnant waters in the low-areas on the eastern side of this part of the town, near the mosque, clinic, and the areas before reaching Red Cross office or the Police Station. Parallel roads and side roads do not have adequate side and cross drainages. There have to be provided with drainage and opening up for blocked drainages be made.

5.2 Financial Plan for Sanitary Facilities

To estimate both the capital cost of building the sanitary facilities and the annual operation and maintenance cost, based on the 1995 prices, the following assumptions have been made.

- The calculated waste water flows for Mille are too low to justify the installation of conventional sewerage system in Mille. On account of this, the sanitary facilities proposed for Mille are on-site sanitary technologies.
- Those households that do not have any toilet facilities in Mille at present are assumed to have one type of toilet facility by the year 2010.
- Sanitary technologies that are new to the culture of the people living in Mille are to be introduced gradually and with proper prior education as to the benefits and usefulness of the new technologies. Social acceptability of the new technology has to be confirmed prior to its introduction.
- Proposals for the appropriate sanitary technologies are drawn up based on the types of water services rendered in Mille.
- The households in the same water service category can have toilets of the standard they can afford to pay for.

5.2.1 Households

From projected population of Mille for target years of 2005 and 2010, households have been estimated using the family size for each type of water services.

Table 5.2.1 Households in Mille for Target Years of 2005 & 2010 by Type of Water Services

Target Year	Households		
	HC	YC	PF
• 2005	230	760	790
• 2010	530	1,380	600

5.2.2 Estimate of Costs

(1) Capital Costs per Unit

For each type of toilet facility that is considered appropriate for Mille and some equipment required indicative costs for constructing each type of sanitary facilities and for purchasing the equipment are estimated as follows.

Table 5.2.2 Indicative Cost of a Type of Sanitary Facility or Equipment

Type of Sanitary Facility or Equipment	Indicative Cost of One Facility or Equipment (Birr)
1. Improved traditional pit latrine	1,000
2. VIP toilet, single pit	1,500
3. VIP toilet, double pit	2,000
4. VIP toilet, shared	15,000
5. VIP toilet, community	45,000
6. VIP toilet, collective (e.g. schools)	65,000
7. VIP toilet, public (e.g. market)	95,000
8. Compost latrine	2,500
9. Pour-flush + soakaway pit	3,000
10. Pour-flush + septic tank + soakaway pit	7,500
11. Cistern-flush + soakaway pit	4,000
12. Cistern-flush + septic tank + soakaway pit	8,500
13. Sullage soakaway pit	800
14. Drain field channel	4,000
15. Medium size vacuum truck	250,000
16. Medium size refuse collection and disposal truck	180,000
17. Animal-drawn cart	12,000
18. Refuse collection bin	250
19. Sludge dumping site	10,000
20. Refuse disposing and burning site	6,500

(2) Annual Operating and Maintenance Costs per Unit

The annual operating and maintenance cost is based on the assumption that most of the work is going to be done by labor only. For the equipment both running and maintenance costs are included.

Table 5.2.3 Annual Operating and Maintenance Cost per Unit

Type of Sanitary Facility or Equipment	Annual Operating and Maintenance Cost (Birr)
1. Improved traditional pit latrine	200
2. VIP toilet, single pit	250
3. VIP toilet, double pit	300
4. VIP toilet, shared	400
5. VIP toilet, community	700
6. VIP toilet, collective (e.g. schools)	800
7. VIP toilet, public (e.g. market)	3,000
8. Compost latrine	750
9. Pour-flush + soakaway pit	1,000
10. Pour-flush + septic tank + soakaway pit	1,250
11. Cistern-flush + soakaway pit	1,200
12. Cistern-flush + septic tank + soakaway pit	1,400
13. Sullage soakaway pit	100
14. Drain field channel	800
15. Vacuum truck	7,500
16. Refuse collection and disposal truck	8,500
17. Animal-drawn cart	3,000
18. Refuse collection bin	50
19. Sludge dumping site	2,000
20. Refuse disposing and burning site	2,500

(3) Assumptions for Estimating the number of Toilets to be Implemented in Mille by the Year 2005 and 2010

To find the number of toilets to be implemented in Mille by the year 2005 and 2010, the following assumptions have been made.

- By the year 2005

  - All schools in Mille will have, at least, VIP collective toilets.
  - The Mille Hospital toilet facilities will be rehabilitated; and the clinic and possibly a health center will have VIP collective toilets.
  - Mille market area and bus terminal will have VIP public toilet.
  - 100% of households that have house water supply connections (HC) will have some kind of flush toilet.
  - 75% of the households that have yard water supply connections (YC) will have VIP or higher toilets.
  - 75% of households that use public fountain (PF) as a source of water supply will have improvement traditional toilets or VIP toilets.

- By the year 2010

  - 50% of households that have HC water supply will have some kind of flush toilets.
  - 50% of households that have YC will have VIP or higher toilets.
  - 100% of household that use PF will have improved traditional latrine or VIP latrine or higher grade toilets.

- In each category (HC,YC,PF), those that can afford more can have higher standard of toilets of their choices.

- All equipment will be replaced by this time.

(4) Total Capital Cost

Indicative capital costs for sanitary facilities for Mille based on 1995 prices are shown in Table 5.2.4 for the year 2005 and in Table 5.2.5 for the year 2010.

Table 5.2.4 Capital Costs of Sanitary Facilities for Mille for Year 2005

Facilities	No	Unit Cost (birr)	Total Cost (1,000 Birr)
• VIP collective toilets for schools	8	65,000	520
• VIP collective toilets for clinics and health centers	2	65,000	130
• VIP public toilet for market area and bus terminal	2	95,000	190
• 100% households with HC to have PF toilets	230	7,500	1,725*
• 75% households with YC to have VIP shared toilets or higher toilets	570	15,000	8,550*
• 75% households with PF to have VIP toilets	593	2,000	1,186*
• Vacuum truck	1	250,000	250
• Refuse disposal truck	1	180,000	180
• Sludge dumping site	2	10,000	20
• Refuse disposing site	2	6,500	13
• Refuse collecting bins	40	250	10
Total			12,774
Excluding Households' (*)			1,313

Table 5.2.5 Capital Costs of Sanitary Facilities for Mille for the Year 2010

Facilities	No	Unit Cost (birr)	Total Cost (1,000 Birr)
• 50% of households with HC to have flush toilets	265	7,500	1,988*
• 50% of households with YC to have VIP toilets or higher	690	3,000	2,070*
• 100% households with PF to have VIP toilets	600	2,000	1,200*
• Replacement of vacuum truck	1	250,000	250
• Replacement of refuse disposal truck	1	180,000	180
• Replacement of refuse collecting bin	50	250	13
Total			5,701
Excluding Households' (*)			443

(5) Total Operating and Maintenance Cost

Indicative operating and maintenance cost for sanitary facilities for Mille are shown in Tables 5.2.6 and 5.2.7 for the years of 2005 and 2010 each.

Table 5.2.6 Annual Operating & Maintenance Costs for the Year 2005

Facilities	No	Unit Cost (birr)	Total Cost (1,000 Birr)
• VIP collective toilets for schools	8	800	6.40
• VIP collective toilets for clinics and health centers	2	800	1.60
• VIP public toilet for market area and bus terminal	2	3,000	6.00
• 100% households with HC to have PF toilets	230	1,250	287.50*
• 75% households with YC to have VIP shared or higher toilets	570	400	228.00*
• 75% households with PF to have VIP toilets	593	300	177.90*
• Vacuum truck	1	7,500	7.50
• Refuse disposal truck	1	8,500	8.50
• Sludge dumping site	2	2,000	4.00
• Refuse disposing site	2	2,500	5.00
• Refuse collecting bins	40	50	2.00
Total			734.40
Excluding Households' (*)			41.00

Table 5.2.7 Annual Operating & Maintenance Costs by the Year 2010

Facilities	No	Unit Cost (birr)	Total Cost (1,000 Birr)
• Flush toilets for households with HC	265	1,250	331.25*
• VIP or higher toilets for households with YC	690	1,000	690.00*
• VIP toilets for households using PF	600	300	180.00*
• Vacuum truck	1	7,500	7.50
• Refuse disposal truck	1	8,500	8.50
• Refuse collecting bins	50	50	2.50
Total			1,219.75
Excluding Households' (*)			18.50

(6) Summary of Costs

- Capital Costs

Year	Cost in 1,000 Birr (Total)	Excluding Households'
2005	12,774	1,313
2010	5,701	443
Total	18,475	1,756

- Annual Operating & Maintenance Costs

Year	Cost in 1,000 Birr (Total)	Excluding Households'
2005	734.40	41.00
2010	1,219.75	18.50
Total	1,954.15	59.50

5.3 Application of Sanitary Education Program

Based on the approach detailed in the Main Report the following specific suggestions have been made for sanitary education in Mille. These take into account the findings of the field survey:

Sanitation and sanitary behavior improvements were not a felt need in Mille. Any sanitation intervention would have to be undertaken in a gradual manner using all possible channels. These include using those influential leaders already respected by the community. The effect of unemployment on the population was severe and efforts to incorporate income generation and motivational initiatives as part of the sanitary education program are important.

Table 5.3.1 Sanitary Education Priorities in Mille

Priority level	Type of Behavior	Blocks to Improved Practice
High	Solid waste disposal in covered pits or burned	Sites not allocated for public waste disposal sites or not managed strictly (Municipality/ Woreda) Individuals (women) must be informed of where (Municipality/ Woreda) and how to dispose of waste (CPP/ all)
High	Waste water disposal in pits, drains or vegetable gardens	Drainage insufficient and disposal into drains not strictly managed (Municipality/Woreda) Individuals (women) must be informed of where to dispose waste water (Municipality/Woreda) and shown safe disposal techniques (CPP/all)
Medium-High	Fly Control	Associated with climate but also related to solid and liquid waste disposal and excreta disposal (Municipality/Woreda /All role) Behaviors like covering of food and water pots during storage should be maintained (CPP/All)
Medium-High	Latrine coverage for all households*	Latrines to be built and maintained (Public-Municipality/Woreda) and (Community/private latrines-WSS/CPP/All made easier with examples of low cost latrines and loans (WSS))
Medium-High	Latrine use by all members of household*	Where there is a latrine, not all (children) of the household members use it. Use by all family members should be encouraged and status of latrine users promoted (CPP/all)
Medium-High	Sanitary disposal of children's excreta*	Small children should be encouraged to use the latrine as soon as they are able (all family members) Clearing up of children's excreta (women and girls role) must be encouraged and status of latrine users promoted (CPP/all))
Medium-Low	Access to Piped water	Improved access and level of piped water supply (WSS role) All use water but this depends mostly on opening times, location of supply sources and to a lesser extent to price (women/girls roles)
Medium-Low	Piped water used always*	Piped water not always available in sufficient quantities (WSS role) and not available when required by people (WSS role) at sites convenient for collection (WSS role).
Medium-Low	Handwashing with soap after defecation**	Personal hygiene (all) made more easy by making access to water and soap/ash nearer to the latrine (women's role) and by improving the status of the improved behavior (all)
Medium-Low	Handwashing with soap after handling children's stools*	Personal hygiene (women and girls roles) made easier by improving access to water and soap/ ash nearer to latrine (women) and improving the status of such behavior (all)
	* High priority for low income households	
	** Medium-High priority for low income households	

Chapter 6 Reinforcement of Organization

It is advised to refer to Table 6.1.1 and Figure 6.1.1 when you read this section.

6.1 Comprehensive Organization and Management

The production of water will increase markedly under the proposed plan from 130 m^3/day in 1995 to 268 m^3/day in 2000, 472 m^3/day in 2005 and 853 m^3/day in 2010.

In line with it, the organizational structure will be enlarged, new functions will be added and the number of employees will be increased.

Basically the number of employees in the target years was estimated dividing water production by water production per employee. In estimating water production per employee, labor efficiency resulting from a greater production was assumed. It is proposed that the existing satellite status of Mille water supply service be elevated to the fully independent status from 2010 onward. Also, it is proposed that sanitation functions be introduced in the organization of WSS from 2000 on. It means that more manpower will be required.

In adding sanitation functions to WSS the full name of WSS will be changed to Water Supply and Sanitation Service. But, the abbreviated name will be WSS as has been the case.

Considering all the above factors, it is proposed that the number of employees will increase from 8 in 1995 to 15 in 2000, 19 in 2005 and 25 in 2010.

Note: The existing number of employees is 11. However, 6 of them are employed on daily basis. If one assumes that their average work days per year are 50% of those of permanent/contract workers, then the total number of employees will work out to 8 in terms of permanent/contract workers.

The organizational structure will get enlarged and more diversified. The ultimate organizational structure of WSS is shown in Figure 6.1.1.

As it shows, the organizational structure of WSS will be basically composed of 7 elements: Manager, Internal Audit, Customer Services, Administration Service, Financial Service, Technical Service and Sanitary Service. These are a skeletal structure or fundamental requirements of water supply and sanitation services. The functions of the last four big Services will get more diversified as years go by in accordance with greater water production.

6.2 Organization and Management of Water Supply

The number of personnel for water supply functions of WSS will be 13, 16 and 21 in 2000, 2005 and 2010 respectively.

A brief explanation on the ultimate organizational structure and functions will be given below:

The objectives of water supply functions of WSS are to supply sufficient piped water on one hand and to financially stand on its own feet. In this regard Customer Services and Internal Audit are typical functions of WSS. Besides them there will be three major Services.

Administration Service is composed of General Administration, Personnel, Storage and Legal Sections. General Administration Section will be in charge of secretarial/clerical work. Guards and sweepers also belong to this section. Personnel Section will be in charge of recruitment, assignment and training of personnel, and remuneration. Storage and purchasing of materials and supplies will be done in Storage Section. Such matters as complaints and penalties can be taken care of by Legal Section.

Financial Service controls Budgeting, Accounting, Financial Management and Operation Sections. Annual and monthly budget of income and expenditures will be prepared in Budgeting Section. Monthly and annual accounting of expenditures and income will be performed in Accounting Section. Financial Management Section makes analysis and evaluation of financial performances. Operation Section is in charge of meter reading, billing and collection, and cash water selling.

Technical Service covers Technical Records, Operation and Maintenance, Inspection and Work Sections, and Workshop. Records of equipment and supplies such as acquired dates, number, plans, dimension, breakdowns and repairs will be kept in Technical Records Section. Operation and maintenance of pumping stations, reservoirs, pipelines, public fountains, etc. will be taken care of by the section of the same name. Inspection of the above-mentioned facilities will be regularly done by the section of the same name. Repairing and manufacturing belong to Workshop. Works Section is in charge of rehabilitation/replacement/construction of facilities.

The number of personnel to be assigned by position/function in 2000, 2005 and 2010 is shown in the latter half of Table 6.1.1.

6.3 Organization and Management of Sanitation

The number of personnel for sanitation functions of WSS will be 2, 3 and 4 in 2000, 2005 and 2010 respectively.

A brief explanation on the ultimate organizational structure and functions will be given below:

An independent department called Sanitation Service will be introduced. The Service will be comprized of Public Relations, Loan Service and Maintenance Sections.

Public Relations Section will be in charge of the provision of information and public relations services to help people to install septic tank toilets and dry pit latrines. Loan

Service Section will provide loan/subsidy to clients for the installation of septic tank toilets and keep related records. Maintenance Section will have a vacuum truck to regularly empty toilets and will regularly clean and maintain drainages.

The number of personnel to be assigned by position/function in 2000, 2005 and 2010 is shown in the latter half of Table 6.1.1.

Table 6.1.1 Personnel Requirements

1. Total No. of Personnel (* = recalculated number)

Item	1995	2000	2005	2010
1. Total Production of Water (m^3/day)	130	268	472	853
2. Water Production per Worker (m^3/day/worker)	16.3	20	30	40
3. Coefficient	1	1	1	1
4. No. of Personnel	8*	13	16	21
5. Additional Personnel for Sanitation	0	2	3	4
6. Final No. of Personnel	8	15	19	25

2. Breakdown of Personnel by Position/Function

Positions/Functions	1995	2000	2005	2010
1. Manager	0	0	0	1
2. Customer Services	0	0	0	0
3. Internal Audit	0	0	0	0
4. Administration Service				
1) Head	0	0	0	0
2) General Administration Section				
Secretaries/Typists/Clerks	1	1	1	1
Guards (* = recalculated number)	1.5*	3	4	5
Sweepers/Janitors	0	0	0	0
Drivers	0	0	0	0
Sub-Total	1.5	3	4	5
3) Personnel Section				
Recruitment and Assignment	0	0	0	0
Training	0	0	0	0
Remuneration	0	0	0	0
Sub-Total	0	0	0	0
4) Storage Section				
Store Keepers	0	1	1	1
Purchase of Materials/Supplies	0	0	0	0
Sub-Total	0	1	1	1
5) Legal Section	0	0	0	0
Total	1.5	4	5	6

2. Breakdown of Personnel by Position/Function (Continued)

Positions/Functions	1995	2000	2005	2010
5. Financial Service				
1) Head	0	0	0	0
2) Budgeting Section	0	0	0	0
3) Accounting Section				
Accountants	0	0	0	1
Cashiers/Treasurers	0	0	0	0
Sub-Total	0	0	0	1
4) Financial Management Section				
Financial Analysts	0	0	0	0
5) Operation Section				
Meter Readers	0	0	0	1
Bill Distributors/Collectors	0	0	0	1
Water Sellers (* = recalculated No.)	3.5*	4	5	4
Sub-Total	3.5	4	5	6
Total	3.5	4	5	7
6. Technical Service				
1) Head	0	0	0	0
2) Technical Records Section	0	0	0	0
3) Operation and Maintenance Section				
Mechanics	0	0	0	1
Electricians	0	0	0	0
Motor Operators	2	4	4	4
Plumbers	1	1	2	2
Sub-Total	3	5	6	7
4) Inspection Section				
Water Meter Technicians	0	0	0	0
Leakage Detectors	0	0	0	0
Water Quality Analysts	0	0	0	0
Sub-Total	0	0	0	0
5) Workshop	0	0	0	0
6) Works Section				
Contracting	0	0	0	0
Designing/Drafting	0	0	0	0
Sub-Total	0	0	0	0
Total	3	5	6	7
7. Sanitary Service				
1) Public Relations Section	0	1	1	1
2) Loan Service Section	0	1	1	1

2. Breakdown of Personnel by Position/Function (Continued)

Positions/Functions	1995	2000	2005	2010
3) Maintenance Section				
Technicians	0	0	0	1
Drivers	0	0	1	1
Sub-Total	0	0	1	2
Total	0	2	3	4
Grand-Total	8	15	19	25

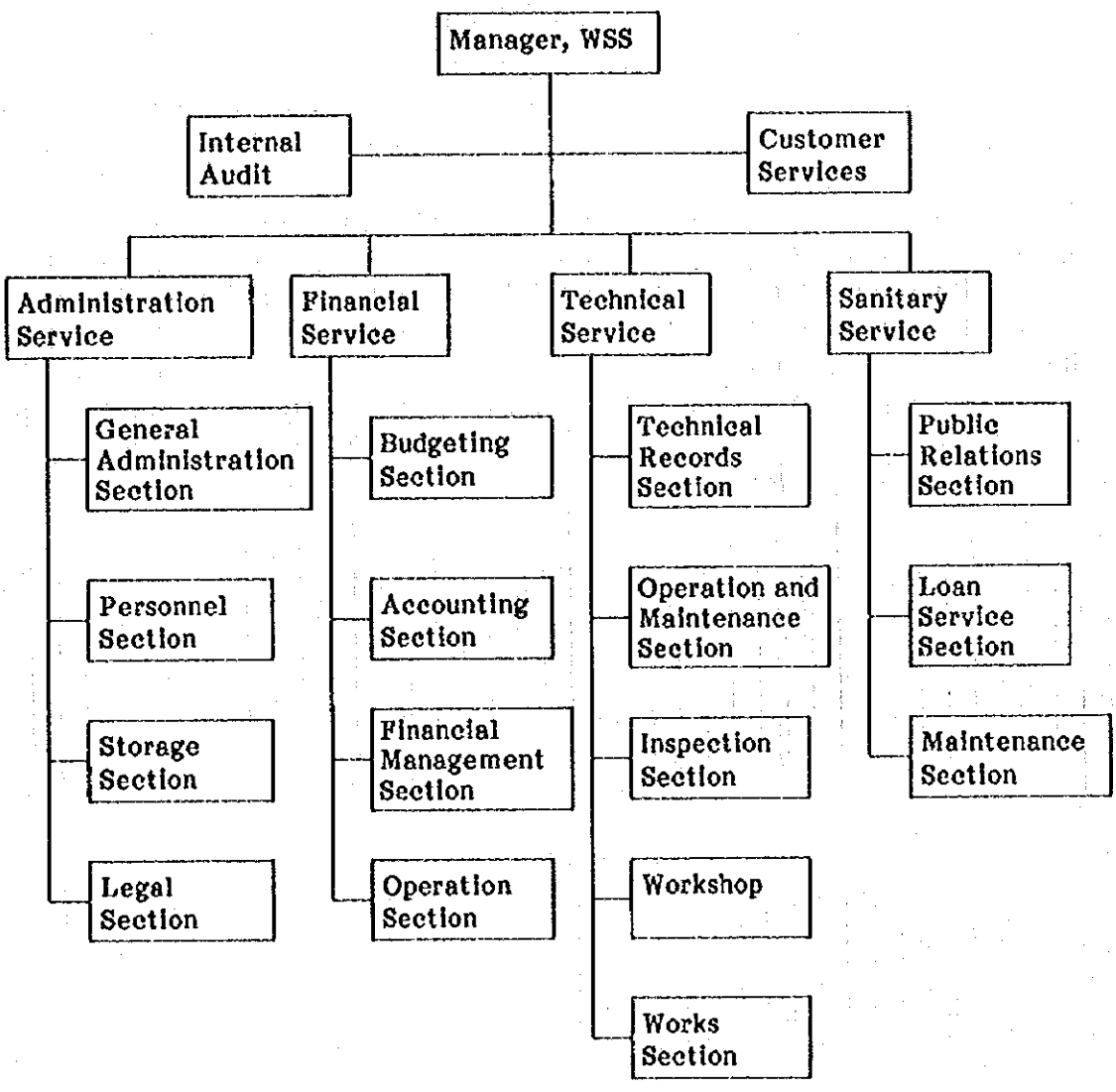


Figure 6.1.1 Proposed Model Organization Set-up of WSS

6.4 Community Building / Participation and WID

Based on the approach detailed in the Main Report the following specific suggestions have been made for community building and WID in Mille. These take into account the findings of the field survey:

- Mille was suffering mainly from economic recession due to the closure of the Mille plantation. Water improvements were generally seen as a lower priority then increased employment. In Lower Mille water was seen as a higher priority. Sanitation and sanitary behavioral improvements were seen as the lowest priority. The sense of depression in a town where employment has been fuller in the recent past is difficult to overcome. In this way the employment and income generation activities associated with this project need to be maximized. Attention should be given to the formerly employed men. They are likely to feel more vulnerable than any other group regarding employment opportunities. If income generation and employment is seen to favor women in particular, resentment may build up towards the project.

- Five additional PFs (four in Lower Mille) were selected by the community during the field survey. The community was prepared to manage these additional facilities. At this time they appointed water user's committees and chose the most appropriate locations. As this level of participation generated expectations, it is vital that the community be involved in any further decisions about the water system, particularly siting of facilities and management systems for operation and maintenance.

Chapter 7 Project Evaluation

7.1 Economic Evaluation

7.1.1 Economic Benefits

(1) General

There are two major benefits deriving from the implementation of the Project.

One is the time benefit. Under the present circumstances people in the eleven centers more or less go to the far-away springs/rivers and/or public fountains every day to fetch water. The time spent in such a way comes to an enormous amount when it is aggregated as an annual total for the whole town.

If the Project is implemented, less people will go to the above-mentioned water sources as more people will use house connections or yard connections. That is to say, the time for water fetching will be greatly reduced.

The JICA Study Team calculated the time to be reduced annually for the whole town in the future years under the "with project" conditions.

Eventually, the team converted the time into financial terms. This is the time benefit.

Another is the reduction of water-borne diseases. When the Project is implemented, more people will have an access to clean piped water. It will reduce the opportunities for them to get in touch with contaminated water and contract such diseases as diarrhea, dysentery, typhoid and scabies.

However, how many such cases will be reduced is very hard to estimate. Therefore, the team just wants to remind people that such an important benefit will be realized in the "with project" case.

(2) Calculation of Economic Benefits

How the above-mentioned time benefit was calculated is summarized below:

As a result of the socio-economic questionnaire survey conducted by JICA, the following information was collected:

Users	Time spent at a time (min.)	Daily frequency (times)	No. of persons at a time
Public fountains	38	2.5	1.1
Springs/rivers	77	1.8	1.1

If the number of households using public fountains and the number of households using springs/rivers is estimated in both the "without project" and "with project" cases in the

target years, one can work out the total time spent fetching water every year in both cases by utilizing the above tabulated information.

The respective number of households using the above two water sources in the "with project" case was estimated based on the service population projection in the other chapter. The respective number of such households in the "without project" case was calculated on the assumption that piped water users will increase by 3% every year.

Then, the difference in the aggregated annual water-fetching time between the two cases was calculated for each year.

Finally, such a time was converted into financial terms by using the following information:

Monthly household income (birr)	Family size (persons)	Waking hours in a day	Time value per hour (birr)
A	B	C	D=A/30/B/C
223	4.6	16	0.1010

The results are shown in Table 7.1.1.

7.1.2 Cost

The cost can be divided into capital cost and operation and maintenance (O & M) cost.

Capital cost is huge compared to the economic benefits resulting from the reduction of water fetching time. If one could quantitavely incorporate the subdual of water-borne diseases, benefit related to WID and multiplier economic effect into benefits, then one could consider the total cost including capital cost. But, the reality is such that one considers O & M cost - actually, a part of it - only for the sake of convenience.

O & M cost consists of electric cost, fuel cost, disinfection cost, personnel cost, installation cost of connections, purchase cost of water meters and other cost. (For more details refer to 4.5.) It was estimated as an annual recurrent cost for future years.

It turned out that the whole O & M cost is too large in comparison with the above benefits. Eventually, personnel cost was picked up, representing O & M cost.

The personnel cost used here is the incremental one, that is to say, the difference between the personnel cost in the " with project " case and the personnel cost in the " without project " case.

7.1.3 Economic Evaluation

Based on the data calculated in the above-mentioned way, cost benefit streams were prepared as shown in Table 7.1.2.

As it shows, the cumulative cost and benefits for 30 years come to 2,973 thousand birr and 2,950 thousand birr respectively. It means benefits are 99% of cost at the discount rate of zero.

That is to say, the cumulative benefits of the reduction of water fetching time for 30 years are almost equal to the cumulative personnel cost of WSS at 0 opportunity cost.

It is to be noted that time benefit resulting from project implementation is virtually the same as personnel cost of WSS.

Table 7.1.1 Saved Time and Benefit

Year	Saved Time (hours)	Benefit (birr)
1996	0	0
1997	0	0
1998	0	0
1999	132,905	13,423
2000	252,924	25,544
2001	322,876	32,609
2002	399,755	40,374
2003	484,107	48,893
2004	576,524	58,227
2005	677,533	68,428
2006	802,223	81,022
2007	935,632	94,495
2008	1,078,403	108,915
2009	1,231,220	124,349
2010	1,394,819	140,872
2011	1,394,819	140,872
2012	1,394,819	140,872
2013	1,394,819	140,872
2014	1,394,819	140,872
2015	1,394,819	140,872
2016	1,394,819	140,872
2017	1,394,819	140,872
2018	1,394,819	140,872
2019	1,394,819	140,872
2020	1,394,819	140,872
2021	1,394,819	140,872
2022	1,394,819	140,872
2023	1,394,819	140,872
2024	1,394,819	140,872
2025	1,394,819	140,872

Table 7.1.2 Cost Benefit Streams

CC=Capital Costs; OM=O/M Costs; CS=Costs; BF=Benefits
CF=Cash Flow (=BF - CS)

(Unit:thousand birr)

NO.	YEAR	CC	OM	CS	BF	CF
1	1996	0	0	0	0	0
2	1997	0	0	0	0	0
3	1998	0	0	0	0	0
4	1999	0	64	64	13	-50
5	2000	0	72	72	26	-46
6	2001	0	76	76	33	-43
7	2002	0	80	80	40	-39
8	2003	0	84	84	49	-35
9	2004	0	88	88	58	-30
10	2005	0	92	92	68	-24
11	2006	0	99	99	81	-18
12	2007	0	105	105	94	-10
13	2008	0	111	111	109	-2
14	2009	0	118	118	124	7
15	2010	0	124	124	141	17
16	2011	0	124	124	141	17
17	2012	0	124	124	141	17
18	2013	0	124	124	141	17
19	2014	0	124	124	141	17
20	2015	0	124	124	141	17
21	2016	0	124	124	141	17
22	2017	0	124	124	141	17
23	2018	0	124	124	141	17
24	2019	0	124	124	141	17
25	2020	0	124	124	141	17
26	2021	0	124	124	141	17
27	2022	0	124	124	141	17
28	2023	0	124	124	141	17
29	2024	0	124	124	141	17
30	2025	0	124	124	141	17

7.2 Financial Evaluation

7.2.1 Calculation of FIRR

Regarding detailed information on revenues and cost, refer to Section 4.5.

(1) Initial Trial

Initially it was assumed that the central government would provide subsidy to the Mille WSS amounting to 80% of initial cost.

It is to be noted that the cost related to the construction of accommodation facilities as well as WSSD's management is not included in the above initial cost.

Based on the revenues and cost estimated in Section 4.5 under such an assumption, cost benefit streams were prepared for the 30 years starting in 1996.

Using them, financial internal rate of return (FIRR) was calculated. As a result, it worked out to be 1.9%.

The value was judged to be too low in consideration of the assumed interest rate of 1%.

After repeated simulations, it was finally decided that the subsidy ratio of initial cost would be 90%.

(2) Final Results

Under the above-mentioned subsidy conditions, cost benefit streams were prepared as shown in Table 7.2.1.

Using the streams, FIRR was calculated. As a result, the value of 4.6% was obtained.

The value exceeds 1%, which is the assumed interest rate of external loan by 3.6%. It is judged to be sufficiently and reasonably high considering the nature and objective of the Project.

7.2.2 Sensitivity Analysis

To see how the value will be affected under different circumstances, sensitivity analysis was conducted. The conditions and results are shown below:

Item	Conditions	Results	Difference from Base Case
1. Case 1	Benefits : -10%	FIRR: 2.6%	-2.0%
2. Case 2	Initial Cost : +10%	FIRR: 4.0%	-0.6%
3. Case 3	Progress of : 1997=70% Construction 1998=30%	FIRR: 4.8%	+0.2%
4. Case 4	Progress of : 1998=70% Construction 1999=30%	FIRR: 3.9%	-0.7%

In Cases 3 and 4 detail design will be done in 1996 and 1997 respectively.

As the table shows, the value of FIRR is robust enough by maintaining the level of substantially more than 1% under adverse circumstances conceivable.

Case wise, the shortage of revenues will deal the strongest negative impact on the financial feasibility of the Project, followed by the delayed progress of works and, then, cost overrun, while earlier completion of works will raise the feasibility by a significant margin.

Table 7.2.1 Cost Benefit Streams

CC=Capital Costs; OM=O/M Costs; CS=Costs; BF=Benefits
CF=Cash Flow (=BF - CS)

(Unit:thousand birr)

NO.	YEAR	CC	OM	CS	BF	CF
1	1996	98	39	137	50	-87
2	1997	1071	41	1111	52	-1060
3	1998	1071	42	1113	53	-1059
4	1999	0	157	157	123	-34
5	2000	0	171	171	192	21
6	2001	0	209	209	229	20
7	2002	0	222	222	259	38
8	2003	0	235	235	290	56
9	2004	0	247	247	321	73
10	2005	0	260	260	351	91
11	2006	0	328	328	420	91
12	2007	51	351	402	477	75
13	2008	257	373	629	535	-95
14	2009	257	395	651	592	-59
15	2010	0	417	417	650	233
16	2011	0	321	321	627	306
17	2012	13	321	333	627	294
18	2013	13	321	333	627	294
19	2014	0	321	321	627	306
20	2015	0	321	321	627	306
21	2016	0	321	321	627	306
22	2017	0	321	321	627	306
23	2018	0	321	321	627	306
24	2019	0	321	321	627	306
25	2020	0	321	321	627	306
26	2021	0	321	321	627	306
27	2022	0	321	321	627	306
28	2023	0	321	321	627	306
29	2024	0	321	321	627	306
30	2025	0	321	321	627	306

7.3 Organizational Evaluation

The existing organizational situation related to water supply and sanitation in Mille can be summed up as follows:

- Mille is a satellite town of Asayta so far as water supply is concerned. The status will in the long run become detrimental for Mille to manage financially by itself with a growing population and increasingly more water production.

- The satellite WSS of Mille is financially in the black, which is a rare phenomenon so far as the eleven centers are concerned. But, it is not given the power commensurate with its financial performance.

- The satellite WSS of Mille is financially in the black. However, workers are underpaid, they have little supplies and equipment for operation and maintenance and there is a shortage of skilled manpower.

- Sanitation functions in the satellite WSS of Mille have been totally neglected. But, the sanitary situation in the town is such that organizational/institutional countermeasures are urgently required.

- A key for a successful implementation of water supply/sanitation projects lies in community involvement. It seems that the authorities have not given proper consideration in this regard.

- Another key for a successful implementation of water supply/sanitation projects lies in female participation. It appears that the authorities have not been properly aware of it.

To rectify the above situation, the following organizational/institutional measures have been proposed.

- It is recommended that the satellite status of Mille WSS be elevated to the independent WSS after the Phase 2 Project is completed in 2009 so that water supply activities of Mille may be commensurate with the extent of water production and the size of population.

- Autonomy is a trump for a financially good performance. The satellite WSS of Mille should have a say regarding water tariff, personnel management and purchase of equipment and materials subject to the approval of Asayta.

- In the event the independent WSS of Mille is started, it is essential for the WSS to be institutionally given its own decision-making power regarding the revision of water tariff, remuneration, hiring and firing of staff, execution of small-scale rehabilitation or new works, purchasing of supplies and equipment, etc. Approval will be given by the regional organization, and it will be reported to the central organization.

- The fundamental conditions for any WSS to have a successful financial performance are to have a sufficient supply of water on one hand and to have a reasonable level of water price on the other. Both conditions seem to be satisfied in one way or another under the existing circumstances. They are hopefully expected to continue to be satisfied in future through the Project. If the WSS of Mille has a successful financial performance and its own decision-making power to manage by itself as well, then the accompanying difficulties such as the shortage of skilled manpower and little availability of equipment and supplies will be eventually overcome.

- The organization related to sanitation will be newly established in the organizational set-up of WSS after the Phase 1 Project is completed in 1998. It will perform loan service and promotion activities regarding the installation of sanitation facilities.

- Sanitary/Health Committee will be organized in the town. The members will be composed of representatives from schools, hospitals, Weroda council, municipality, the bank, central and regional water supply organizations, WSS and community. The major objective of the committee is coordinating and unifying the related activities so that sanitary awareness of the townspeople and the installation of sanitation facilities will be effectively promoted.

- Public fountains to be newly constructed in future will be managed by the community if people are overwhelmingly in favor of it. According to the socio-economic questionnaire survey conducted by JICA, they strongly side with it. People will freed from the frustrations and constraints they experience every day today in connection with the opening hours, breakdowns and repairs, water tariff, etc. The community will have decision-making power in financial, personnel and technical terms subject to WSS's approval. The community is expected to financially stand on its own feet.

- Construction of community toilets will be promoted. Financial resources may come from the community itself or other sources. Sanitary/Health Committee and WSS will assist in the acquisition of fund. A strict financial management of the toilet will be required. The maintenance and operation, payment and collection of the user charge, the decision on user charge, etc. will be totally in the hand of the community. Sanitary/Health Committee and WSS will be always ready for helping the community in this regard.

- It is also proposed that the female participation ratio in the workforce of WSS, the community managed public fountain and the community toilet be more than 50%.

7.4 Technological Evaluation

The proposed water supply system is composed of relatively simple facilities, those of which are not quite different from existing ones. Although new material made of fiberglass reinforced plastic is to be introduced into such work as well casing, the light material could facilitate the construction work very smoothly. The material is also

expected to be long life-span comparing to other conventional material, thus maintenance and renewal cost could be reduced in the long run.

In the Project, two and one number of boreholes are newly required in years of 2005 and 2010 and those including existing ones are located with certain distance from each other or sometimes away from another. Therefore, mobilization is due required for the daily operation of those boreholes. In this regard, transportation must be strengthened by means of vehicle or motorbike, otherwise well attendant is additionally required in the number.

In this center, which is classified as satellite, WSS office shall be set-up to maintain and operate the facilities as planned, since there is no WSS office at present.

7.5 Environmental Impact Assessment (EIA)

Currently, there are not Ethiopian laws or regulations which stipulate that development activities represented as a project require an EIA prior to the approval of the project. However, the procedure to establish the EIA is going on within the relevant authority as of 1995.

In this Study, initial environmental examination (IEE) firstly had been carried out throughout Phase I study and supplemented during the field survey of Phase II, based on the "Guideline of Environmental Consideration for Groundwater Development" prepared by JICA. IEE conducts preliminary assessment in terms of social environment, natural environment and public nuisance, as summarized on the formats in relevant appendix "Result of Initial Environmental Examination". The formats of project and site descriptions brief the content of the Project and the site, thus facilitate the relating person/organization to understand the outline of the Project at the early stage. The scoping format categorizes the environmental component with a classification mentioned below by screening the each component.

A; Advance impact is expected by the Project,
B; Negligible impact is expected by the Project,
C; The impact is Unknown at present, and
D; Enhancement is expected by the Project.

No advance impact classified "A" above is shown on the format, and most components are expected to undertake negligible impact from the Project. Also enhancement is expected in some components such as economic activities, public health and hygienic condition.

The components classified as "C" are identified as the ones to be considered for EIA. The result of EIA is described below, and no negative environmental impact is expected.

7.5.1 Vested Rights

Although the facilities planned are small in the scale, a part of dwelling and commercial areas, and such properties as houses and trees might be affected, to which compensation shall be made in accordance with government regulation. With consideration above, facilities have been so planned that such circumstance be avoided as much as possible in the design stage. With reference to the outcome of GEP survey, probable water sources had been planned away from dwelling areas, and new reservoir sites planned nearby existing ones or away from dwelling areas, from which little effect is expected. Also, main distribution lines had been designed alongside existing roads to avoid any considerable resettlement.

Afar people customarily states their own land right despite the fact that the land is officially owned by the state. In Mille and Dupti, conveyance pipeline from the source to reservoir could be expected to cross the Afar areas, which are located mainly at outskirt of the town. Although it is very difficult to identify the Afar area because of their nomadism, due consultation shall be made prior to the commencement of the construction work. Since the effect is expected only during pipeline installation, any conflict could be avoided by the prior consultation.

There are water vendors whose income source relies on selling water, however the income is conjectured to occupy a part of their whole income. Therefore, the loss of vending water is not expected to give any considerable effect.

As mentioned above, any vested right in terms of properties, land right and vending water could not be seriously affected by the Project.

7.5.2 Public Health and Hygienic Condition

The improved water supply will increase the quantity of waste water. If the drainage system was not accompanied, it could lead to unhygienic condition and leave people vulnerable to water-borne diseases.

In this Study, sewerage is regarded as a component of the Project and not as a mitigative measure. During field survey, the areas had been delineated, which were suffering from poor drainage condition at present and also toilet condition had been investigated. Based on those assessment, the improvement of drainage and toilet had been proposed in this Study. Disposal of spillage water at public fountains has also been designed in such manner of soakaway pit or connecting to an existing drainage.

With the implementation above, public health and hygienic condition could be enhanced rather than negative impact by the Project.

7.5.3 Accidental Damages to Existing Facilities

Although construction of pipeline network and reservoir may be expected to give damages accidentally to the dwellers and existing facilities, such cases have not been reported

based on the previous construction experiences. Under proper supervision of the construction, such damages can be avoided or reduced to negligible level even if any.

7.5.4 Soil Erosion

Judging from the construction scale, little soil erosion is expected both during and after the construction. Although minor soil erosion may be expected in case of sandy and silty formation of the ground, such erosion has not been reported in noticeable level based on previous construction experience. It is also recommended that construction work be carried out during dry season not only to facilitate the construction work but also to reduce the soil erosion as much as possible.

7.5.5 Groundwater Quality and Quantity

The current water source is groundwater, and there may be a possibility that the existing sources could be affected due to over-exploitation of groundwater by this Project. However, with reference to the scheme mentioned below, employed in the design of this Project, it is expected that any noticeable effect to the existing sources could not be arisen.

The location of new boreholes has been designed with a distance from the existing sources enough to avoid any influence to the water table for the existing ones.

The maximum of groundwater extraction in this Project has been designed to be a part of great amount of recharge in the catchment area. This concept enables the new well designed in this Project to avoid noticeable over extraction of groundwater, leaving the existing sources unaffected.

7.5.6 Traffic Nuisance

Some water distribution pipelines had to be designed to cross the trunk road, and the installation work may interrupt traffic and cause nuisances. Based on the site investigation, two (2) installation methods were identified; namely to install the pipe through existing drainage under across the road, and to install half of the pipe first and then the remainder by shift. The installation of pipelines across the trunk road in Mille has been designed with the former method, therefore any traffic nuisance could be avoided.

7.6 Indirect Benefit Evaluation

7.6.1 Subdual of Excreta and Water Borne Diseases

Many infections come from excreta and contaminated water, and both have become the major sources of diseases in Mille. From the field survey that has been carried out by this Study,the incidence of diseases that has taken place in the recent three months has been reported as having the following as top diseases.

Diseases	Number of Cases
1. Respiratory tract infection (bronchitis,prleumonia, T.B.)	137
2. Unknown fevarile illness	126
3. Malaria	68
4. Amoebic diseases	68
5. Gastro-enteritis	54
Total Number of Cases	453

The number of cases per year in Mille as a percentage of population comes to about 12.4%. The excreta and water borne diseases among above could be subdued on condition that the followings are made in line with improvement of water supply.

- Provision of toilets that will eliminate the use of open-field for excreta disposal.
- Undertaking regular and timely operation and maintenance of the toilet facilities.
- Providing effective user's education to properly use the toilets and care for them.
- Identification and elimination of faecally contaminated sites that breed insects.
- Treatment of sewage and sullage, if possible, prior to discharge.
- Improvements of domestic water supply of Bati to reduce the effect of contaminated water to health.
- Undertaking sustained and effective sanitary education programme to improve environmental, domestic and personal hygiene.
- Making the communities in Bati to participate in the planning, choice and constructing toilet facilities; and to take over the operation, maintenance and management of these facilities.

7.6.2 Benefit Related to WID

By improving the piped water supply to Mille, the intended benefits will include significant reduction of time and energy spent in water collection. The beneficiaries from additional PFs will be men and women, and to a lesser extent girls and boys. This will allow women and men in particular to have more time for other activities, including relaxation, improved sanitary behaviors or income generation activities. It will allow girls and boys more time for studying. This should improve the quality of life for these social groups including making Mille a better place to live in. It will also reduce the amount of sickness and release time of men and women in the caring for sick members of the household.

By providing toilets, women and girls in particular will benefit from additional privacy which they have not been allowed in the past. Also females will be freed from inconvenience peculiar to them in the absence of a proper latrine.

The project will allow the community to determine the positioning and style of water and sanitation facilities in Mille. This will increase the sense of worth of the beneficiaries, giving them a sense of power over their environment. In addition the project will give women employment opportunities at the implementation and operation and maintenance stages. The employment in the latter is often permanent. Female employment en masse at this stage will contribute to the elevation of female status in society and the business world.

7.6.3 Economic Activities

There are prerequisites for a town to grow economically. Physically, it must have a sufficient level of basic infrastructure such as, road, electricity and water. Socially, it must have, above all, a sufficient educational and medical level.

Road is essential for exchange of materials, finished goods and persons with outside areas. Both electricity and water constitute indispensable components for manufacturing industry. Also, they are a necessity for commercial activities.

A sufficient level of education begets an enlighted type of people with a desire and will for better life. A sufficient medical level makes a healthy people and a healthy people can easily turn a hard working people.

If these five factors are satisfactorily combined, a town is ready for an economic growth.

So far as road is concerned, Mille is located at a strategic point with many truck drivers transporting materials and goods stopping over there. Regarding educational and medical level and electricity, the existing situation cannot be said all right. Water is not acutely deficient. But, since population is fast growing, there will arise a need for increasingly more water as years go by.

The center has to resolve basic problems as mentioned above for an overall economic growth.

Water has especially strong impacts on manufacturing industry such as food & beverages, chemicals, mineral products, iron & steel and machinery & equipment, hotels, restaurants & bars, and hospitals. In an event water is sufficiently supplied through this Project, Mille's economic activities may be stepped up centering on them.

7.6.4 Benefit Related to Others (i.e. religion and tribe)

The level of access to water and sanitation facilities currently existing for Muslims and Christians was almost the same. The level of income for all religious groups present was also very similar. The level of ethnic variation in Mille was high relative to the other towns in the Study, however the results of the household survey showed only slight variations in service levels for water or sanitation facilities. The benefits of the project were likely to permeate to all religions and tribes to a similar degree. These will be the benefits of time savings allowing people to do other activities in that time, an improved level of health and well-being and increased feelings of power over their lives. These

benefits should be carefully monitored by segregating data collected during the implementation and operation and maintenance phases to ensure that the benefits were being gained equitably.