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
BATI

(Volume II-III)

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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PREFACE

This is the Feasibility Study Report for Bati 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.

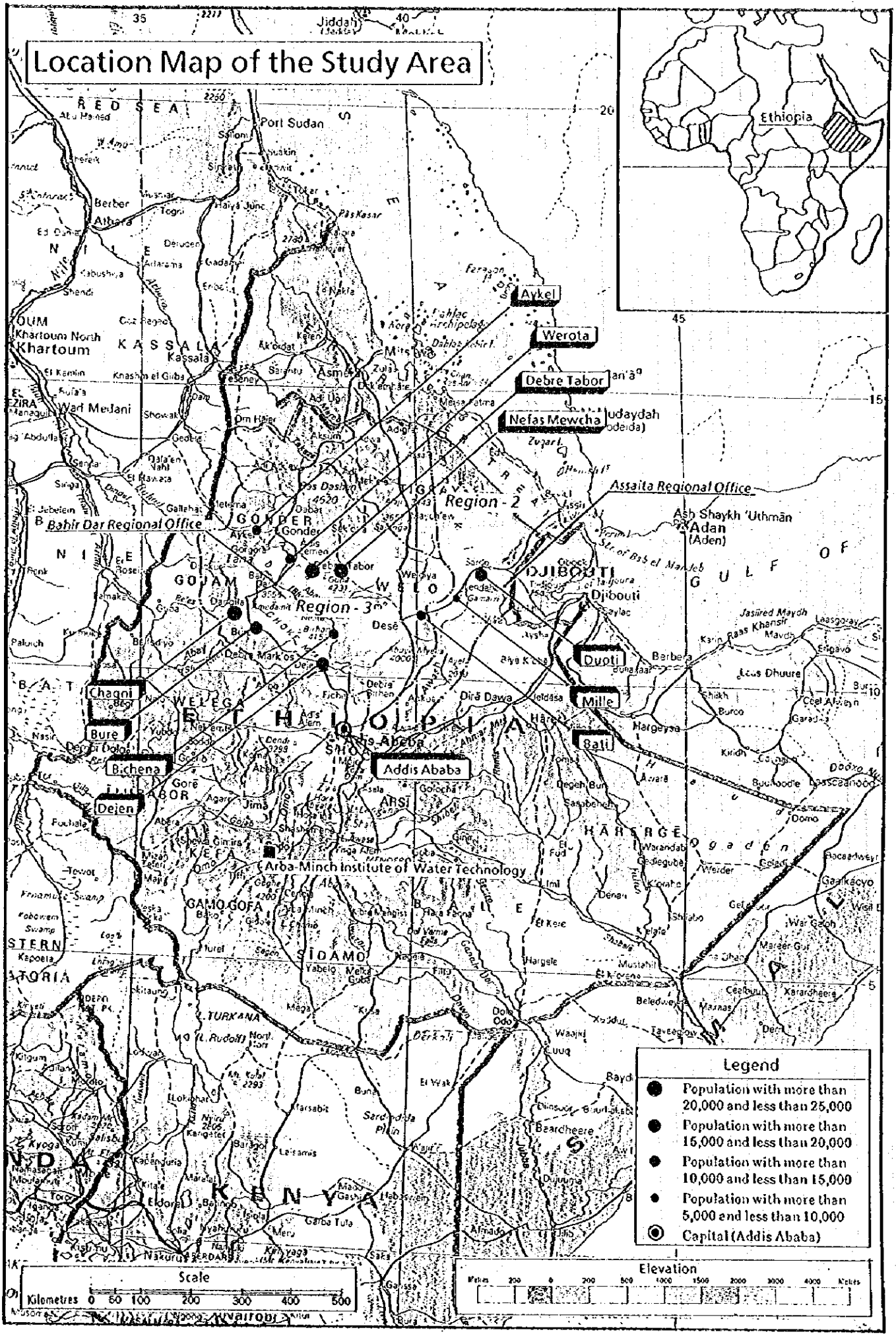
The major objectives of this Study are 1) to conduct a feasibility study on the water supply system in order to improve living condition of the population in the Study area by enhancing the level of the water supply services in terms of water quantity, water quality and its accessibility, 2) to formulate 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
Djibouti
Dubti
Mille
Bati
Chagni
Bure
Bichena
Dejen
Addis Ababa
Arba-Minch Institute of Water Technology
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 end less than 10,000
Capital (Addis Ababa)
Scale
Kilometres 0 50 100 200 300 400 500
Elevation
Meters 200 0 200 500 1000 1500 2000 3000 4000 Meters

General Description of Current Condition in Bati

Items	Description
Administration	Amhara Region, Oromia, No. of Kebele : 3
Residents	Total population : 14,354 (55.2 persons/ha) Average family size : 6.2 persons Amhara : 49% Tigre : 5% Oromo : 28% Christians : 12% (1 church) Afar : 13% Moslems : 88% (4 mosques)
Educational Conditions	Kinder garden / Elementary school / Junior & Senior high s. No. of school: 1 / 1 / 1 No. of teachers: 2 / 44 / 24 No. of students: n.a. / 1500 / 1000
Medical Conditions	Hospital : - Doctor : 2 Health center : 1 Nurse : 8 Health clinic : -
Economic Conditions	Hotels/restaurants : 68 Shops : 163 Cottage industry : 12 : Average monthly household income : 306 birr
Water Supply Condition	The source of WSS : Borehole (4) Major other sources : Spring Domestic consumption : 200.3 cum/day (16.0 lpcd) Other consumption : 31.9 cum/day (total 232.2) Water service coverage : 87% House connection : 48.8 lpcd (2%, 1.0 birr/cum) Yard connection : 26.2 lpcd (38%, 1.0 birr/cum) Neighbors : 15.0 lpcd (2%, 1.0(3.1) birr/cum) Public fountain : 6.1 lpcd (45%, 1.0(2.2) birr/cum)
Sanitary Condition	Septic toilet : 3/100HH Dry pit toilet : 65/100HH Community toilet : 4/100HH Open field : 28/100HH Toilet condition : Ill-maintained and constructed. Most are filled up and need to be emptied. Sullage disposal site : No allocated and vacuum track is required. Drainage facilities : No existed except along main road, poorly maintained.
People's Health Awareness and Needs	Group awareness : 50% Diarrhea awareness : 55% ORS awareness : 55% Sanitary behaviors score : 1215/1600 (76%) Needs : Sanitation improvement with toilet emptying System
Remarks	1. Water charge in bracket is actually paid. 2. HH means "household". 3. ORS means Oral Rehydration Solution. 4. Faecal coliforms found in samples from connections and household containers.

Project Description of Bati

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 2000 2005 2010 14,354 (3.5%) 17,048 (3.0%) 19,763 (2.5%) 22,360
Water Demand Projected in cum/day	in 1995* 2000 2005 2010 Domestic : 200 419 659 932 Non Domestic : 32 81 102 128 Losses : 168 56 104 187 Total : 400 556 864 1,247
Dimensions of Water Supply System	Target Service Coverage: 95%(87% at present) Target Year of 2005 Deep Wells : 3 (414m) Rising Main : ϕ150 (0.9km), ϕ100 (2.13km) Booster of Rising : ϕ150mm,Q=0.72m3/min,H=80m Reservoir : 240m3(120×2) Distribution : ϕ200(285m),ϕ150(1,305m),ϕ100(740m), ϕ75(5,300m),ϕ50(6,330m) Booster of Dist'n : ϕ75mm,Q=0.1m3/min,H=14m Target Year of 2010 Deep Well : 1 (114m) Rising Main : ϕ75(2km)
Water Tariff Structure & Accounting System	Introduction of Progressive Water Tariff** HC: 3.06 birr/m3,YC: 1.94 birr/m3,PF: 1.05 birr/m3 Introduction of Double Accounting System
Plan of Sanitary Facilities Improvement	Construction of 4 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 35 in 2005 and 41 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 Bati, water service coverage is 87 %, however the water consumption per capita per day is extremely low with the amount of 16.0 lpcd in average. 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.

Although toilet coverage is 72 %, which is relatively high figure, 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). Bati is the one, located in Amhara Region, among the Eleven Centers along with Dupti, Mille, 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. Bati 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 10 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, construction of experimental toilet (community type) and experimental sanitary education practice have been carried out in Bati. Also, 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

Batl is located in a hilly area in the escarpment of the highland. The drainage pattern is strongly controlled by the faults.

Batl has a meteorological station of NMSA and an abandoned river gauging station of WRDA located at Kersa river about 200 m below the confluence of Abanago river and Bone river.

Kersa river at the gauging station has a catchment area of 28.9 km^2. See Figure 2.1.1 for the locations and the watershed.

Table 2.1.1 shows the long term monthly mean values of precipitation, potential evapotranspiration and air temperature processed from the monthly historical data 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)	47.1	67.6	61.1	99.0	36.4	20.1	198.4	186.9	80.9	28.6	21.0	34.8	881.9
ETo (mm)	134	135	139	139	141	141	141	142	137	135	132	133	1,649.0
A.Temp. (°C)	17.8	19.6	20.1	21.2	22.7	24.8	23.3	21.4	21.8	20.7	19.2	19.4	21.0

The distribution of the monthly precipitation through year shows one weakly pronounced rainy seasons in April and one pronounced rainy season in July and August. The monthly potential evapotranspiration does not vary much ranging from 132 mm in November to 142 mm in August. The monthly mean air temperature ranges from 17.8°C in January to 24.8°C in June.

The proposed sites for the new boreholes are located along the Kersa river.

In order to assess the ground water recharge in the area, the water balance sheet is prepared as shown in Table 2.1.2. The precipitation data is prepared from the 12 year records between 1960 and 1994. The runoff is assumed at 40% of the precipitation, because the discharge data is not available with WRDA. The potential evapotranspiration is assumed to be same as the long term mean values. The crop factor for reference crop evapotranspiration is assumed at 0.7.

Table 2.1.2 Water Balance Sheet of the Ground Water Recharge Area, Bati

Unit : mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	37.5	61.1	39.9	99.9	32.5	8.3	214.1	198.6	86.3	26.0	26.7	33.6	864.5
Q	15.0	25.3	16.0	40.0	13.0	3.3	85.6	79.4	34.5	11.6	10.7	13.4	347.8
P-Q	22.5	35.8	23.9	59.9	19.5	5.0	128.5	119.2	51.8	14.4	16.0	20.2	516.7
ETo	134	135	139	139	141	141	141	142	137	135	132	133	1,649
ETcrop	93.8	94.5	97.3	97.3	98.7	98.7	98.7	99.4	95.9	94.5	92.4	93.1	1,154.3
ETa	22.5	35.8	23.9	59.9	19.5	5.0	98.7	99.4	51.8	14.4	16.0	20.2	467.1
ΔS	0	0	0	0	0	0	29.8	19.8	0	0	0	0	49.6

Note: P = Precipitation
Q = Runoff
ETo = Potential Evapotranspiration
ETcrop = Reference Crop Evapotranspiration
ETa = Actual Evapotranspiration
ΔS = Recharge

Table 2.1.2 shows that the ground water recharge takes place only in July and August. The quantity of recharge is calculated for the total watershed area of Kersa river at the gauging station, because there is no impervious layer in the basin:

$$0.0496 \times 28.9 \times 10^6 = 1.43 \times 10^6 \text{ m}^3/\text{year} = 3{,}918 \text{ m}^3/\text{day}$$

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

Since the watershed area of the Abanago river is small (A = 9.3 km^2) and has four (4) productive wells, it must be checked if there is a sufficient recharge for the wells. Yearly water balance sheets were prepared for 12 years between 1960 and 1994 as shown in Appendices. The recharge of each year is shown below in Table 2.1.3.

Table 2.1.3 Monthly Recharge Estimated by Means of Surface Water Balance Analysis

Unit : mm

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1960	—	—	—	—	—	0	31.6	0	0	0	0	0	31.6
1965	0	0	—	0	0	0	75.4	98.8	0	—	0	0	174.2
1967	0	0	0	0	0	0	27.3	35.0	0	0	0	—	62.3
1968	—	—	—	21.5	0	0	112.6	0	0	0	0	0	134.1
1971	0	0	0	0	0	0	0	37.4	0	—	—	—	37.4
1987	—	—	—	—	—	0	0	37.6	0	0	0	0	37.6
1988	0	0	0	0	0	0	118.6	34.9	0	0	0	0	153.5
1989	0	0	0	0	0	0	0	0	0	0	0	9.0	9.0
1990	0	150.5	0	0	0	0	0	0	0	0	0	0	150.5
1992	0	0	0	0	0	0	0	89.8	0	0	0	0	89.8
1993	0	0	0	30.5	0	0	23.4	0	0	0	0	0	53.9
1994	0	0	0	0	0	0	101.2	25.1	0	0	—	—	126.3

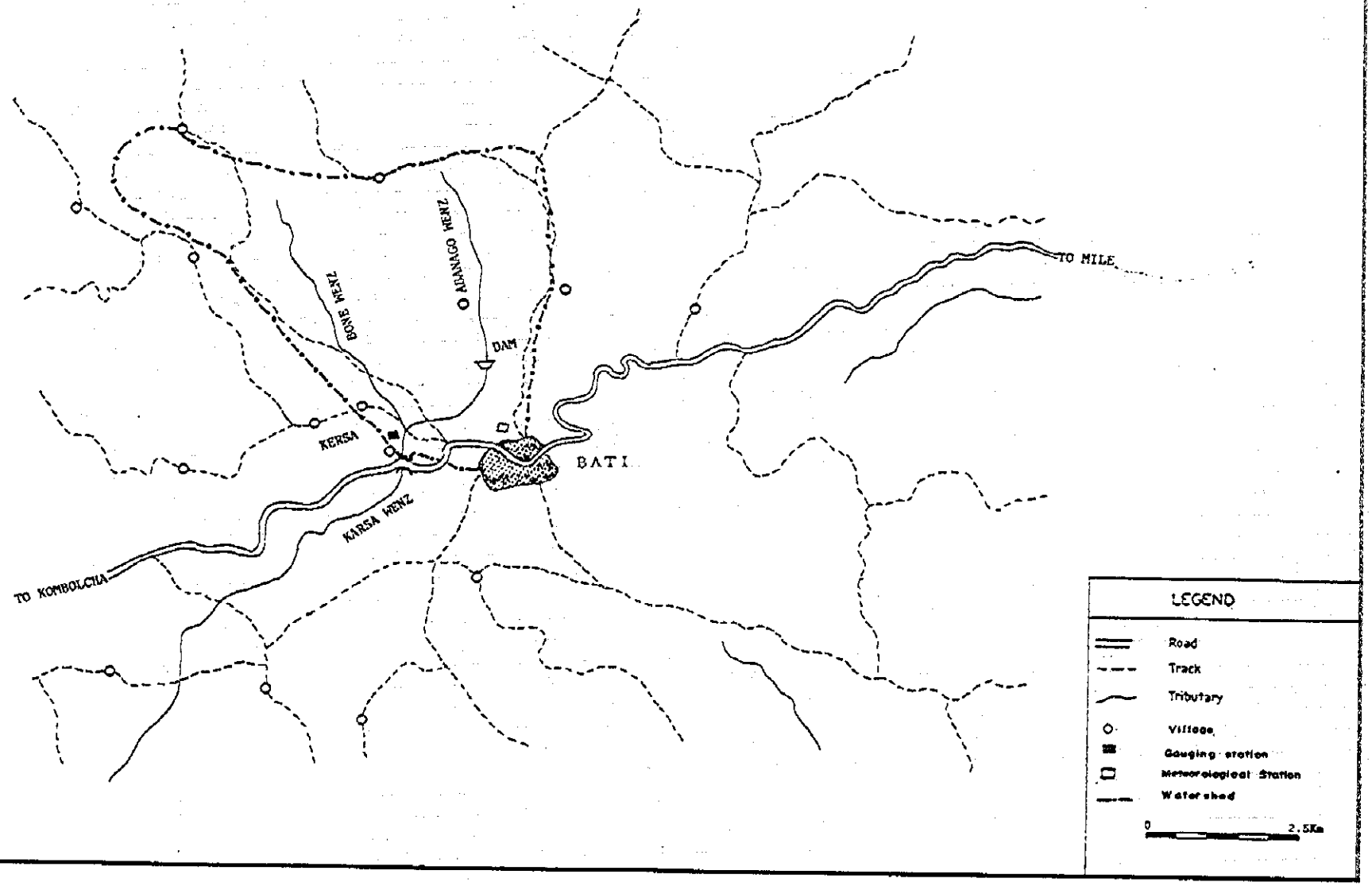
Note: — not calculated due to missing data

According to the probability analysis of annual recharge using log-normal two parameter distribution function, 5-year recharge and 10-year recharge in return period are resulted at 31.9 mm and 21.7 mm respectively. For the watershed area of Abanago river:

5-year recharge $0.0319 \times 9.3 \times 10^6 = 0.297 \times 10^6$ m^3/year
10-year recharge $0.0217 \times 9.3 \times 10^6 = 0.202 \times 10^6$ m^3/year

These are equivalent to 814 m^3/day and 553 m^3/day respectively.

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



2.2 Hydrogeology

2.2.1 Geology

Since Bati is situated on the rift escarpment, the geology of the area is controlled by faulting structures which are dominantly oriented parallel to the rift valley. The regional geology reveals the Ashangi basalt which is commonly trachyte and amygdaloidal basalt with zeolite and ogate nodules. Sedimentary intercalation, interbedded tuff and agglomerates are rare. Highly weathered basalt is generally exposed, namely spheroidal weathering (onion shaped disintegration) which is a special characteristics of most basalt is well observed both on cliff walls and along valleys.

As the result of analysis of aerial photographs and topographical maps, a major lineation trending to NW-SE is observed along the Bone Shet in the west side of the town and another major lineation trending to ENE-WSW is observed along the Aba Negewo Shet in the northern side of the town. Minor lineations of NNW-SSE are crossing the ENE-WSW lineation and the existing boreholes are located at these cross points.

2.2.2 Hydrogeology

(1) Existing Borehole

Five boreholes have been drilled within the town area. As one borehole was abandoned due to the influence of pumping by the adjacent borehole, four boreholes are operated at present.

There is no sufficient data about the well hydraulics and the lithology. According to the field measurement, the yields of BH1 and BH2 are 2.8 l/s and 3.3 l/s respectively. The yields of BH3 and BH4 are less than the reported yields due to electrical problems according to verbal information. After all, the four operational boreholes give a total yield of about 7 l/s (field measurement at the reservoir tank).

(2) Other Water Source

There are two springs which outcrop along the valley at 0.5 km east from the town. These springs are called as Legea Shenbeko, and Legea Hita. Their discharge is very small, about 0.05 l/s and 0.1 l/s according to rough measurements conducted during the field work. From the verbal information, these springs dry up during the dry season, and hence they can't be considered as potential water supply sources.

To the north of the town, there is also a spring that seeps out from a marshy area along the Aba Negewo Shet. In its upstream, there is a dam for irrigation whose total volume is about 1,170,000 m^3 with a catchment area of 18 km^2. Along the main stream, the discharge increased toward the downstream.

This might be an effect of dam leakage through a previous reservoir bed. Therefore, this spring water should be considered as the surface water. Another surface water available is

the Bone Shet. This stream has an average flow 90 l/s which is greater than the Aba Negewo Shet. Additionally, this water has not been utilized yet.

Table 2.2.1 Boreholes in Bati

BOREHOLE No.	DEPTH (m)	YIELD (l/s)	YEAR DRILLED	SWL	SLOT POSITION	REMARK
BH1	105	2.8 (#1)	1985	6.0	9-105m	productive
BH2	98	3.3 (#2)	1985	6.5	7- 98m	productive
BH3	124	4.0	1985	2.0	9.7-15.7, 22.7-124m	productive
BH4	95	1.5 (#3)	1983	8.0	29.8-35.1, 45.1-95m	productive
BH5	57	1.5 (#3)	1981	7.2	15.2-57m	abandoned

Note: #1- Yield by field measurement coincides with WSS data.
#2- Yield is observed by field measurement. WSS data is 10.0 l/s.
#3- Yield is from WSS data. According to WWDR data, 2.0 l/s (BH4), 4.0 l/s (BH5)

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

Six (6) samples had been undertaken for physical and chemical test. Among them, four (4) samples were collected from boreholes No.1, No.2, No.3 and No.4, those of which are the source of WSS source, and 1 sample from spring beside Ghion hotel and the last from Legashenbeko spring. The Legashenbeko spring is located about 300m north-east away from the edge of the town.

All the analyzed constituents regarding the sources of WSS are within the acceptable range according to WHO drinking water guideline values. Also, the constituents for the spring located beside Ghion Hotel are with in the acceptable guideline values.

The result of Legashenbeko spring shows that nitrate concentration is above the WHO drinking water guideline value. WHO guideline recommends the value of 50 mg/l, and the sampled water shows 98.56 mg/l. Since the spring is located nearby the town with lower elevation, it is expected that the spring is contaminated with excreta of domestic animals specially goat, which were found during the site survey as of February 1995, and sewerage coming from the Bati residential area. When nitrate present in excessive amounts in water, it indicates that the pollution occurred could not have been recent since nitrate is the final oxidation product of the element nitrogen which is usually present in sewerage and fertilizer. Excessive amount of nitrate in drinking water causes methaemoglobinaemia in bottle-fed infants in most cases and occasionally in some adults. Although no such report is heard at present, it is recommended that the spring be abandoned and the spring users be introduced into the service of WSS water.

3.1.2 Bacteriological Aspects

Bacteriological test were carried out twice, each of which was conducted in February and June 1995 respectively. The latter test was focused on residents for the community in which experimental toilet was constructed.

(1) Result of Test on February 1995

Three (3) boreholes such as No.1, 3 and 4 had been undertaken for faecal coliforms test. The results indicate that 2 boreholes of No.3 and 4 are not contaminated but borehole No.1 is contaminated, which is indicated by 3 number of faecal coliforms per 100 ml.

The waters from those boreholes are firstly collected into a chamber and then conveyed to the reservoir located on a hill behind the town. The water supply system was disinfected by chlorine about three (3) months ago from the tested date of February 1995. Samples from the collecting chamber show contamination with five (5) and 40 number of faecal coliforms. However, nine (9) samples from the reservoir, public fountains and private connections show no contamination except two (2) samples with a few of faecal coliforms.

Household and private containers show a certain level of contamination, but the level is relatively low comparing to other study centers.

Legashenbeko spring, from which some residents living in eastern part of the town fetch the water, shows full of contamination because cattle specially goats can easily access to the spring as observed as of February 1995. As mentioned in physico-chemical aspects, this spring is recommended to be abandoned.

(2) Result of Test on June 1995

Five (5) water samples from public fountain and private connection, from which the community for the experimental toilet fetches water, had been undertaken for faecal coliform test. Those samples show one (1) to four (4) faecal coliforms per 100 ml without any sample showing no coliform. Because about seven (7) months have passed since the last chlorination, the coliforms in water distribution system may have probably increased, requiring occasional chlorination in order to keep the system free from contamination.

Seven (7) samples had been collected from household containers like clay pot and Jerry-can. The samples show high contamination with too-many-to-count faecal coliforms in most cases.

3.2 Current Water Consumption and Demand

3.2.1 Water Consumption and Production

The data of the production and the billed consumption were given by WSS. The data from July, 1993 E.C. to June, 1994 E.C. were summarized in Table 3.2.1.

The commerce connection and governmental connection are included in individual connection. Individual connection accounted for about 85 % of total consumption, and public fountain accounted for about 15 %. Annual consumption and production are given as blow. According to the data, there is no remarkable variation due to seasonal change in the individual consumption.

Total production	207,112 m^3
Total consumption	118.896 m^3
Losses	about 42 %

3.2.2 Water Users

According to the water consumption census conducted in February, 1995, it was found that the total population served by the water supply was 12,500 approx., which accounted for about 87% of the total population. Domestic, institutional, commercial and industrial consumption was also estimated on the basis of above census data.

Domestic consumption was subdivided into the ones of house connection, yard connection, public fountains and those who bought and 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	2,225	12,494	(100.0)	200.3	(16.0)	454.4	(36.4)
House Connection	34	281	(2.2)	13.7	(48.8)	15.9	(56.6)
Yard Connection	777	5,428	(43.4)	141.9	(26.2)	257.8	(47.5)
Public Fountain	1,311	6,428	(51.4)	39.3	(6.1)	167.1	(26.0)
Neighbors	103	357	(2.9)	5.4	(15.0)	13.6	(38.0)
Institutional	18			17.3			
Commercial	114			9.2			
Industrial	5			5.4			
Total	2,362	12,494		232.2			

There were 44 customers with house connection. The large Consumers are Anwar Mosque, Health Center, Malaris Protection, Commercial Bank, the army camp and Asab Grocery. All of these except for Asab Grocery were considered as institutional customers. Asab Grocery was considered as a commercial as well as domestic customer, because the family members resided in the grocery shop. Most of the other customers were private customers and 10 of them used water for their business as well as domestic purposes. 18 customers of ordinary houses were selected to estimate the domestic lpcd. The lpcd was calculated at 48.8. The domestic consumption of house connection customers was estimated at 13.7 m^3/day from this lpcd figure and the population served counted at 281. There were 10 institutional customers. Their institutional consumption was estimated at 12.3 m^3/day. There were 11 commercial customers. Their commercial consumption was estimation at 5.5 m^3/day by the same way of estimation as the institutional consumption.

There were 2 industrial customers, one was a grain mill and the other was a private house under construction. Their industrial was estimated at 0.4 m^3/day.

There were 785 customers with yard connections. Most of them were private customers and some of the private customers used water for their businesses as well as domestic purposes. 777 customers of ordinary houses were selected to estimate the domestic lpcd. The lpcd was calculated at 26.2 lpcd. The domestic consumption of yard connection customers was estimated at 141.9 m^3/day from this lpcd figure and the population served counted at 5,428. These were 8 institutional customers. Their institutional consumption was estimated at 5.0 m^3/day. There were 71 commercial customers whose businesses were restaurant, coffee bar, brewery, etc. Their commercial consumption was estimated at 3.7

m^3/day by the same way of estimation as the institutional consumption. There were 3 industrial customers, one was a grain mill and the others were private houses under construction. Their industrial consumption was estimated at 5.0 m^3/day.

Public fountain users accounts about a half of the population served. There are 15 houses which engaged in small business. Since their consumption for business was negligible, all the consumption from the pts was considered domestic. The lpcd was calculated at 6.1. The users of Mesjid Ber, Training Center and Gebeya Dar PFs consumed 11.1, 10.7 and 10.4 lpcd respectively, which were about twice as much as the average consumption of PF users. In those areas, the water supply situation was relatively good comparing with the other areas.

Number of those who borrowed and bought water from the neighbors were small comparing with other towns. Those who borrowed and bought water from the neighbors were counted at 103 houses with the population of 357. Their domestic consumption 15.0 lpcd was obtained by the census survey and checked with the consumption records of those who gave water. There were about 30 houses which engaged in small businesses, such as shops. It was considered that the consumption for their businesses was negligible to the total consumption.

There was a hydrant user who was a construction company. Their consumption was excluded from the consumption of Bari, because they took water to their camp located outside of the town.

3.2.3 Current Demand

The water required by the users of different mode of service for different domestic purposes was estimated as shown in Table 3.2.2. In the study, there are five major categories of the users. Since there are no neighbor hood tap users in Bati, it is considered that they are equivalent to those who borrow and buy water from neighbors.

Table 3.2.1 Water Production and consumption in Bati

Consumption (m3)

	IC	PF1	PF2	PF3	PF4	PF5	PF6	PF7	PF8	PF9	PF10	PF11	PF12	PF13	Sub Total	Hydrant	Grand Total
Jul-93	8,418	113	36	39	152	140	208	51	63	86		49	59	49	1,045		9,463
Aug-93	8,729	112	109	51	186	129	202	99	106	97		52	105	51	1,299		10,028
Sep-93	9,279	169	125	67	176	176	175	69	94	65		47	80	35	1,228		10,507
Oct-93	6,256	75	152	66	180	131	323	64	89	91		60	101	50	1,382		7,638
Nov-93	7,727	100	173	68	185	119	211	101	74	106		70	114	30	1,351		9,078
Dec-93	7,805	64	102	66	154	67	141	82	48	113		45	42	45	969		8,774
Jan-94	6,805	95	216	66	142	120	285	54	53	95		60	149	59	1,394		8,199
Feb-94	7,868	105	138	94	167	148	254	66	58	118		72	115	42	1,377		9,245
Mar-94	6,883	73	113	61	148	100	187	50	56	105		68	75	72	1,108		7,991
Apr-94	6,093	86	105	61	177	66	245	50	66	105		87	100	54	1,202		7,295
May-94	8,848	106	145	96	219	130	197	55	85	120		115	120	118	1,506		10,354
Jun-94	6,223	115	152	90	227	142	240	73	97	124		81	160	44	1,545		7,768
Sep-94	7,347	90	132	34	185	124	197	63	109	108		56	101	73	1,272	100	8,719
Oct-94	9,094	99	157	79	173	149	198	115	118	106		59	106	42	1,401	220	10,715
Nov-94	6,256	76	114	60	168	80	174	58	62	88		60	67	42	1,049	170	7,475
Dec-94	6,700	74	135	63	146	104	154	57	135	172		48	87	48	1,223	120	8,043
Jan-95	9,222	78	141	65	129	133	177	59	113	123	7	56	84	46	1,211	22	10,455
Feb-95	7,149	84	129	53	145	126	159	49	100	66	67	63	80	41	1,162		8,311
Mar-95	6,348	84	114	103	148	126	164	61	89	57	63	57	170	39	1,275		7,623
Apr-95	6,010	76	138	76	160	132	160	87	88	56	41	63	95	32	1,214		7,224
May-95	6,087	75	148	50	136	139	182	82	85	73	57	90	30	20	1,167		7,254
Jun-95	6,345	90	205	46	174	189	244	73	119	152	77	93	95	25	1,582		7,927
Total	90,934														27,962	632	118,896
Average																	8,640
Maximum																	10,715

Production (m3)

Well				
No.1	No.2	No.3	No.4	Total
3,608	3,024	-	2,616	9,248
3,401	1,722	2,666	2,476	10,265
3,465	1,943	2,564	970	8,942
3,940	1,559	-	3,681	9,189
3,550	1,959	282	3,075	8,866
2,496	781	2,503	2,817	8,597
4,066	1,661	-	3,130	8,857
3,520	2,406	-	3,518	9,444
3,426	2,173	-	3,991	9,590
2,556	1,954	1,977	3,233	9,718
2,212	1,590	4,450	2,610	10,862
3,418	1,409	5,639	1,435	11,901
476	1,702	5,657	1,228	9,063
1,533	2,714	4,869	690	9,806
2,949	1,996	2,305	1,566	8,816
2,066	2,793	1,840	2,827	9,526
2,097	2,462	2,903	2,122	9,584
1,774	2,351	2,087	1,690	7,902
1,891	2,588	1,954	1,919	8,352
1,857	2,428	2,214	1,659	8,158
2,260	2,912	3,102	1,012	9,286
2,437	3,232	3,860	1,611	11,140
39,670	22,181	20,076	33,552	207,112
				9,414

Unaccounted Losses

(m3)	(%)
-215	-2
237	2
-1,565	-17
1,551	16
-212	-2
-177	-2
656	7
199	2
1,599	16
2,423	24
508	4
4,133	34
344	3
-909	-9
1,341	15
1,483	15
-871	-9
-409	-5
729	8
934	11
2,032	21
3,213	28
88,216	42

*Recorded in Ethiopian Calendar

*The data in Jul. '94 and Aug. '94 are neglected due to unreliablity

IC: Individual Connection

PF: Publiic Fountain

3.3 Water Supply Facilities Condition

3.3.1 General

The water supply has been served by the piped water system. The existing water supply system is composed of the boreholes, transmission facilities and distribution facilities and operated by hydroelectric power for 24 hours by EELPA.

In 1993, the transmission facilities including electrical equipment was improved by Italian cooperation. The schematic existing water supply system is shown in Figure 3.3.1.

3.3.2 Water Source

There are five boreholes which are located along the Aba Negewo river. Of these boreholes, four boreholes are in operation as production boreholes. Remaining one borehole is abandoned due to the influence of pumping of Borehole No.4. The borehole data is summarized in Table 3.3.2.

Table 3.3.2 Existing Borehole Data

Borehole	Depth (m)	Pumping Rate (l/s)
No.1	105	2.8
No.2	35	3.3
No.3	57	not measured
No.4		not measured

It is reported that the submersible pump in Borehole No.3 is incapable to pump groundwater sufficiently. It reportedly caused by the dropdown of the voltage due to the distance between the transformer and the borehole location.

Three of the boreholes are fitted with check valves and flow meters. The remaining one is fitted with a check valve, but a flow meter is installed at the inlet of the collecting chamber.

Besides, the people, living in remote area from the water supply system, is utilizing the existing two springs.

3.3.3 Transmission Facilities

The groundwater pumped from the boreholes is delivered to a collecting chamber, a metal sheet tank with a capacity of 20m^3 located next to the well No. 1. A boosting pump station is located at the same site, and it is equipped with the two vertical centrifugal pumps (one is stand-by).

These boosting pumps are installed by Italian cooperation. No technical data on those pumps was available so far. These pumps deliver the water to the distribution reservoir through the transmission main.

The operation of the boosting pump is related with the group of the reservoirs and the collecting chamber. The boosting pump will be switched off manually when the reservoirs are full of water and also when the water level of collecting chamber decreases to the low level.

3.3.4 Distribution Facilities

The distribution reservoir consists of a group of three reservoirs: two reservoirs with a capacity of 45m^3 and one reservoir with a capacity of 50m^3. The flow meter installed at outlet showed the distribution is at 6.7l/sec.

Water from the reservoir is distributed to the town by gravity. The distribution pipeline is dead-end distribution system with a galvanized steel pipes. The diameter of the pipes is ranging from DN 20 to DN 100. The length of pipeline is summarized as follows:

Table 3.3.3 Existing pipeline data

Diameter (mm)	Length (m)	Material
20	125	G.S
25	158	-do-
40	612	-do-
50	3360	-do-
65	1052	-do-
80	1497	-do-
100	925	-do-

In addition, some parts of the pipeline crossing the road are installed in drainage culverts or running overground. Most of the culvert are buried with sediments, and there are lot of garbage and body disposal in the sediments. Furthermore, there are a lot of private houses which are built on the pipeline routes.

3.3.5 Service Level

Water service level is divided into two modes: individual connection and public fountain. There are 852 individual connections and 12 public fountains.

With regard to public fountain, there are 12 operational public fountains in the town. The design of the public fountain is classified into two types: old type (cylindrical structure) and new type (newly standardized by WSSA). The number of faucets with the public fountain ranges from 4 to 6.

3.3.6 O & M

There is a water service office in Bati under the control of Regional office in Kombolcha. Bati office is managing not only financial works but also maintenance works such as replacement of valve and meter. Any regular check up for the maintenance was not made except yearly inspection tour by regional office.

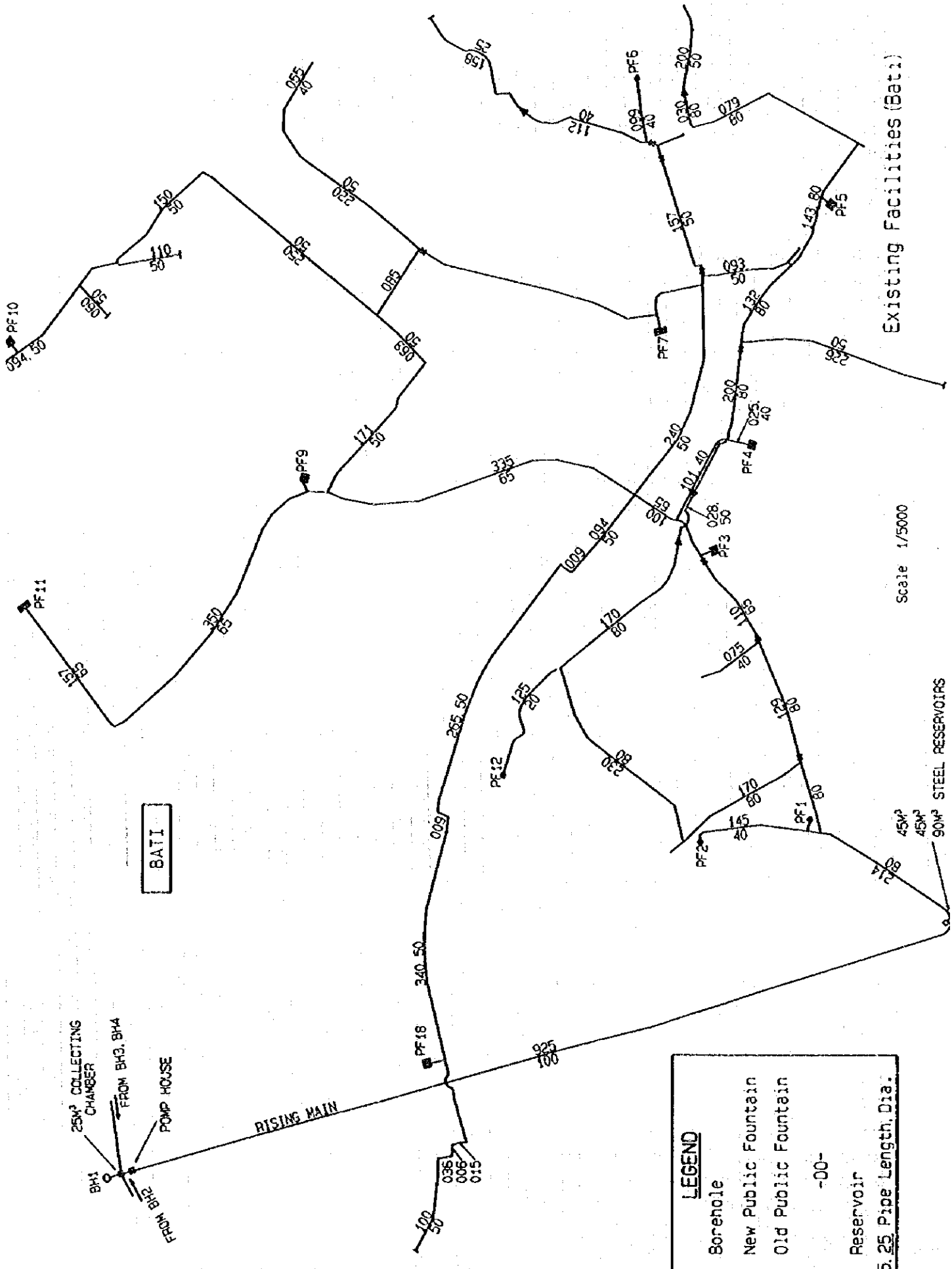


Figure 3.3.1 Schematic layout of Existing Facilities (No scale)

3.4 Sanitary Facilities Condition

3.4.1 Toilet Facilities

In general, the sanitation of Bati is not good. There are 3 public toilets in the town, two of which are already filled up; and the 3rd one is on the verge of being filled up. The filled up public toilets have not been emptied and new ones have not been constructed to take their places. The third Public Toilet is located near Bati Prison and is still being used mostly by the prisoners. When the Team has undertaken emptying pit toilets in Bati, this was one of those that have been emptied and put to re-use again. Bati has a Monday-Market once a week where people come from all over the places and it is the biggest in that area. All people that come to the Market use the open-area close by to dispose of their body wastes.

The Population and Housing Census has taken sanitary survey of the whole town in 1984 and updated the data in 1993. The results of the survey showed the following.

Table 3.4.1 Distribution of Housing Units by Type of Toilet Facility in Bati

Number and percentage	Type of Toilet Facility						Total
	Flush		Dry pit		None i.e. (open-) field	Other	
	Private	Shared	Private	Shared			
• Number	47	8	358	343	1,333	50	2,139
• Percentage (%)	2.2	0.4	16.7	16.0	62.3	2.4	100.0

On can see from the table that 62.3% of households in Bati do not have toilet facilities; 32.7% have pit latrines, both private and shared; and 2.6% have have flush toilets.

In 1995 the Team has carried out households survey of 100 households in Bati. The result revealed that the distribution of the household by type of toilet facilities used as:

- 65% of the households have dry pit toilet facility;
- 28% have no toilet facilities at all; and they use open-field;
- 4% have community toilet facility;and
- Only 3% have flush toilets that use septic tanks.

The above results of 100 households survey indicate that the largest majority of the population (69%) use pit latrines, and the second largest majority 28%, do not have toilets but use open defecation. Bati is one of the two towns where experimental toilet was constructed. When the dry pit latrines filled-up, the owners dig new ones if they have space to do so. Those who can afford to pay for vacuum truck, if they get from Dessie, they empty their pit latrines. But getting a vacuum truck from Dessie has been found to be difficult and most people with filled-up pit latrines go to open-defecation if they cannot dig new ones. Bati dose not have prepared sites for dumping sludges. When the Team arranged for a vacuum truck to empty about 50 out pit latrines in Bati, only 24 sludge disposal tripes were made due to disputes that arose between the Municipality of Bate and the people who live near the place where sludges were being dumped. The Wereda

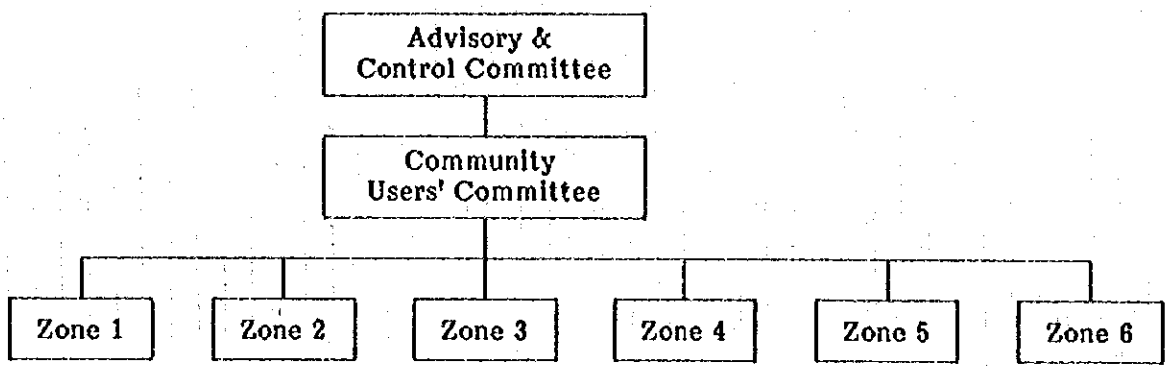
Administration could not settle the dispute at the time of the operation and the work has to be called off. It is very important that proper sludge-dumping sites be prepared ahead of time based on the consent of all concerned.

The Population and Housing Census of 1984 has also surveyed the housing units in Bati by types of materials used in the construction of walls, roofs and floors. The survey results indicate that 90% of the walls of the housing were built out of wood and mud; 79% of roofs were built out of corrugated iron sheets and 81% of the floors out of earth and mud. The superstructures of the toilet facilities of Bati also use similar local materials.

3.4.2 Experimental Toilet

Bati is the other town where an Experimental Toilet has been constructed. With the agreement of the people in the community and the officials of Bati a convenient site has been selected. The people in this community are very poor and they did not have any toilet facility. They have been using open-area for disposing their body wastes.

While the toilet was being constructed people from the community have participated. They have been organized and have formed their own committee to look after the toilet, operate it, maintain it and safe-guard it. A Control and Advisory Committee consisting of members from WSSA, Health Center, Werada Administration, Bati Municipality, Bati schools and the community to oversee the activities of the toilet and to assist whenever the community needs any help;They are organized as follows.



The community has divided itself into six zones for the purpose of administering and managing the experimental toilet. Each Zone has its own chairman leading the Zone Committee. They have started contributing funds for regular operation, maintenance and management of the toilet. The community was very happy to have the first toilet in their community and has expressed it gratitude and appreciation to this experimental practice.

3.4.3 Desludging Toilets in Bati

The Team has arranged a vacuum truck from WSSA in Bahir Dar to empty some toilets in Bati. Emptying of toilets of schools, health centers, public toilet, and toilets of those who could not afford to pay has been emptied. After the operation has carried out 24 disposal trips, a dispute arose between the Bati Municipality and the people who live in the area of sludge dumping site. The Wereda Administration did not settle the dispute in time, and the

operation was called off. The need of prior preparation of sludge dumping sites based on the agreement of all concerned has been strongly felt; and the Wereda Administration has agreed to have all involved to come together and find solution.

Apart of dumping site dispute, the people who have their toilets desludged were very happy and were very appreciate of the work done within a week.

3.4.4 Other Sanitary Facilities

Dry solid wastes are mostly dumped indiscriminately in various places. The Survey of 100 households in Bati has revealed that 30% of the households dump their refuse any place, and 62% burn the dry solid wastes. The general observation during the time of the study was that some of these sites are also being used for open excrete disposal.

The same household survey of 100 housing units showed also that 79% of the households throw their sullages any where where it is convenient; 15% dump in pits and 4% of them let the sullage flow in the open-drains. Most of these sullages accumulate and have become places of breeding for flies and insects, have very bad odours and are very displeasing sights. They have created environmental pollution, caused water contamination and have become serious health hazards especially for children .

There is no place in Bati prepared for killing meat animals. They are slaughtered in any convenient place and the wastes that result are thrown in the same places. These have created environmental pollution, water contamination and bad odours.

Except for the main paved road that passes through Bati, no adequate drainage facilities are available along the other side and parallel roads. Waste dry materials and various types of rubbishes are seen dumped along the streets blocking the water passage of existing drainage ditches causing over flooding in certain parts and creating stagnant waters in other parts during the rainy season.

In general, the sanitary facility conditions in Bati are very poor. The people and the officials concerned need to take active role in improving the prevailing bad sanitation situation.

3.5 Organization and Management

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

The number of personnel for the Water Supply Service of Bati is 25, which is the largest among the 11 towns. 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. Head, WSS	1	0	1	0	0
2. Customer Services	1	0	1	0	0
3. Administration					
Administrator	1	0	1	0	0
Store keeper	1	0	1	0	0
Guards	6	0	1	5	0
Clerk	1	0	1	0	0
Sub-total	9	0	4	5	0
4. Finance					
Cashier	0	1	1	0	0
Bill collector	0	1	1	0	0
Meter reader	1	0	1	0	0
Water sellers	3	3	4	2	0
Sub-total	4	5	7	2	0
5. Technical					
Astt. technician	1	0	1	0	0
Motor operator	1	0	0	1	0
Plumbers	3	0	3	0	0
Sub-total	5	0	4	1	0
Total	20	5	17	8	0

As the table shows, out of the total 10 persons or 68% are permanent workers and 8 or 32% are contract workers. The share of contract workers seems to be on the high side. Female workers are 5 in number or 20%. It is less than 27%, which is the average percentage of female workers in 11 towns. When one classifies the functions into administrative, financial and technical ones, the head of WSS and the customer service staff being included in technical and administrative functions, their respective shares work out to 40%, 36% and 24%. On the other hand, their 11 town averages are 37%, 41% and 22%. It means that the share of administrative functions is higher and that of financial functions is lower compared to their respective 11 town averages.

Annual water production per worker, which is the broadest labor productivity indicator is calculated at 4,541 m^3. It is estimated to be the highest among the 11 towns. The monthly remuneration per worker is 204 birr, which is on the high side.

It follows from the above that a low participation rate of female workers and a high percentage of contract workers are to be noted, the number of personnel is well controlled, and functional composition of personnel is a standard one.

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 birr for all clients.

Production and consumption of water in the last fiscal year (Jul. 1993 to Jun. 1994) was 113,523 m^3 and 90,218 m^3 respectively. Both are the largest among the 11 towns. Leakage ratio works out to 20.5%, which is on the high side. The daily water consumption as divided by population comes to 17.2 liter. This is the second highest, next to 20.5 liter in Mille.

Income for the last year was 131,144 birr. The major sources of income are measured water sales (56.6%), service charge (19.1%) and cash water sales (11.8%). Income per m^3 of water consumed works out to 1.45 birr, which is on the low side. Bill collection rate is 94.4%, which is on the high side.

Expenditures for the same year were 132,245 birr. The major items of expenditures were salary (46.2%), electricity (20.2%) and pipes & fittings (5.0%). Expenditures per m^3 of water produced work out to 1.16 birr, which is on the low side. The income-expenditure ratio comes to 99.2%. Bati is at the fourth place in this regard, following the solvent 3 towns.

The number of personnel is 25. It is the largest among the 11 towns. Annual water production per worker is calculated at 4,541 m^3, which is the highest. Annual income per worker is 5,246 birr, which is the highest. Expenditures per worker is 5,290 birr, which is the second highest, next to 6,019 in Dupti. Average monthly income of WSS employees is 204 birr. It is on the high side.

It follows from the above that WSS of Bati is the largest among the 11 towns in terms of water production, income and the number of employees and that financially it is doing comparatively well. Lowering of leakage ratio and raising water rate may make WSS financially in the black.

3.7 Social Background and People's Awareness

3.7.1 Population and social composition

The population was approximately 14,354 during the field survey. The majority of the population was Muslim (88% of respondents in the household survey) with the rest being Christian. The ethnic mix represented by the survey was mainly Amhara (49%) with 28% Oromo, 5% Tigre, 4% Arab and 6% Afar. The proportion of male to female household heads was 50%:50%. Some people were exhibiting extreme dependency syndrome relying on food aid and begging. This was a result of the frequently occurring famines in the area and to the relief aid which continued for decades but had stopped. People were not used to being consulted about their needs for water and sanitation and often commented positively about this aspect of our work.

Eder system was very strong in the community. The leader was the older at the Mosque. This system had been used in other social mobilization programs and could be used for hygiene promotion.

It was very difficult to access the Afar community and the Christian community to fully appreciate their views.

3.7.2 Sanitary condition

The majority of households used latrines (78% of households in survey). Those who did not have a latrine were lacking space, control of land but the greatest block seemed to be financial, according to the results of the household survey. Those who had latrines sometimes did not use them because they require emptying. The existing latrine design requires removal of the solid material by suction truck. No suction truck was available in Bati and occasionally one could be hired from WSSA in Desie. On occasions when the truck had been hired, it returned to Desie without emptying the agreed number of latrines.

Various community and public latrine facilities have been built by the kebeles and municipality. Many of these were also full and no attempt had been made to empty them. People preferred latrines which do not require water for flushing. Although women used water for anal cleansing, men were using paper and stones. There was a felt need for sanitation facilities, mainly community latrines which they could manage themselves. Public latrines in areas like the bus station would need to be managed by the Government. However, before any latrine program could be initiated successfully, the existing pit emptying problem needs to be addressed.

Drainage was mentioned as a problem in part of the town. In the wet season the PF can not be accessed due to the flooding round about that area.

3.7.3 Water situation

The existing water supply system seemed to be operating well and the people served by this system did not require any major improvements or alterations. However in the parts of the town where there was limited access to this water system, there was a problem with water availability. A number of households requested that previous PFs were reconstructed and reopened particularly in the East and West areas of the town or that those PFs nearer these areas needed to have longer service hours.

Where water was in short supply, people were forced to take drinking water from the small springs and streams which they believe to be contaminated. Results of the household survey indicate that more Christians than Muslims use other sources. All laundry was done at the river, except for the most wealthy households with PCs who do their laundry at home. Women and girls collect water and wash laundry. Men and boys only occasionally participate in these activities from PF sources. Women and girls would benefit from and improved water supply system.

In Kersa village water was a major problem. A borehole and hand pump located there had been decommissioned and a small spring insufficient to supply adequate water used for

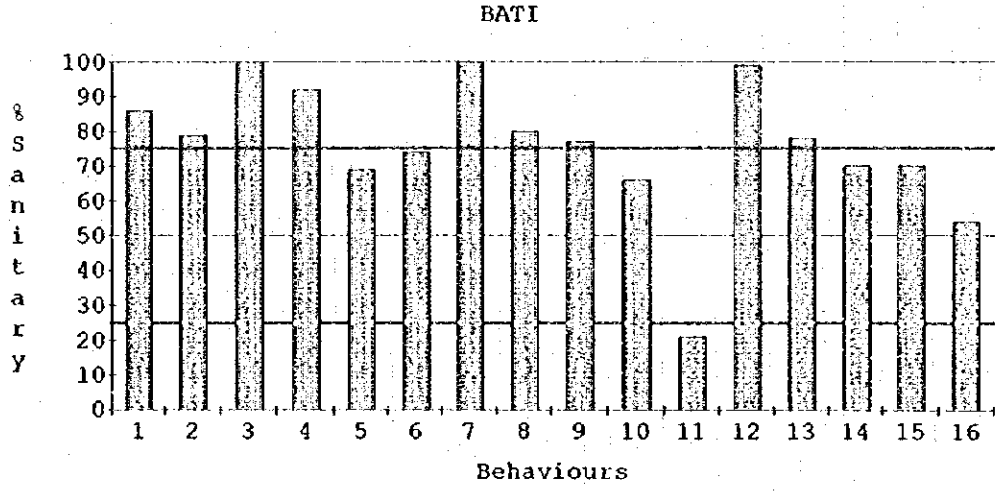
drinking. People in this area were forced to drink river water and to use the river for all other purposes. The people of Kersa wanted a PF from the main system or if not, to have a new hand pump and to be trained in it's operation and maintenance. Kersa was the only part of Bati town who felt prepared to manage the water facility when they get one. The rest insisted that facilities be Government managed.

Public showers were of interest to the existing PF users, which could be managed by the community with sufficient support from the administration at least in the early stages.

3.7.4 Health Indicators

Health services were provided by Bati Health Center. This was Government run but used to be supported by NGOs, including provision of free treatment, free medicines and even free refreshments. People including the health staff were disappointed with the level of service which they could provide. Health education given by the health center is the standard didactic way and a personal advice to patients. It was not thought to be effective. The health center staff were keen that some novel health education activities be undertaken and would support any hygiene promotion campaign.

There was a high incidence of bilharzia, diarrhoeal disease and malaria. People were generally aware of the cause of bilharzia but other health knowledge was more limited. Bati had a relatively high ORS awareness level, quite high diarrhoeal disease control awareness and moderate attendance at health education sessions in the town in comparison with other survey results from among the 11 Centers (See Chart 14-16). The sanitary indicator behaviors for Bati are the best out of the 11 Centers (See Figure 3.7.1). The rate for diarrhea incidence is the lowest.



No.	SANITARY BEHAVIOURS	%score
1	Access to piped water	86
2	Use piped water supply always	79
3	Covered water container	100
4	Water scoop kept off the floor	92
5	Handwashing with soap after defecating	69
6	" after handling childrens stools*	74
7	Covering cooked food during storage	100
8	Not eating unwashed raw fruit and vegetables	80
9	Kitchen utensils stored off the floor	77
10	Rubbish burried or burned	66
11	Wastewater disposed in pit/drain/veg. garden	21
12	No animals kept in the house	99
13	Home not infested with flies	78
14	Latrine in use by household	70
15	Latrine in use by all household members	70
16	Infant's excreta disposed of in latrine*	54
TOTAL SCORE FOR SANITARY BEHAVIOURS		1215

* As percentage of houses with young children

Figure 3.7.1 Indicator Sanitary Behaviours

There is little variation in this score between user groups. However there are other variations as follows. The number of Christians households in the household survey is not statistically significant but analysis of these results indicate that there is not much difference in behaviors of Christians and Muslims, except that Muslims seem to have better access and handling of water while Christians have better access to latrines and better sanitation regarding handling of children's stools and handwashing practices. The situation is also different for different income groups. According to the household survey, those in lower income groups of 1 to 3, there are more female headed households, a lower access to health education and thus lower awareness of ORS and diarrhoeal disease control and lower access to latrines, poor handling of children's stools and poor levels of handwashing; but their access to water is similar.

Regardless of religion or gender, the priority area for behavioral improvements is that of wastewater disposal. There are no Medium-High priorities, but the Medium-Low priorities are handwashing with soap after defecation, handwashing after handling children's stools, burning or burial of solid waste, access and sanitary use of latrines by all household members and sanitary disposal of children's stools. Other sanitary behaviors are good and people should be encouraged to maintain this level.

3.7.5 Education

There were two elementary schools and one recently established high school. The high school had 24 teachers including science teachers and also the HIV/Health Club structure. This could be used for hygiene promotion but students at the school reported that film, posters, drama, songs and lectures were all ineffective methods of communicating health messages. They suggested using respected community leaders to influence health behaviors. There were some 1000 students at the school with a higher ratio of boys to girls, particularly at higher school grades.

3.7.6 Religious Institutions

The Muslim leader of the main mosque was interested in improving the sanitation and health situation. He was keen to use the Koran teachers in any hygiene promotion activities and also the Eder system of which he was a key member.

The mosque also had full latrines which were closed and required emptying. The mosque elder was not keen to have any other sanitation facilities built in the town until the solution to the existing latrine pit emptying problem had been initiated.

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, electricity, meteorology, relief and municipal affairs.

The number of government employees is 366. It is one of the smallest among the 11 towns. The number of them per 1,000 population works out to 25, which is the second lowest, next to 15 in Werota. Their average monthly salaries are 355 birr, which is at a medium level.

One does not have much to stress upon administratively for this town.

Bati has 3 Kebele. There is no NGO.

3.8.2 Population

The population of the town is estimated at 14,354 according to the preliminary results of the 1994 population census. It belongs to the medium size group along with that of Bure, Dupti and Bichena, all falling under the 14,000 to 15,000 bracket. Ethnically, it is composed of Amhara (49.0%), Oromo (27.7%), Afar (12.5%), Tigre (4.5%) and others (6.3%). Religion-wise, Moslem population comprises 88% and Christian population 12%. 4 mosques and 1 church testify to the above religious composition of the people.

This town is a conspicuously Islamic town with various ethnic groups besides Amhara, notably Oromo and Afar.

The average family size is 6.2 persons. This is on the large side. The area of the town is 260 ha. The population density is calculated at 55.2 persons/ha. This is one of the highest among the 11 towns.

3.8.3 Educational Conditions

There are 1 kindergarten, 1 elementary school and 1 high school with up to 12th grade. The total number of pupils/students comes to 2,500. It is the second smallest among the 11 towns, next to 457 in Mille. The number of pupils/students per 100 population is calculated at 17, which is the second lowest, next to 14 in Mille.

Literacy ratio and primary school enrollment ratio were 48% and 53% respectively according to the 1984 population census. They are both the lowest among the 11 towns. Mille has the same enrollment ratio as Bati in this regard.

The above tells poor educational conditions and levels in the town.

3.8.4 Medical Conditions

There is 1 health center, 1 district health management and 3 private drug stores. The total number of medical personnel in the health center comes to 22, which is a medium size among the 11 towns. It means that there are 1.5 medical personnel for every 1,000 population. It is at a medium level.

The types of diseases people suffer most are eye, skin and ear diseases, respiratory tract infections such as pneumonia and bronchitis and water-borne diseases such as intestinal parasite and malaria. It seems that it has something to do with unsanitary conditions, climatic conditions and shortage of piped water in the town. The number of top ten disease cases treated in the Health Center in 1993/94 was 11,642, which is on the small side among the 11 towns.

The estimated total number of cases treated last year in the Health Center was divided by the estimated service population. It came to 24.3%, which is on the low side.

Under 5 mortality rate and life expectancy were 163/1000 and 52 years respectively according to the 1984 population census. The mortality rate is on the high side, while the life expectancy is on the low side.

Ratio of households more or less using septic tanks and pit latrines is 68%. It is the second highest, next to 86% in Dupti.

It follows from the above that incidence of diseases in the town is on the low side and people are more sanitation conscious. Nevertheless, one witnesses a high mortality rate and a low life expectancy.

3.8.5 Economic Conditions

The number of hotels and restaurants is 68 (28.0%), that of shops 163 (67.1%) and that of cottage industry 12 (4.9%), adding up to 243 (100.0%). This total number of commercial/industrial establishments is the second smallest among the 11 towns, next to 240 in Mille. The total number per 1,000 population comes to 17, which is the lowest along with Bure. The number of hotels and restaurants per 1,000 population is 4, which is the second lowest along with Bure.

Bati cannot be said to be a commercial town so far as the number of permanent commercial establishments is concerned.

Major occupations in the town are retail trade, government employees, agriculture (farming and animal husbandry) and day laborers. It is to be noted that in Bati agriculture is practiced as one of the major occupations.

Major marketable items are grains such as millet and tef, animals such as ox, cow, camel, sheep, goat and donkey, and daily household items.

There is a big market every Monday. About 60,000 people are said to gather on that day.

Average monthly household income is 306 birr. This is on the high side among the 11 towns.

3.9 Town Planning and Development

The master plan for town planning has been formulated in the era of the Imperial government. According to the field survey, it is expected that sixty percent of the current master plan has been completed as shown in Figure 3.9.1.

The electric power is now supplied to the Centers by the hydroelectric power by EELPA, but the existing water supply facilities is operated by the on-site generators. The future water supply facilities at the target year of 2005 and 2010 will be also operated by the hydroelectric power.

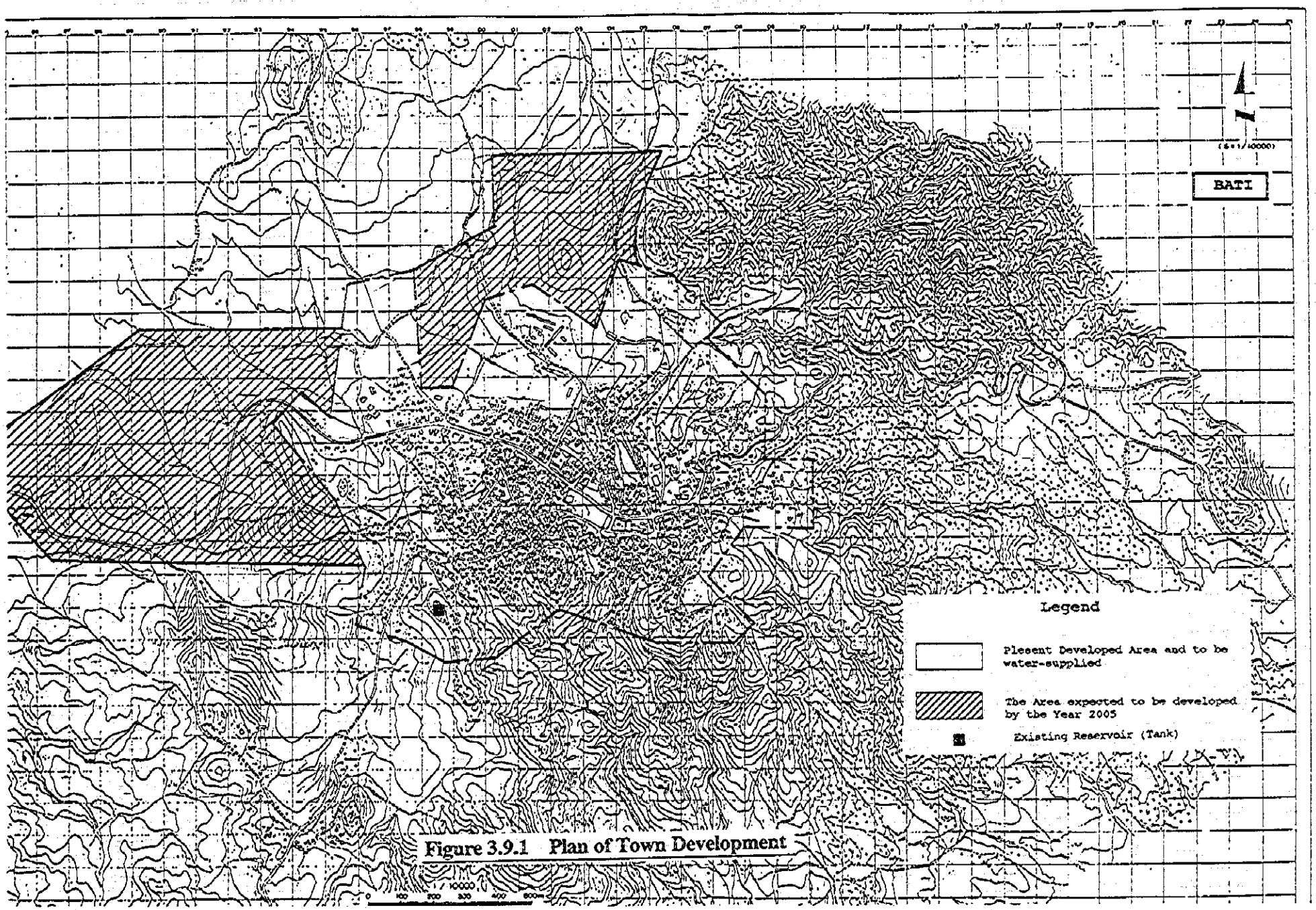


Figure 3.9.1 Plan of Town Development

Chapter 4 Plan of Water Supply System

4.1 Water Demand Projection

4.1.1 Population Projection

The population of Bati was 9,852 in 1984 according to the results of the 1984 Population Census. The census is the first one the Ethiopian government has ever took.

Before 1984 no established population figures are available. However, Central Statistical Authority (CSA) published 1974 population estimates for those towns whose population was supposed to be more than 2,000. Also, it had similar 1972 and 1973 estimates.

According to CSA estimates, 1974 population for the town was 9,570. Similarly, 1972 and 1973 population was 8,430 and 8,980 respectively. When one adopts CSA estimates, the average annual population growth rate during the 10 years 1974 to 1984 is calculated at 0.29%. It appears to be too low.

Since 1984 also CSA published its own estimates of population. According to them population of the town in 1992 and 1993 was 14,689 and 15,378 respectively.

In 1993 to 1994 CSA conducted the Cartographic Census for all the towns over the nation, using its own staff just before the 1994 Population Census. CSA says the results of the former is dependable, even more than those of the latter.

According to the Cartographic Census the population of the town was 13,970 in 1994. When one uses the figures, the average annual population growth rate during the 10 years from 1984 to 1994 works out to 3.55%. The JICA Study Team projected future population of the town based on the rate.

In October, 1994 the second Population Census was carried out. The results are not yet published. However, the team has gotten the preliminary figures of the census for Bati during the field survey. They are 14,354. The team adopted them for the 1995 population of the town.

Weroda people say industrialists are ready to invest in edible oil, leather processing and meat factories if sufficient infrastructure including water, electricity and transport is available.

As the average annual population growth rate 1995 to 2000 3.5% was adopted based on the average annual population growth rate 1984 to 1994. 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 3.0% and 2.5% respectively.

As a result the projected population of the town for 2000, 2005 and 2010 works out to 17,048, 19,763 and 22,360 respectively (Refer to Table 4.1.1).

Table 4.1.1 Population of Bati

1. Past Population

1974 Estimates by CSA	1984 Population Census	Average Annual Growth Rate 1974 to 1984
9,570	9,852	0.29%
1984 Population Census	1994 Cartographic Census	Average Annual Growth Rate 1984 to 1994
9,852	13,970	3.55%

2. Population Projection

1995	2000	Average Annual Growth Rate 1995 to 2000
14,354	17,048	3.5%
2000	2005	Average Annual Growth Rate 2000 to 2005
17,048	19,763	3.0%
2005	2010	Average Annual Growth Rate 2005 to 2010
19,763	22,360	2.5%

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 97%, and 41% of these ratio is house connection.

The ratio of the population served by the piped water at the target year of 2010 is 95%, and the ratio served by the traditional water source is 5%, considering the current ratio.

Table 4.1.2 Population Forecast by Service Modes

	Population (%)							
	1995		2000		2005		2010	
House Connection	281	2.0	1,022	6.0	3,061	15.5	5,813	26.0
Yard Connection	5,785	40.3	7,075	41.5	9,730	49.2	10,956	49.0
Public Fountain	6,428	44.8	7,366	43.2	5,622	28.4	4,473	20.0
Sub total	12,494	87.1	15,463	90.7	18,413	93.1	21,242	95.0
TSU	1,860	12.9	1,585	9.3	1,350	6.9	1,118	5.0
Total	14,354	100.0	17,048	100.0	19,763	100.0	22,360	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.

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	14	(48.8)	61	(60)	199	(65)	407	(70)
Yard Connection	147	(25.4)	248	(35)	370	(38)	449	(41)
Public Fountain	39	(6.1)	110	(15)	90	(16)	76	(17)
Total	200		419		659		932	
Average	67	(16.0)	140	(27)	220	(36)	311	(44)

(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	2,500	12.5	
Hospital	20 l/staff	22	0.4	
Hotel	100 l/bed	270	27.0	6 beds/place × 45 places = 270 beds
Bar...	200 l/bar	48	9.6	
Mosque	5 l/visitor	2,400	12.0	600 visitors/place × 4 places = 2,400
Offices	5 l/person	126	0.6	
Total			62.1	

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	12.5	14.8	17.2	19.5	Population growth rate
Hospital	0.4	0.5	0.6	0.7	-do-
Hotel	27.0	37.0	49.5	64.7	Population growth rate +3%
Bar, Tea shop	9.6	13.2	17.7	23.1	-do-
Mosques	12.0	14.3	16.6	18.8	Population growth rate
Offices	0.6	0.7	0.8	0.9	-do-
Total	62	81	102	128	

(3) Total Water Demand

Total water demand at the target years including the accounted losses are estimated as follows:

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

	1995*	2000	2005	2010
Domestic	200	419	659	932
Non Domestic	32	81	102	128
Losses	168	56	104	187
Total	400	556	864	1,247

* Actual consumption

(4) Maximum Day Demand and Peak Day Demand

The factor 1.2 is adopted for the projection of maximum day demand, and the factor 1.6 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)		400	556	864	1,247
Maximum Day Demand (m^3/day)	1.2	480	667	1,037	1,496
Peak Day Demand (m^3/hour)	1.6	32	44	69	100

4.2 Water Resources Development

4.2.1 Evaluation of Water Resources

Bati has the annual precipitation of 864.5 mm and the groundwater recharge of 49.6 mm in an average year. Since the town is located on the hill and the domestic waste is discharged to the adjacent river "Abanago river", it is not recommended for water supply to develop the river except for the headwater and Karsa river which is the downstream of Abanago river. Abanago river has an earth dam in the upstream area and the water is going to be used for irrigation. There are two springs in the vicinity of the town. However, their yield is very little and they dry up in dry seasons.

In Bati, the WSS has four (4) operational wells along Abanago river and the safe yields reported by the drillers are summed at 11.6 l/s (1,002 m^3/day). On the other hand, 5-year recharge of dry years is estimated at only 814 m^3/day for the watershed area of Abanago river. It is not recommended to develop the groundwater of the area further more in order to avoid the overpumping situation in future. Not only with this reason but also the water quality is expected to be deteriorated by contamination because the population will increase and a concentration of NOx was detected by the water quality test although it was below the WHO guideline.

The geology is basalts and trachyte of Ashangi group which is dissected by the linearments according to the aerial photograph interpretation. The primary permeability of volcanic rocks is low but it could be increased with secondary porosity caused by faults and fracture openings. 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 10 points as shown in Drawing including the existing operational wells. The apparent resistivity curves have very similar shapes, that is, the apparent resistivity in the shallow depth shows about 10 ohm-m and the curve gradually rising up to about 70 ohm-m at about 80 m depth, and then decreases. On the basis of results from the apparent resistivity curve interpretation, in the strict sense, although there are lots of minor varieties at each point, geophysical formation in this area is generally divided into the six layers. First layer is top soil i.e. sandy silt with resistivity of 10-30 ohm-m at the depth of 0-2 m. The second layer seems to be silty clay with resistivity of 5-10 ohm-m and thickness of 2-5 m. Third layer seems to be weathered basalt with resistivity of 20-30 ohm-m and thickness of 10-20 m. Fourth and fifth layers seem to be slightly weathered and fractured or fissured basalt with resistivity of 100-300 ohm-m and thickness of 40-60 m each. The last layer seems to be weathered and fractured basalt with resistivity of 30-60 ohm-m.

Considering recharging unit from both Abanago river and Bone river, lineation and result of VES, borehole sites are selected at VES St. 6 near the confluence of the forementioned streams and VES St. 9 and VES St. 10 near Karsa river. The results of VES are shown in Appendices.

4.2.2 Strategy of Water Resources Development

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

The depths of major aquifers were detected by the geoelectrical survey. Excluding the operational wells, the thickness of major aquifers is reduced into a half because a part of basalts are highly weathered and may become clayish. The permeabilities are assumed according to the design criteria. The optimal yields of the wells are estimated with the formula listed in the design criteria with a diameter of well to be 200 mm and a drawdown of 20 m. The optimal yields of the wells are shown in Table 4.2.2.

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	2 - 23.5 86 - 105	Weathered and Fractured Basalt Slightly Weathered Vesicular Basalt	40.5	1	WSS No.1
2	VES St.2	15 - 29	Weathered Vesicular Basalt	14	1	WSS No.2
3	VES St.4	6 - 27 80 - 120	Weathered Vesicular Basalt Slightly Weathered Vesicular Basalt	61	1	WSS No.3
4	VES St.3	5 - 26 90 - 95	Weathered Vesicular Basalt -Ditto-	26	1	WSS No.4
5	VES St.6	105 - 150※	Weathered Vesicular Basalt	22.5	1	New Well
6	VES St.9	104 - 150※	Weathered Vesicular Basalt	23	1	New Well
7	VES St.10	60 - 110※	Weathered Trachyte	25	1	New Well
8	St.11	60 - 110※	Weathered Vesicular Basalt	25	1	New Well

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

Table 4.2.2 Optimal Yields and Dynamic Water Levels of the Wells

Well No.	Optimal Yield (m^3/day)	Static Water Level (GL-m)	Dynamic Water Level (GL-m)	Remarks
1	123	6.0	26.0	WSS No.1
2	42	6.5	26.5	WSS No.2
3	185	2.0	22.0	WSS No.3
4	79	8.0	28.0	WSS No.4
5	273	1.0	21.0	New Well for Year 2005
6	279	1.0	21.0	- Ditto -
7	303	1.0	21.0	- Ditto -
8	303	1.0	21.0	New Well for Year 2010

The total optimal yield of Well No.1 to Well No.7 totaling to 1,284 m^3/day covers the demands of year 2005 and the average demand of year 2010. However, it is not sufficient for the maximum demand of year 2010. The shortage must be supplied by Well No.8 which is planned for Year 2010.

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 = Optimal yield (l/s)
- A: Surface area of screen 0.5 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.		5	6	7	8
Pumping Rate	(m^3/day)	273	279	303	303
	(l/s)	(3.2)	(3.2)	(3.5)	(3.5)
Diameter of Well	(mm)	200	200	200	200
Casing Length	(m)	114	114	78	78
Screen Length	(m)	36	36	36	36
Well Depth	(m)	150	150	114	114
Drilling Diameter	(mm)	300	300	300	300

4.3 Plan of Water Supply System

The water supply system proposed for the center of Bati 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.

4.3.1 Water Supply System in 2005

(1) Boreholes

There are three potential sites for borehole as stated in chapter 4.2, and these boreholes will be constructed in the first phase. The groundwater pumped up is transferred to the collecting chamber. The production rate planned is summarized as follows.

W1 (Existing Well)	123 m^3/day
W2 (Existing Well)	42 m^3/day
W3 (Existing Well)	185 m^3/day
W4 (Existing Well)	79 m^3/day
W5 (proposed)	273 m^3/day
W6 (proposed)	279 m^3/day
W7 (proposed)	303 m^3/day
Total	1,284 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 ~ W4	Q = 0.13 m^3/min., H = 60 m, P = 3 kW
W5 ~ W7	Q = 0.21 m^3/min., H = 70 m, P = 5 kW

(3) Boosting Pump and Rising Mains

Rising mains will range from dia. 150 mm to 100 mm transferred water to the new reservoir by boosting pump. Total length is about 3,030 m.

Capacity of the collecting chamber will be 53 m^3, considering the reservoir capacity of one hour of day demand. The characteristic of the boosting pump to be installed are assumed as follows:

BP ϕ150 mm	Q = 0.72 l/min., H = 80 m, P = 30 kW

(4) Reservoir

The existing reservoirs is replaced to new reservoirs due to the lack of capacity of existing reservoirs. The capacity of the reservoir is required to meet the water demand at the year of 2005, and the required capacity is 240 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)
200	285
150	1,305
100	740
75	5,300
50	6,330

(6) Disinfection

Disinfection will be performed by the injection system directly into the outlet of the reservoirs. Daily consumption ratio of chemical will be estimated at about 1.2 kg and necessary more than 0.11 PPM at the end of distribution pipe.

4.3.2 Water Supply System in 2010

(1) Borehole and Pump

Additional boosting pump will be required to meet the water demand of 2010. The characteristics of the pumps to be installed are assumed as follows:

W8; $Q = 0.35\ m^3/min.$, $H = 84\ m$

(2) Distribution Network

The layout of distribution network for the target year of 2010 is not prepared in this Study. It is because the current master plan is expected to be carried out by the year of 2005. It is preferable to design a layout of distribution network after formulation of the master plan.

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, Mine and Energy Bureau of the Amhara 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	11,747	5,865	17,512
2010			10,576

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	1,656
2010	450

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	3.06
2. Yard Connection Users	1.94
3. Public Fountain Users	1.05

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. It is estimated that 114 birr, 177 birr and 256 birr will be daily required in 2000, 2005 and 2010 respectively.

The second is fuel cost. It will not be required as there will be sufficient electricity so far as Bati is concerned.

The third is disinfection cost. It is estimated that 8 birr, 13 birr and 18 birr will be daily required in 2000, 2005 and 2010 respectively.

The fourth cost is personnel cost. It is estimated that 30, 35 and 41 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 58, 134 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	9,027	3,703	12,730
2) Engineering Cost (12% of 1))	1,528		1,528
3) Contingency (5% of 1) + 2))	528	185	713
Sub-Total	11,083	3,888	14,971
4) Buildings		1,226	1,226
5) WSSD's Management Cost (2% of 1) + 2) + 3) + 4))		324	324
Sub-Total		1,550	1,550
Total	11,038	5,438	16,521
6) Water Purification Units (included in total)	10	15	25
2. Phase 2			
1) Construction Cost			6,155
2) Engineering Cost (10% of 1))			616
3) Contingency (10% of 1) + 2))			677
Total			7,448
Grand-Total			23,969

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
   - 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. 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 income tax system will be applied, including 40% tax rate on 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 the 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 = 140.8%
Working Capital/Revenues = 32.5%

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	1,373	1,229	1,011	995
2) Yard Connection Users	483	471	406	369
3) Public Fountain Users	172	179	161	166
2. Share of Households (%)				
1) House Connection Owners	2.0	6.0	15.5	26.0
2) Yard Connection Users	40.3	41.5	49.2	49.0
3) Public Fountain Users	44.8	43.2	28.4	20.0
3. Water Consumption/Household/Month (m^3)				
1) House Connection Owners	9.1	11.2	12.1	13.0
2) Yard Connection Users	4.7	6.5	7.1	7.6
3) Public Fountain Users	1.1	2.8	3.0	3.2
4. Water Price (birr/m^3)				
1) House Connection Owners	1.00	3.06	3.06	3.06
2) Yard Connection Users	1.00	1.94	1.94	1.94
3) Public Fountain Users	1.00	1.05	1.05	1.05
5. Payment for Water Supply/Household/Month (birr)				
1) House Connection Owners	9.1	34.1	37.0	39.8
2) Yard Connection Users	4.7	12.6	13.7	14.8
3) Public Fountain Users	1.1	2.9	3.1	3.3
6. Ratio of Water Payment to Income (%)				
1) House Connection Owners	0.7	2.8	3.7	4.0
2) Yard Connection Users	1.0	2.7	3.4	4.0
3) Public Fountain Users	0.6	1.6	1.9	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	62,535	15,656	12,429	25,011	9,356	7,204	132,191
1997	63,160	15,812	12,554	25,011	9,449	7,262	133,248
1998	63,792	15,971	12,679	25,011	9,544	7,320	134,316
1999	145,593	24,416	52,883	11,316	13,184	6,858	254,250
2000	231,553	40,050	85,945	11,316	13,881	7,655	390,399
2001	277,252	38,593	90,402	26,152	15,490	8,958	456,847
2002	322,951	37,137	94,858	26,152	17,099	9,964	508,161
2003	368,649	35,681	99,315	26,152	18,709	10,970	559,476
2004	414,348	34,224	103,771	26,152	20,318	11,976	610,790
2005	460,047	32,768	108,228	26,152	21,927	12,982	662,105
2006	514,816	31,748	113,745	22,163	23,291	14,115	719,879
2007	569,584	30,729	119,263	22,163	24,655	15,328	781,722
2008	624,353	29,710	124,780	22,163	26,019	16,540	843,565
2009	679,121	28,690	130,298	22,163	27,383	17,753	905,408
2010	733,889	27,671	135,815	22,163	28,747	18,966	967,251
2011	733,889	27,671	135,815	0	28,747	18,522	944,644
2012	733,889	27,671	135,815	0	28,747	18,522	944,644
2013	733,889	27,671	135,815	0	28,747	18,522	944,644
2014	733,889	27,671	135,815	0	28,747	18,522	944,644
2015	733,889	27,671	135,815	0	28,747	18,522	944,644
2016	733,889	27,671	135,815	0	28,747	18,522	944,644
2017	733,889	27,671	135,815	0	28,747	18,522	944,644
2018	733,889	27,671	135,815	0	28,747	18,522	944,644
2019	733,889	27,671	135,815	0	28,747	18,522	944,644
2020	733,889	27,671	135,815	0	28,747	18,522	944,644
2021	733,889	27,671	135,815	0	28,747	18,522	944,644
2022	733,889	27,671	135,815	0	28,747	18,522	944,644
2023	733,889	27,671	135,815	0	28,747	18,522	944,644
2024	733,889	27,671	135,815	0	28,747	18,522	944,644
2025	733,889	27,671	135,815	0	28,747	18,522	944,644

Note: H./Y. Connec. = House/Yard Connection
Public Founta. = Public Fountain
Non-Domest. = Non-Domestic
Techni. Servic. = Technical Service

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	132	133	134	254	390	457	508	559	611	662
Operation and Maintenance	134	135	136	279	288	364	376	388	399	411
Depreciation	0	65	130	130	130	130	130	130	130	130
Payment of Interest	0	0	0	0	0	0	0	0	0	0
Expenditure	134	200	266	409	418	494	506	518	529	541
Profit before Tax	-1	-67	-132	-155	-28	-37	2	42	81	121
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	-1	-67	-132	-155	-28	-37	2	42	81	121
Funds Statement										
Profit after Tax	-1	-67	-132	-155	-28	-37	2	42	81	121
Loans	321	2112	2112	0	0	0	0	0	0	0
Subsidies	1284	5347	5347	0	0	0	0	0	0	0
Depreciation	0	65	130	130	130	130	130	130	130	130
Sources	1603	7457	7456	-25	102	93	132	172	211	251
Capital Works	1604	6683	6683	0	0	0	0	0	0	0
Payment of Principal	0	0	0	0	0	0	0	0	0	0
Working Capital	-1	773	773	-25	102	93	132	172	211	251
Applications	1603	7457	7456	-25	102	93	132	172	211	251
Loan Liabilities	324	2460	4617	4664	4710	4757	4805	4853	4902	4951
Cash Balance	-2	771	1544	1519	1621	1714	1847	2019	2230	2481

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	720	782	844	905	967	945	945	945	945	945
Operation and Maintenance	409	423	437	452	466	370	370	370	370	370
Depreciation	130	130	153	175	175	175	175	175	175	175
Payment of Interest	4	27	49	47	44	42	40	37	35	32
Expenditure	542	580	639	673	685	587	585	583	580	578
Profit before Tax	177	202	205	232	282	357	360	362	364	367
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	177	202	205	232	282	357	360	362	364	367
Funds Statement										
Profit after Tax	177	202	205	232	282	357	360	362	364	367
Loans	0	136	677	677	0	0	0	0	0	0
Subsidies	0	542	2708	2708	0	0	0	0	0	0
Depreciation	130	130	153	175	175	175	175	175	175	175
Sources	308	1010	3743	3792	457	533	535	537	540	542
Capital Works	0	678	3385	3385	0	0	13	13	0	0
Payment of Principal	16	122	229	232	234	236	239	241	243	246
Working Capital	292	210	128	176	223	296	284	284	296	296
Applications	308	1010	3743	3792	457	533	535	537	540	542
Loan Liabilities	4980	5018	5474	5934	5716	5495	5271	5046	4818	4588
Cash Balance	2773	2982	3110	3286	3509	3805	4089	4373	4669	4966

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	945	945	945	945	945	945	945	945	945	945
Operation and Maintenance	370	370	370	370	370	370	370	370	370	370
Depreciation	175	175	175	175	175	175	175	175	175	175
Payment of Interest	30	29	34	38	35	32	28	25	21	18
Expenditure	575	574	579	584	580	577	574	570	567	563
Profit before Tax	369	370	365	361	364	368	371	374	378	381
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	369	370	365	361	364	368	371	374	378	381
Funds Statement										
Profit after Tax	369	370	365	361	364	368	371	374	378	381
Loans	0	0	0	0	0	0	0	0	0	0
Subsidies	0	0	0	0	0	0	0	0	0	0
Depreciation	175	175	175	175	175	175	175	175	175	175
Sources	545	546	541	536	540	543	546	550	553	557
Capital Works	0	0	0	0	0	0	0	0	0	0
Payment of Principal	248	258	294	331	334	338	341	345	348	351
Working Capital	296	288	247	205	205	205	205	205	205	205
Applications	545	546	541	536	540	543	546	550	553	557
Loan Liabilities	4356	4113	3826	3495	3161	2823	2482	2137	1789	1438
Cash Balance	5262	5550	5796	6002	6207	6412	6617	6822	7027	7232

Source: JICA

Chapter 5 Improvement of Health and Sanitation

5.1 Plan for Sanitary Facilities

Bati has one of the worst sanitation situation among the eleven centers. Its water supply is generally good when compared to other centers. Any plan of improving the sanitation condition in Bati should go hand in hand with better improvement of the water supply and sanitary education. From the water demand data , the waste water production in liters per capita per day was estimated to find out whether the generation of waste water justifies introducing the conventional sewerage system in Bati: This was done on the basis of types of water supply services.

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

Item	HC			YC			PF		
	1995	2005	2010	1995	2005	2010	1995	2005	2010
• Water demand (lpcd)	49	65	70	26	38	41	6	16	17
• Waste water generation rate (%)	71	75	77	65	68	69	60	63	64
• Waste water production (lpcd)	35	49	54	17	26	28	4	10	11

Form the water demand and waste water production as seen in Table 5.1.1, conventional sewerage system cannot be justified for Bati even by the year 2010. Therefore, the sanitary technologies envisaged for Bati are on-site technologies such as drainage and waste water disposal pit.

5.1.1 Plan of Toilet Facilities

The sanitary technologies envisaged for Bati 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; and 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 sanitation technology is generally the simplest and the cheapest. Those that can afford more can build 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 Bati, 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 posts of the depth leaving about 30 cm from the top for pointed lining (see drawing). 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

In order to stop the present indiscriminate dumping of refuse and to prevent both environmental pollution and water contamination, four strategic sites just outside the skirt of the town on the north, south, east and west of Bati are proposed for preparing proper refuse dumping sites.

Refuse collecting bins should be placed at strategic locations within the community so that people dump their refuse. Then refuse collecting and disposal truck or animal-drawn cart should empty the bins to transport the refuse to the prepared dumping sites. This work has to be administered by close relationship of the community, the Kebele and the Municipality. The refuse at the dumping site should be burnt close supervision of the Municipality.

(3) Drainage

The drainage problems near the Bati Mosque, near the Market, the Bus Terminal, the Kebele 2 office, etc. are the results of neglect where rubbishes have blocked the passages of water. The first action on drainage in Bati is to open-up the blocked passages and keep them always open by undertaking regular maintenance. This applies for all Bati.

The side streets and parallel streets that do not have both side and cross drainages should be provided to avoid formation of stagnant waters in the low lying areas like near the Elementary School of Bati. In some places specially in the crowded part of Bati, earth channels or ditches can be done with coordinated labor force of the community; and this effort will eliminate formation of stagnant waters and thereby reducing the health hazard of the community, in particular the children.

Drain field channels should be used when the soakaway pits fail to discharge all the sullage that come out from households.

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 Bati are too low to justify the installation of conventional sewerage system in Bati. On account of this, the sanitary facilities proposed for Bati are on-site sanitary technologies.
- Those households that do not have any toilet facilities in Bati 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 Bati 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 Bati.
- 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 Bati 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 Bati for Target Years of 2005 & 2010 by Type of Water Services

Target Year	Households		
	HC	YC	PF
• 2005	490	1,570	1,250
• 2010	940	1,770	720

5.2.2 Estimate of Costs

(1) Capital Costs per Unit

For each type of toilet facility that is considered appropriate for Bati 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 Bati by the Year 2005 and 2010

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

- By the year 2005

  - All schools in Bati will have, at least, VIP collective toilets.
  - The Bati Hospital toilet facilities will be rehabilitated; and the clinic and possibly a health center will have VIP collective toilets.
  - Bati 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 Bati 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 Bati 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	4	65,000	260
• VIP public toilet for market area and bus terminal	4	95,000	380
• 100% households with HC to have PF toilets	490	7,500	3,675*
• 75% households with YC to have VIP shared toilets or higher	1,178	15,000	17,670*
• 75% households with PF to have VIP toilets	938	2,000	1,876*
• Vacuum truck	1	250,000	250
• Refuse disposal truck	1	180,000	180
• Sludge dumping site	2	10,000	20
• Refuse disposing site	4	6,500	26
• Refuse collecting bins	80	250	20
Total			24,877
Excluding Households' (*)			1,656

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

Facilities	No	Unit Cost (birr)	Total Cost (1,000 Birr)
• 50% of households with HC to have flush toilets	470	7,500	3,525*
• 50% of households with YC to have VIP toilets or higher	885	3,000	2,655*
• 100% households with PF to have VIP toilets	720	2,000	1,440*
• Replacement of vacuum truck	1	250,000	250
• Replacement of refuse disposal truck	1	180,000	180
• Replacement of refuse collecting bin	80	250	20
Total			8,070
Excluding Households' (*)			450

(5) Total Operating and Maintenance Cost

Indicative operating and maintenance cost for sanitary facilities for Bati 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	4	800	3.20
• VIP public toilet for market area and bus terminal	4	3,000	12.00
• Flush toilets for households with HC	490	1,250	612.50*
• VIP shared toilet for households with YC	1,178	400	471.20*
• VIP toilets for households using PF	938	300	281.40*
• 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	4	2,500	10.00
• Refuse collecting bins	80	50	4.00
Total			1,420.70
Excluding Households' (*)			55.60

Table 5.2.7 Annual Operating & Maintenance Costs by the Year 2010

Facilities	No	Unit Cost (birr)	Total Cost (1,000 Birr)
• 50% of households with HC to have flush toilets	470	1,250	587.50*
• 50% of Bati households with YC to have VIP toilets or higher	885	1,000	885.00*
• 100% of households with PF to have VIP toilets	720	300	216.00*
• Replacement of vacuum truck	1	7,500	7.50
• Replacement of refuse disposal truck	1	8,500	8.50
• Replacement of refuse collecting bins	80	50	4.00
Total			1,708.50
Excluding Households' (*)			20.00

(6) Summary of Costs

- Capital Costs

Year	Cost in 1,000 Birr (Total)	Excluding Households'
2005	24,877	1,656
2010	8,070	450
Total	32,947	2,106

- Annual Operating & Maintenance Costs

Year	Cost in 1,000 Birr (Total)	Excluding Households'
2005	1,420.70	55.60
2010	1,708.50	20.00
Total	3,129.20	75.60

5.3 Application of Sanitary Education Program

In line with the approach detailed in the Main Report the following specific suggestions are made for sanitary education in Bati as a result of the findings of the field survey data collected there:

Despite the high level of sanitary behaviors and reasonable level of health awareness, the impression was that sanitary education in Bati would not be well received. An additional element to be involved in the sanitary education approach might be using the Eder system in coordination with the Koran teachers at the Koran school. This would help the sanitary education program to tap into the established and respected communication channels in Bati society. However, Christians and poor people must not be omitted. Special attention to their involvement must be made.

Table 5.3.1 Sanitary Education Priorities in Bati

Priority level	Type of Behavior	Blocks to Improved Practice
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 simple sanitary disposal techniques, inc veg gardens (CPP/all)
Medium -Low	Handwashing with soap or ash 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 providing information about handwashing with soap/ash and improving the status of the improved behavior (all)
Medium -Low	Handwashing with soap or ash after handling children's stools	Personal hygiene (women/boys/girls roles) made easier by improving access to water and soap/ ash nearer to latrine (women). Provide information about health risks of children's stools and improving the status of such behavior (all)
Medium -Low	Solid waste disposal in covered pits or burned	Sites not allocated for public waste disposal or not managed strictly (Municipality/ Woreda) Individuals (women) must be informed of where (Municipality/ Woreda) and how to dispose of waste (CPP/ all)
Medium -Low	Latrine coverage for all households	Latrines to be built and maintained, including a solution to the filled latrine issue (Public - Municipality/Woreda and Community/private latrines -WSS/CPP/All (made easier with examples of low cost latrines and loans (WSS)
Medium -Low	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 -Low	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))

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 400 m^3/day in 1995 to 556 m^3/day in 2000, 864 m^3/day in 2005 and 1,247 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 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 the above factors, it is proposed that the number of employees will increase from 25 in 1995 to 33 in 2000, 35 in 2005 and 41 in 2010.

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 31, 32 and 37 in 2000, 2005 and 2010 respectively.

Personnel for Administration, Financial and Technical Services will be basically distributed in such a way that their respective shares will be 30%, 35% and 35%.

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

Item	1995	2000	2005	2010
1. Total Production of Water (m^3/day)	400	556	864	1,247
2. Water Production per Worker (m^3/day/worker)	16.0	20	30	40
3. Coefficient	1	1	1.1	1.2
4. No. of Personnel	25	28	32	37
5. Additional Personnel for Sanitation	0	2	3	4
6. Final No. of Personnel	25	30	35	41

2. Breakdown of Personnel by Position/Function

Positions/Functions	1995	2000	2005	2010
1. Manager	1	1	1	1
2. Customer Services	1	1	1	1
3. Internal Audit	0	0	0	1
4. Administration Service				
1) Head	1	1	1	1
2) General Administration Section				
Secretaries/Typists/Clerks	1	1	1	1
Guards	6	6	6	6
Sweepers/Janitors	0	0	0	0
Drivers	0	0	0	1
Sub-Total	7	7	7	8
3) Personnel Section				
Recruitment and Assignment	0	0	0	1
Training	0	0	0	0
Remuneration	0	0	0	0
Sub-Total	0	0	0	1
4) Storage Section				
Store Keepers	1	1	1	1
Purchase of Materials/Supplies	0	0	0	0
Sub-Total	1	1	1	1
5) Legal Section	0	0	0	0
Total	9	9	9	11

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

Positions/Functions	1995	2000	2005	2010
5. Financial Service				
1) Head	0	0	0	1
2) Budgeting Section	0	0	0	1
3) Accounting Section				
Accountants	0	0	0	1
Cashiers/Treasurers	1	1	1	1
Sub-Total	1	1	1	2
4) Financial Management Section				
Financial Analysts	0	0	0	1
5) Operation Section				
Meter Readers	1	1	1	1
Bill Distributors/Collectors	1	1	1	1
Water Sellers	6	6	7	4
Sub-Total	8	8	9	6
Total	9	9	10	11
6. Technical Service				
1) Head	1	1	1	1
2) Technical Records Section	0	0	1	1
3) Operation and Maintenance Section				
Mechanics	0	0	1	1
Electricians	0	1	1	1
Motor Operators	1	4	4	4
Plumbers	3	1	2	2
Sub-Total	4	6	8	8
4) Inspection Section				
Water Meter Technicians	0	1	1	1
Leakage Detectors	0	0	0	0
Water Quality Analysts	0	0	0	1
Sub-Total	0	1	1	2
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	5	8	11	12
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	0	1
Sub-Total	0	0	1	2
Total	0	2	3	4
Grand-Total	25	30	35	41

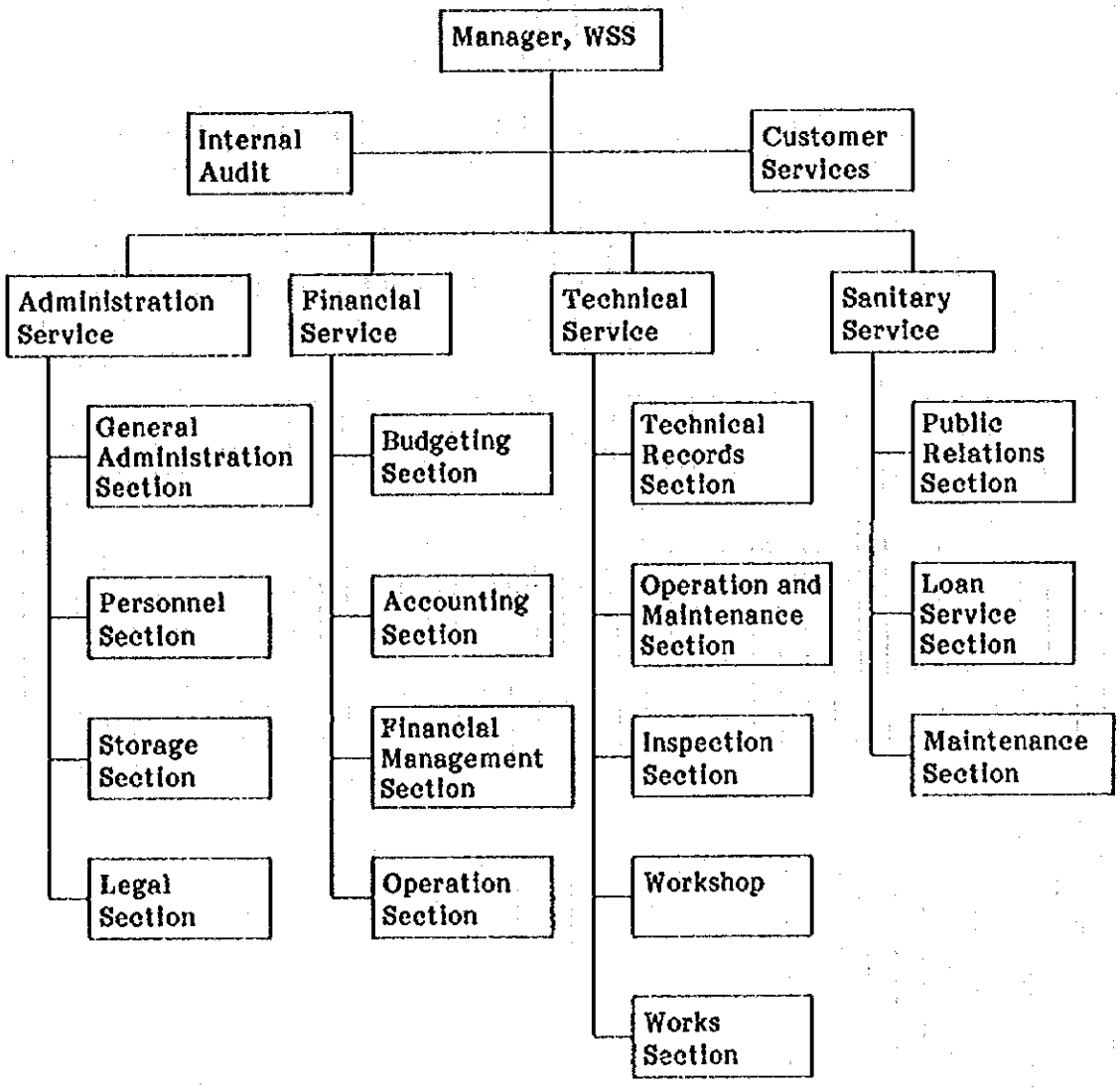


Figure 6.1.1 Proposed Model Organization Set-up of WSS

6.4 Community Building / Participation and WID

Corresponding with the approach outlined in the Main Report the following suggestions have been made specifically for Bati as a result of the findings of the field survey data collected there:

- Bati was not in urgent need of a major water intervention. Some additional PFs and improvements to water system management would be sufficient improvement and would provide a minimal amount of extra time for women and girls from middle income and poor households.

- Only one group of users (Kersa village) were prepared to consider community management of these facilities (at the time of the Study). Public fountains would have to remain WSS managed. Unfortunately this reduces the possibility of building up the development capacity of the society, at least in the short term.

- Sanitation was an urgent perceived need in the town. The majority of the population were ready to participate in the management of community latrines and showers. This gives opportunities for community development work. Before a sanitation program can be initiated, the existing problem with full latrines and lack of reliable pit emptying system must be adequately addressed.

- Health education is the major area where community building and WID can be addressed in Bati. However, it may meet with initial resistance.

- All institutions, like the High school, Health Center and religious institutions have offered their assistance. The work of the CPP with the experimental toilet target community in Bati showed that an intensive quantity of motivational work can get people participating in activities around hygiene and sanitation.

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	30	3.0	1.3
Springs/rivers	90	0.9	1.4

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 1% 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
306	6.2	16	0.1028

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 4,089 thousand birr and 2,440 thousand birr respectively. It means benefits are 60% 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 equal to 60% of the cumulative personnel cost of WSS at 0 opportunity cost.

It is to be noted that time benefit resulting from project implementation is substantial, coming to more than half the personnel cost of WSS so far as Bati is concerned.

Table 7.1.1 Saved Time and Benefit

Year	Saved Time (hours)	Benefit (birr)
1996	0	0
1997	0	0
1998	0	0
1999	102,504	10,540
2000	188,102	19,341
2001	283,672	29,168
2002	380,877	39,163
2003	479,766	49,331
2004	580,394	59,678
2005	682,778	70,205
2006	762,239	78,375
2007	843,001	86,680
2008	925,095	95,121
2009	1,008,557	103,702
2010	1,093,421	112,428
2011	1,093,421	112,428
2012	1,093,421	112,428
2013	1,093,421	112,428
2014	1,093,421	112,428
2015	1,093,421	112,428
2016	1,093,421	112,428
2017	1,093,421	112,428
2018	1,093,421	112,428
2019	1,093,421	112,428
2020	1,093,421	112,428
2021	1,093,421	112,428
2022	1,093,421	112,428
2023	1,093,421	112,428
2024	1,093,421	112,428
2025	1,093,421	112,428

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	104	104	11	-93
5	2000	0	109	109	19	-90
6	2001	0	114	114	29	-85
7	2002	0	119	119	39	-80
8	2003	0	124	124	49	-75
9	2004	0	130	130	60	-70
10	2005	0	135	135	70	-64
11	2006	0	141	141	78	-63
12	2007	0	147	147	87	-60
13	2008	0	153	153	95	-58
14	2009	0	160	160	104	-56
15	2010	0	166	166	112	-53
16	2011	0	166	166	112	-53
17	2012	0	166	166	112	-53
18	2013	0	166	166	112	-53
19	2014	0	166	166	112	-53
20	2015	0	166	166	112	-53
21	2016	0	166	166	112	-53
22	2017	0	166	166	112	-53
23	2018	0	166	166	112	-53
24	2019	0	166	166	112	-53
25	2020	0	166	166	112	-53
26	2021	0	166	166	112	-53
27	2022	0	166	166	112	-53
28	2023	0	166	166	112	-53
29	2024	0	166	166	112	-53
30	2025	0	166	166	112	-53

7.2 Financial Evaluation

7.2.1 Calculation of FIRR

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

It was assumed initially that the central government would provide subsidy to the Bati 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 4.6%.

The value is judged to be sufficiently and reasonably high in consideration of the nature and objective of the Project.

Therefore, the above subsidy ratio was finally adopted.

Cost benefit streams under the above-mentioned subsidy conditions are shown in Table 7.2.1.

The FIRR value of 4.6% exceeds 1%, which is the assumed interest rate of external loan by 3.1%.

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: 3.0%	-1.6%
2. Case 2	Initial Cost	: +10%	FIRR: 3.9%	-0.7%
3. Case 3	Progress of Construction	: 1997=70% 1998=30%	FIRR: 4.9%	+0.3%
4. Case 4	Progress of Construction	: 1998=70% 1999=30%	FIRR: 3.8%	-0.8%

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, than, 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	321	134	454	132	-322
2	1997	2112	135	2247	133	-2113
3	1998	2112	136	2248	134	-2114
4	1999	0	279	279	254	-25
5	2000	0	288	288	390	102
6	2001	0	364	364	457	93
7	2002	0	376	376	508	132
8	2003	0	388	388	559	172
9	2004	0	399	399	611	211
10	2005	0	411	411	662	251
11	2006	0	409	409	720	311
12	2007	136	423	559	782	223
13	2008	677	437	1114	844	-271
14	2009	677	452	1129	905	-223
15	2010	0	466	466	967	501
16	2011	0	370	370	945	574
17	2012	13	370	383	945	562
18	2013	13	370	383	945	562
19	2014	0	370	370	945	574
20	2015	0	370	370	945	574
21	2016	0	370	370	945	574
22	2017	0	370	370	945	574
23	2018	0	370	370	945	574
24	2019	0	370	370	945	574
25	2020	0	370	370	945	574
26	2021	0	370	370	945	574
27	2022	0	370	370	945	574
28	2023	0	370	370	945	574
29	2024	0	370	370	945	574
30	2025	0	370	370	945	574