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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
CHAGNI

(Volume II-VIII)

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 Feasibiliy Study Report for Chagni 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.

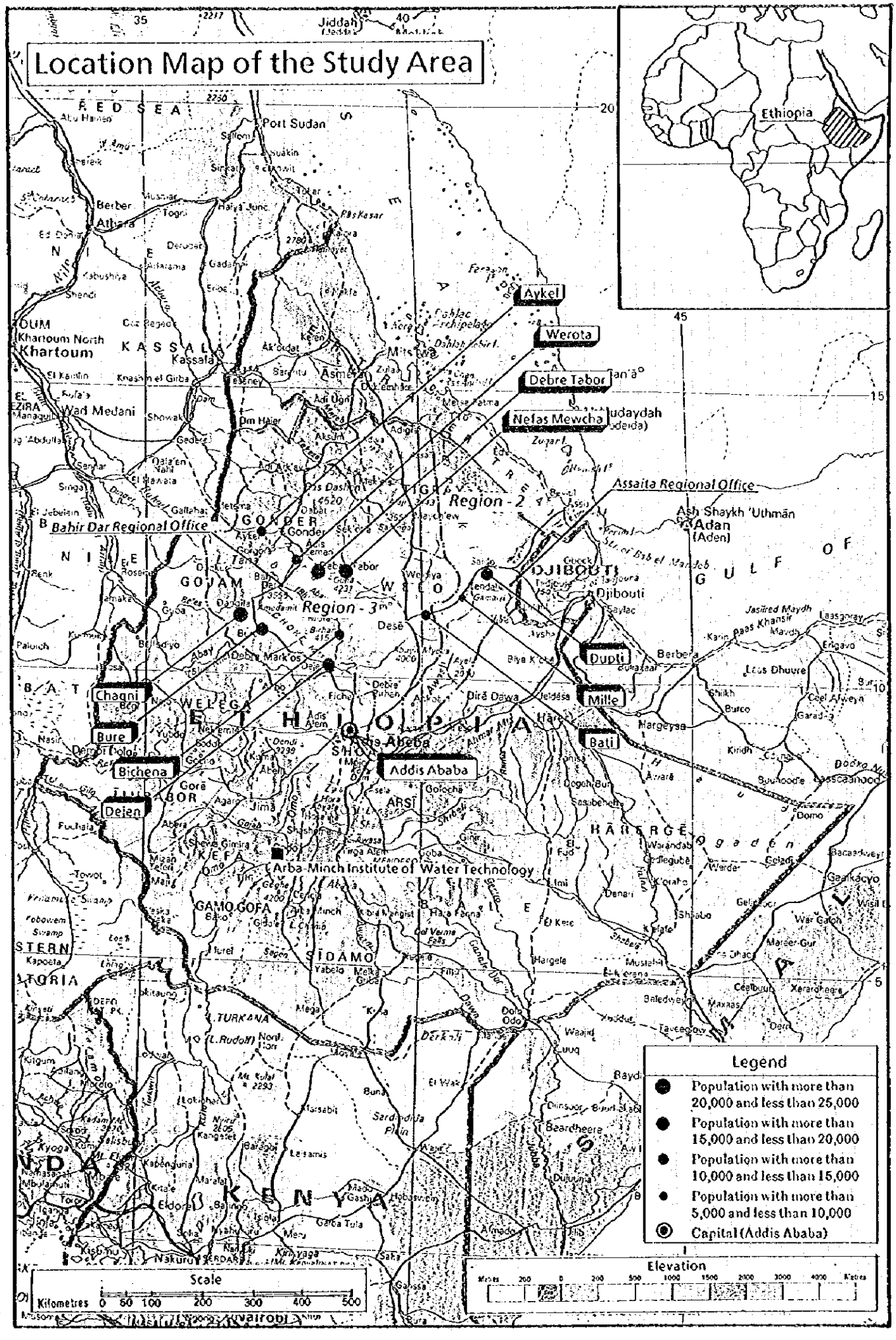
The major objectives of this Study are 1) to conduct a feasibility study on the water supply system in order to improve living condition of the population in the Study area by enhancing the level of the water supply services in terms of water quantity, water quality and its accessibility, 2) to formulate 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
Dupti
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 and 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 Kilotres

General Description of Current Condition in Chagni

Items	Description
Administration	Amhara Region, Agewaw, No. of Kebele : 2
Residents	Total population : 26,823 (2.7 persons/ha) Average family size : 6.1 persons Amhara : 74% Christians : 44% (1 church) Agew : 9% Moslems : 56% (3 mosques) Shinasha : 4%
Educational Conditions	Kinder garden: No. of school 2, No. of teachers 4, No. of students 184 Elementary school: No. of school 2, No. of teachers 72, No. of students 2570 Junior high s.: No. of school 1, No. of teachers 28, No. of students 1240 Senior high s.: No. of school 1, No. of teachers 35, No. of students 1231
Medical Conditions	Hospital : - Health center : 1 Health clinic : - Doctor : - Nurse : 7
Economic Conditions	Hotels/restaurants : 91 Shops : 401 Cottage industry : 42 Others : 12 Average monthly household income : 203 birr
Water Supply Condition	The source of WSS : Borehole (1) Major other sources : Spring & Hand dug well Domestic consumption : 152.7 cum/day (12.3 lpcd) Other consumption : 35.6 cum/day (total 188.3) Water service coverage : 46% House connection : 63.8 lpcd (1%, 1.0 birr/cum) Yard connection : 32.4 lpcd (8%, 1.0 birr/cum) Neighbors : 7.4 lpcd (18%, 1.0(3.8) birr/cum) Public fountain : 4.9 lpcd (18%, 1.0(3.7) birr/cum)
Sanitary Condition	Septic toilet : 1/100HH Dry pit toilet : 56/100HH Community toilet : 1/100HH Open field : 42/100HH Toilet condition : Ill-maintained and constructed. 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 : 75% Diarrhea awareness : 25% ORS awareness : 20% Sanitary behaviors score : 776/1600 (49%) Needs : Adequate Water, Electricity
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 Chagni

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 26,823 (6.0%) 35,895 (5.0%) 45,812 (4.0%) 55,737
Water Demand Projected in cum/day	in 1995* 2000 2005 2010 Domestic : 153 533 900 1,466 Non Domestic : 36 112 154 205 Losses : 102 72 144 295 Total : 291 716 1,198 1,966
Dimensions of Water Supply System	Target Service Coverage: 75% (46% at present) Target Year of 2005 Deep Wells : 5 (406m) Rising Main : ϕ200(1.68km), ϕ150(3.61km), ϕ100(2.39km), ϕ75(0.46km) Booster of Rising : ϕ150mm, Q=1.0m^3/min, H=70m Reservoir : 330m^3(165×2) Distribution : ϕ250(760m), ϕ150(3,785m), ϕ75(7,230m), ϕ50(7,670m) Booster of Dist'n : ϕ200mm, Q=1.6m^3/min, H=9m Target Year of 2010 Deep Wells : 3 (245m) Rising Main : ϕ100(2.79km), ϕ75(0.20km)
Water Tariff Structure & Accounting System	Introduction of Progressive Water Tariff** HC: 2.93 birr/m^3, YC: 2.14 birr/m^3, PF: 1.33 birr/m^3 Introduction of Double Accounting System
Plan of Sanitary Facilities Improvement	Construction of 3 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 44 in 2005 and 54 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 Progcam
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 Chagni, water service coverage is 46 % only, and the water consumption per capita per day is extremely low with the amount of 12.3 lpcd in average. Although water quality of the source 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 suggests that contamination is expected in such way through cross-connection, leaking and back-siphoning associated with aged facilities.

Although toilet coverage is 58 %, which is relatively high, 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). Chagni is the one, located in Amhara Region, among the Eleven Centers along with Dupti, Mille, Bati, Nefas Mewcha, Aykel, Werota, Debre Tabor, 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. Chagni was selected for the detailed survey during Phase II. 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 18 points at each center had been prospected with a maximum depth of 150 meters.

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

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

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

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

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

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

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

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

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

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

Chapter 2 Natural Condition

2.1 Meteorology and Hydrology

Chagni is located in the middle stream of Ardi river and Dura river in the west Gojam. These rivers have large watershed areas such that the Ardi has 219 km^2 at Chagni. The mountains are mostly consisted of basalts and some of them are shaped like intrusive rocky mountains. The rivers are turning through these mountains.

There was a meteorological station in the town but abandoned years ago. The river gauging stations of the Ardi and the Dura exist in and around the town. See Figure 2.1.1 for the locations and the watersheds around Chagni.

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

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

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P(mm)	5.4	6.5	17.2	24.8	160.5	273.8	353.2	362.8	284.8	168.1	26.2	4.3	1,687.6
ETo(mm)	112	111	110	111	111	113	114	117	116	116	1116	114	1,361
A.Temp.(°C)	19.3	20.5	22.2	22.6	21.9	19.7	19.1	19.	19.3	19.7	19.1	18.6	20.1

The monthly precipitation shows one pronounced rainy season peaked in August. It ranges from 4.3 mm in December to 362.8 mm in August. The monthly potential evapotranspiration does not vary much throughout year ranging from 110 m in March to 117 mm in August. The monthly air temperature reflects its warm climate. It ranges from 18.6°C in December to 22.6°C in April.

The proposed sites for new wells are mostly located in the watershed area of Ardi river, upstream of the gauging station. In order to asses the ground water recharge of the watershed area of River Ardi, the water balance sheet is prepared as shown in Table 2.1.2 assuming the runoff to be 40% of the precipitation and the reference crop evapotranspiration to be 70% of the potential evapotranspiration. The precipitation data is prepared from the nine (9) year records between 1977 and 1989. The potential evapotranspiration is assumed to be same as the long term mean values.

Table 2.1.2 Water Balance Sheet of the Ground Water Recharge, Ardi River at Chagni

Unit : mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	2.7	2.6	16.7	44.4	217.4	255.3	380.0	385.2	263.9	158.9	18.0	10.4	1,755.6
Q	9.3	5.2	4.0	3.3	11.8	83.4	245.0	335.0	289.0	146.3	43.3	16.9	1,192.5
P-Q	*	*	12.7	41.1	205.6	171.9	135.0	50.2	*	12.6	*	*	—
ETo	112	111	110	111	111	113	114	117	116	116	116	114	1,361
ETvrop	97.3	100.1	98.7	36.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	—	—	12.7	41.1	94.5	95.2	94.5	50.2	—	12.6	—	—	—
ΔS	—	—	0	0	111.1	76.7	40.5	0	—	0	—	—	228.3

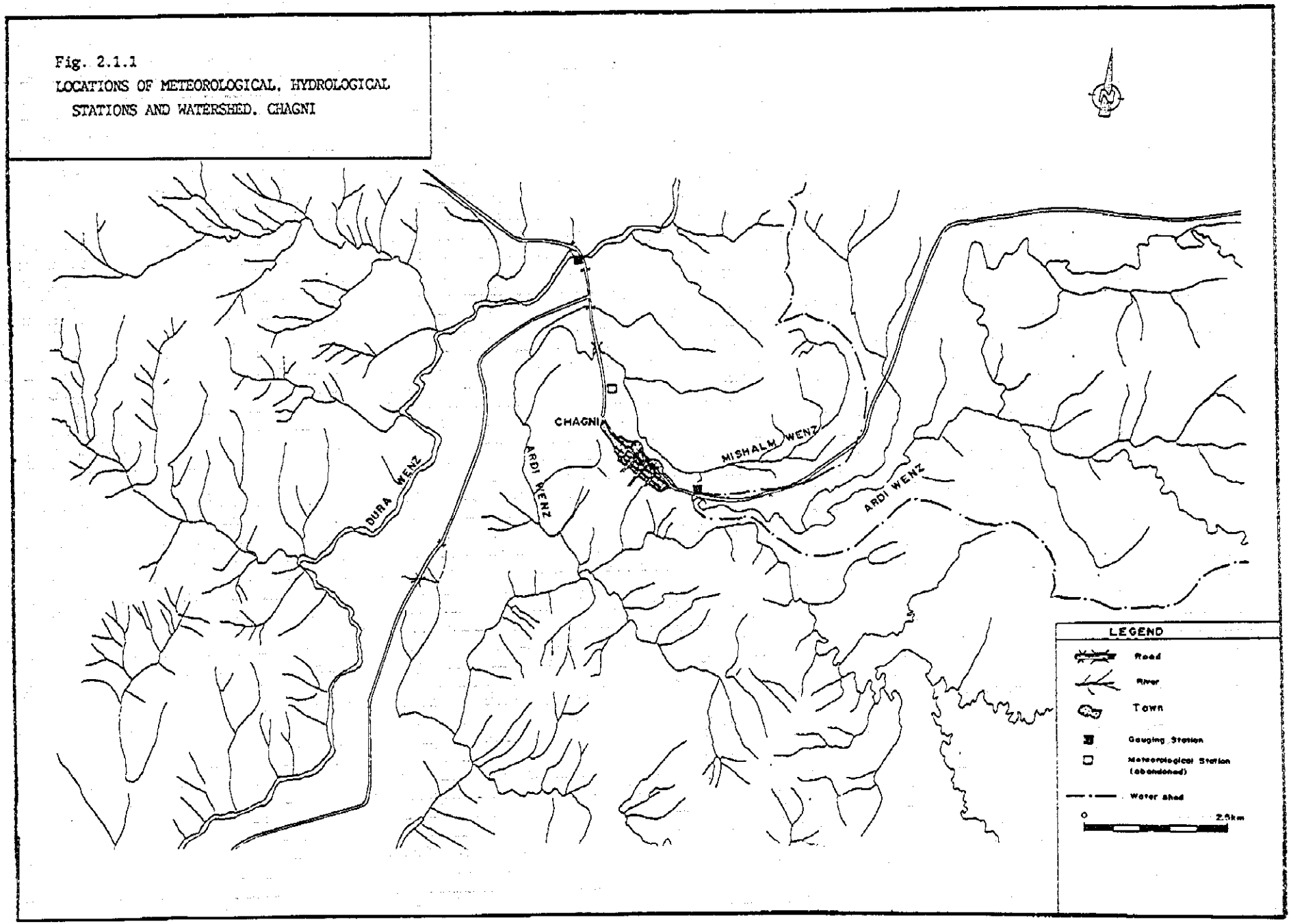
Note: P = Precipitation
Q = Runoff
ETo = Potential Evapotranspiration
ETcrop = Crop Evapotranspiration
ETa = Actual Evapotranspiration
ΔS = Recharge
* = Distorted Data
— = not calculated due to distorted data

With reference to the sheet, the monthly runoff exceeds the monthly precipitation with some months which means the monthly precipitation does not represent the area precipitation of the large watershed area. According to the sheet, the recharge takes place in May, June and July, which amounts to 228.3 mm in an average year. The recharge will be more than this value if the precipitation in the mountains is correctly counted. The quantity of recharge is calculated with this value for the watershed area:

$$0.2283 \times 219 \times 10^6 = 50.0 \times 10^6 \text{ m}^3/\text{year}$$

This is equivalent to 137.0×10^3 m^3/day.

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



2.2 Hydrogeology

2.2.1 Geology

Chagni area is situated on the transitional zone between the western highland and the western lowland. High rock peaks consisting of basalt overlie on the scattered area. Rivers flow down winding in the lowland space. The Ardi River flows surrounding the town as taking a roundabout way and drains out to westward. The rocks which predominate this area is alkali-olivine basalt which belong to Ashangi Group of Paleocene-Miocene. This rock is exposed within stream valley and on the top of the hill. It is highly weathered and friable on the top of the hill and along valley sides. At the south of the town, vesicular basalt is underlain by porphyritic basalt and vesicles are filled with secondary minerals.

Alluvial deposit, which is composed of gravels, sand and fine particles, covers the valley floor.

2.2.2 Hydrogeology

(1) Groundwater

In the area covered by volcanic rocks, ground water is usually stored in fissured or fractured cracks by faulting. The groundwater potential around Chagni area is also controlled by the amount of fracture and the interconnection between the fracture and weathering of basalt. If the weathering and fracturing extend to deeper positions, boreholes with good yield will be expected.

Four (4) boreholes were drilled for town water supply but only one borehole is productive now. Borehole No.1, which is located about 3 km east of the town, was drilled in 1982. According to verbal information, this borehole has good yield (about 5 l/s) but it was plugged with stones by inhabitants. Borehole No.2, which was drilled to 76 m depth in 1982 after No.1 and is operational now, is located about 2km east of the town. Its yield is 5 l/s (taken from "REPOT ON PUMPING TEST OF CHANGE BORE NO.1 (16-18 Jan.1984)" by EWWCA, but it is described as 4.2 l/s according to "PRE-FEASIBILITY STUDY REPORT of 21 TOWNS WATER SUPPLY AND SANITATION PROJECT"). Borehole No.3 was drilled at the right bank of Mishala River but this borehole was dry. Borehole No.4 was drilled at the north direction of the town, on the opposite side of the Ardi River, but this hole was abandoned due to low yield (about 1.5 l/s).

Based on the geomorphology of the area, interpretation of aerial photo and drilling data, the area from 2 to 5 km east and southeast near the junction of the Chewatam River Basin, the Ardi River Basin and the Donder River is assessed for potential sites for ground water development.

(2) Other Water Sources

In this area, surface water is rich as two major perennial rivers, the Dura and the Ardi, drain out from north or east to southwest. Considering the encouragement of ground water potential and the treatment cost of surface water, surface water is not economical.

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

Three (3) samples had been undertaken for the chemical test. Among those, one (1) sample was collected from the source Borehole No.1, and the second one (1) was from Bata Spring, located about 500m south-east away from the south-east edge of the town, and the last from a hand dug well placed south-east area of the town. All the analyzed chemical constituents are acceptable according to the guideline, except color and turbidity detected in the sample of the hand dug well.

3.1.2 Bacteriological Aspects

Twenty eight (28) samples were undertaken for the coliform test, those of which were from the Borehole No.1, its outlets, household containers, hand dug wells and springs. Samples from hand dug wells and springs showed much contamination in most cases as expected.

The water sampled at Borehole No.1 shows free from faecal coliform, however some public fountains, private connections show several number of faecal coliforms. With the water stored in household container like clay pot showed much contamination in almost cases with too-many-to-count faecal coliforms.

The result indicates that the contamination of the potable water from the source takes place through poor sanitary condition or presence of leakage of the distribution scheme and improper handling of the household containers used for storing water.

3.2 Current Water Consumption and Demand

3.2.1 Water Consumption and Production

The data of the production and the billed consumption for past 2 years were given by the staff and summarized in Table 3.2.1. According to the consumption data, the monthly consumption rate decreases in rainy season. The total consumption and production for past two years are given blow.

Production	158,343 m^3
Consumption	102,867 m^3
Losses	about 35 %

3.2.2 Water Users

According to the water consumption census conducted the Team, the total population served by the water supply is approximately 12,400. which accounted for 46% of the total population. Domestic, institutional, commercial and institutional consumptions are estimated being based on the consumption records of May, 1995 and the census data. Domestic consumption is subdivided into house connection and yard connection, public fountains and those who buy and borrow water from neighbors (vendors), considering mode of services. 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	2,523	12,375	(100)	152.7	(12.3)	329.3	(26.6)
House Connection	31	330	(2.7)	21.1	(63.8)	21.1	(63.8)
Yard Connection	292	2,181	(17.6)	70.6	(32.4)	70.6	(32.4)
Public Fountain	1,036	4,959	(40.6)	24.5	(4.9)	115.0	(23.2)
Neighbors	1,164	4,905	(39.6)	36.5	(7.4)	122.6	(25.0)
Institutional	25			20.9			
Commercial	513			11.2			
Industrial	20			3.5			
Total	3,081			188.3			

There are 33 customers with house connection. The largest consumer is an institute named Chagni Cattle Breeding and Improvement which consumes 10.9 m^3/day. They have 11 residential houses in the compound, where 27 households resides. Due to shortage of housing, they are building houses. There are 20 houses engaged in businesses which are five (5) hotels lodgings 7, nine (9) coffee bars and others.

The domestic lpcd of the house connection customers is calculated at 63.8 from the census data, which is ranked in the high lpcd group in the 11 centers. The domestic consumption is accordingly estimated at 21.1 m^3/day from this lpcd and the population served counted at 330.

The institutional consumption which is composed of the consumption of Chagni cattle Breeding and Improvement and WSS, is calculated at 2.0 m^3/day, excluding the domestic consumption of the residents. The commercial consumption is calculated at 1.0 m^3/day, excluding the domestic consumption of the residents. This is under estimated because of the high domestic lpcd calculated as the overage of the house connection customers.

The industrial consumption is estimated at 0.5 m^3/day, which is mostly consumed by the building of houses in Chagni cattle breading and Improvement.

There are 309 customers with yard connections. Most of them are private customers and many use water for their businesses as well as domestic purposes. The domestic lpcd of yard connection is calculated at 32.4 from the census data, which is ranked in the high lpcd group in the 11 centers. From this lpcd figure and the population served counted at 2,181,

the domestic consumption is calculated at 70.6 m^3/day. There are 20 institutional customers including four (4) schools and their consumption is estimated at 18.9 m^3/day, excluding the domestic consumption of the residents.

There are 72 commercial consumption is estimated at 5.4 m^3/day, excluding the domestic consumption of the residents. There are two (2) industrial customers , one is a house under building and the other is a mild jam producer. Their consumption is 0.8 m^3/day.

Public fountain users are accounted for 40% of the total population served. There are 268 households engaged in small businesses such as breweries (Tela, Tej, Hraki houses), tea rooms, shops, etc.. Since the lpcd of PF users is as little as 4.9, it is considered that their consumption for businesses is negligible. There is no institutional users among the PF users.
Those who borrow and buy water from neighbors (vendors) are counted at 1,164 households and 3 institutions. Their population is 40% of the total population which is as large as PF users. The domestic lpcd of those who borrow and buy water is calculated at 7.4 from the census data. The domestic consumption is according calculated at 36.5 m^3/day with the lpcd and the population served counted 4,905. There are three (3) institutions i.e. the army camp , the post office and a mosque. Their consumption is as little as 0.3 m^3/day. There are 169 households engaged in small businesses such as breweries (Tela, Tej, Araki), shops tea rooms, grain stores, grain mills, etc.. Their commercial and industrial consumption are estimated at 4.8 m^3/day and 2.2 m^3/day respectively.

3.2.3 Current Water Demand

The water required by the users of different mode of services for different domestic purposes was surveyed in this study. In the study, five (5) major categories of the users are identified including Traditional Source Users (TSU). Six (6) sample households of each category are selected from those which do not give or sell water to neighbors and do not engage any businesses either. Most of the samples are in the market area located in Kebele 02 where piped water is relatively sufficient. For the samples of TSU, the area opposite side of Ardi river is selected where there are hand dug wells.

As a result, TSU needs 22 lpcd as the minimum and house connection users need 30 lpcd as the maximum. The very large difference between the domestic consumption and the domestic demand with house connection users may be caused of their consumption other than those domestic purposes.

Table 3.2.1 Water Production and Consumption in Chagni

Consumption (m3)

	IC	PF2	PF3	PF4	PF5	PF6	PF7	PF8	PF9	PF10	PF12	PF14	Sub Total	Grand Total
Jul-93	2,763	80	25	58	14	104	107	40	65	50	60	17	620	3,383
Aug-93	2,830	106	50	46	50	140	170	60	80	52	115	40	909	3,739
Sep-93	3,239	99	50	28	37	100	146	67	110	26	104	24	791	4,030
Oct-93	2,922	101	54	31	27	130	133	47	97	63	113	26	822	3,744
Nov-93	2,953	109	34	19	30	147	122	56	101	80	128	41	867	3,820
Dec-93	2,088	54	15	30	20	77	65	30	55	34	71	21	472	2,560
Jan-94	5,347	132	28	41	31	175	106	65	123	87	160	46	994	6,341
Feb-94	4,172	105	44	34	36	144	83	66	94	88	147	29	870	5,042
Mar-94	2,591	68	38	94	21	88	63	44	63	56	90	23	648	3,239
Apr-94	6,086	176	80	45	53	229	174	110	169	126	225	69	1,456	7,542
May-94	3,375	106	43	27	27	127	119	64	94	69	121	49	846	4,221
Jun-94	2,224	94	20	34	27	73	72	83	52	35	101	50	641	2,865
Jul-94	4,203	127	55	35	34	187	48	63	126	92	124	71	962	5,165
Aug-94	2,764	126	47	28	36	146	144	65	101	80	125	61	959	3,723
Sep-94	2,313	102	36	40	31	125	115	47	96	68	101	54	815	3,128
Oct-94	4,554	117	46	42	34	133	127	54	109	77	127	52	918	5,472
Nov-94	3,070	115	49	52	32	123	132	51	111	76	124	56	921	3,991
Dec-94	3,378	107	46	52	27	145	127	57	112	81	128	50	932	4,310
Jan-95	4,078	112	57	44	32	157	121	56	127	97	140	48	991	5,069
Feb-95	4,589	107	62	45	27	174	142	65	138	83	154	40	1,037	5,625
Mar-95	4,426	93	60	50	21	164	121	62	149	91	148	44	1,003	5,429
Apr-95	4,906	66	53	37	21	141	110	65	129	77	142	22	863	5,769
May-95	3,901	68	32	35	22	115	97	68	113	66	111	31	758	4,659
Total	82,772												20,095	102,867
Average														4,472
Maximum														7,542

Production (m3)

Well No.1
5,549
6,048
5,982
5,392
5,858
6,363
9,225
7,500
7,813
8,062
6,752
5,923
6,150
6,789
5,928
6,113
6,177
6,803
7,961
8,585
8,147
8,214
7,009
158,343
6,884

Unaccounted Losses

(m3)	(%)
2,166	39
2,309	38
1,952	32
1,648	30
2,038	34
3,803	59
2,884	31
2,459	32
4,574	58
520	6
2,531	37
3,058	51
985	16
3,066	45
2,800	47
641	10
2,186	35
2,493	36
2,892	36
2,959	34
2,718	33
2,445	29
2,350	33
55,476	35

* Recorded in Ethiopian Calendar

IC: Individual Connection

PF: Public Fountain

3.3 Water Supply Facilities Condition

3.3.1 General

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

Water source in this town is groundwater, and water supply is served by the piped water system. Water supply system is now operated by on-site generator. Existing water supply system consists of one borehole, one transmission pipeline and distribution facilities as shown in Figure 3.3.1.

3.3.2 Water Source

The existing submersible pump is driven by the on-site generator. There are three generators in the generator house. Out of these generators, two generators are operated by turns. Both of the generators are of Italian-made with capacities of 20KVA and 30KVA.

The existing borehole is equipped with a pressure gauge, check valve, and flow meter, and the pumping rate was quantified at about 4.7 l/s.

No information on the existing submersible pump is available, because the pump investigation was not carried out due to the difficulty of taking out the pump from the borehole.

3.3.3 Transmission and Distribution Facilities

Water is pumped from the borehole to the reservoir but supplied to the town from the borehole directly. The existing reservoir is made of masonry and cylinder type with a capacity of 70m3. No measurement appurtenance was provided.

The existing distribution network is the branched system with galvanized steel pipes. The diameters range from DN 25 to DN 100. The lengths of pipelines are summarized as follows:

Table 3.3.1 Existing Pipeline Data

Diameter (mm)	Length (m)	Material
25	770	G.S.
40	2530	-do-
50	3360	-do-
65	780	-do-
80	780	-do-
100	1750	-do-

3.3.4 Service Level

Water service level is divided into two modes: individual connection and public fountain. There are 332 individual connections, and it is subdivided into 3 categories: private (249), commercial (46), and public institution (37). Governmental institution is included in public institution. Individual connection is about 80% of the total consumption, and public fountain about 20%.

It is reported that about 10 customers could make house connection annually. The current number of customers requesting for house connection is not available.

There are 14 public fountains, and 11 operational public fountains. The design of existing fountain was cylinder type, and 4 faucets per public fountain were provided.

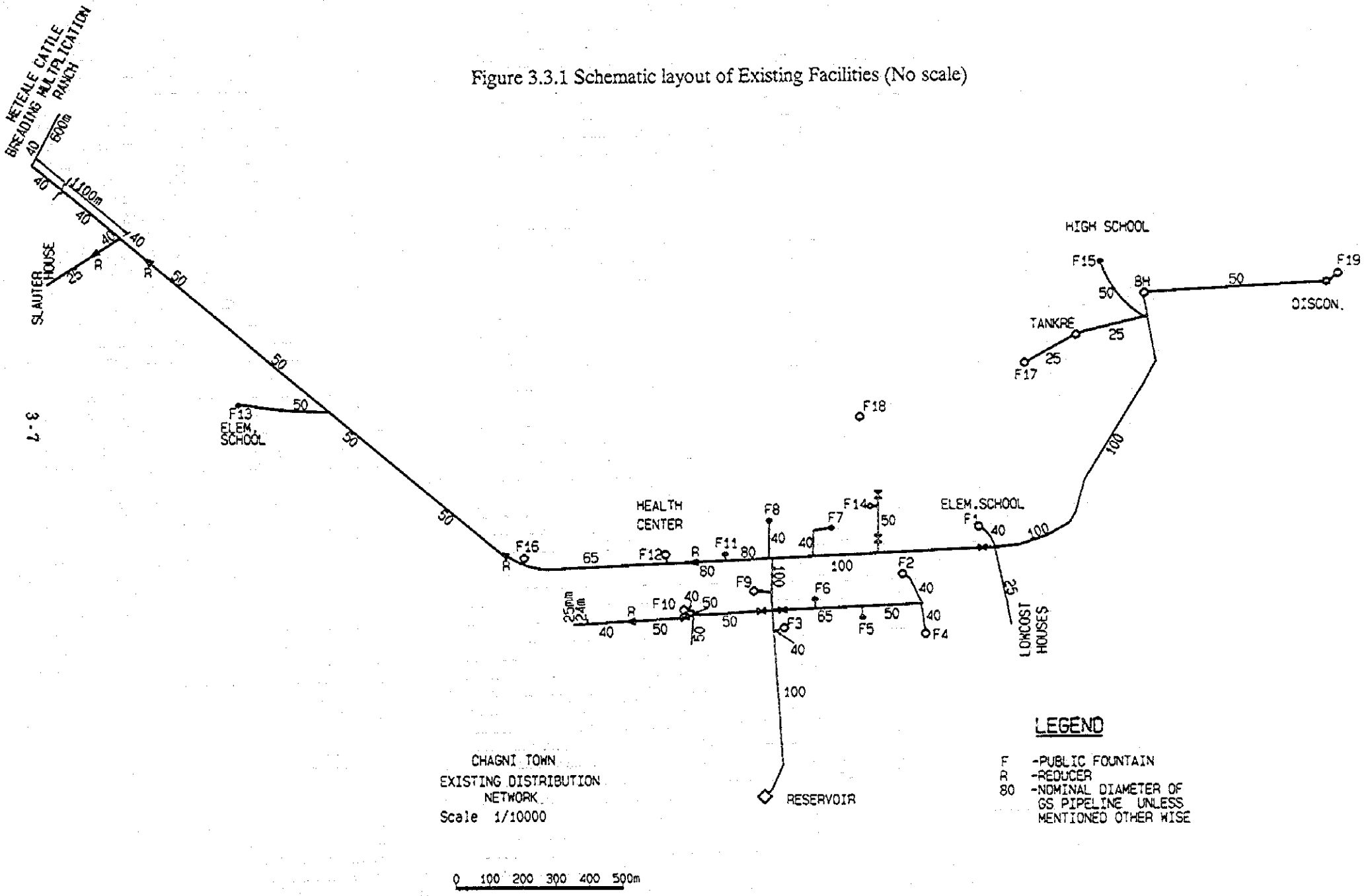
3.3.5 Disinfection

There is no disinfection facility in existing water supply system. It is reported that hypochlorite is added in the service reservoir occasionally, and the service reservoir is being cleaned twice a month.

3.3.6 O & M

Chagni is classified as urban town, and the waterworks is under the control of Regional Office in Amhara Region. No regular check-up for water supply facilities is made in Chagni In case of the breakdown of the facilities, the technician will be dispatched from the Bahar Dar regional office in response to the request.

Figure 3.3.1 Schematic layout of Existing Facilities (No scale)



3.4 Sanitary Facilities Condition

3.4.1 Toilet Facilities

Presently, considerable use of open-field is being made in Chagni for disposal of excreta. The distribution of housing units by type of toilet facilities as reported by the survey of the 1984 Population and Housing Census and as updated in 1993 is indicated in Table 3.4.1.

Table 3.4.1 Distribution of Household Units by Type of Toilet Facility in Chagni

Number and percentage	Type of Toilet Facility						Total
	Flush		Dry pit		None i.e. (open-) field	Other	
	Private	Shared	Private	Shared			
• Number	9	4	319	502	859	19	1,712
• Percentage (%)	0.5	0.3	18.6	29.3	50.2	1.1	100

From Table 3.4.1, one can see that about 50% of the households in Chagni do not have toilet facilities; 48% have traditional dry pit latrines including both private and shared; and less than 1% have flush toilets. The survey of 100 households that was carried out by the Study has come up with the results shown in Table 3.4.2.

Table 3.4.2 Distribution of Households by Type of Toilet Facilities Used

Percentage	Type of Toilet Facility				
	Septic Tank	Dry Pit Latrine	Community Toilet	Open field	Total
%	1	56	1	42	100

Of the 100 households that have been surveyed, Table 3.4.2 shows that 56 households use dry pit latrines; 42 households do not have toilet facilities and use open-field for excreta disposal; only one household has toilet with septic tank and the remaining use community toilets.

The present study confirms that considerable use of open-field is being made and excreta can be openly observed at the bus terminal, near the prison house, near the market and along the edges of streets in the town. This situation has created environmental pollution, water contamination and displeasing sight.

The dry pit latrines that are being used would usually being filled up within 2-3 years. The owners who do have space will dig new latrines; and those who can afford arrange to get vacuum truck from Bahir Dar to empty them. Usually getting vacuum truck from Bahir Dar is very difficult due to shortage in Bahir Dar itself. If they are able to get vacuum truck and disludge the pit latrines, there are no proper places to dump the sludge. Therefore, dumping is done at any convenient places on the road towards Pawe just outside the edge of the town. This makes the process of dumping the sludge hazardous to health.

The Population and Housing Census of 1984 which surveyed the whole town of Chagni has come up with the distribution of housing units by type of materials used for construction of walls, roofs and floors. Table 3.4.3 indicates the survey results.

Table 3.4.3 Distribution of Housing Units by Type of Materials Used in the Construction of Walls, Roofs & Floors in Chagni

Wall			Roof		Floor		
Wood & Mud	Stone & Mud	Stone & Cement	Corrugated Iron Sheet	Thatched (Grass)	Earth/Mud	Cement/ Concrete	Wood Tile
89%	1%	3%	69%	28%	91%	4%	2%

Most of the housing units in Chagni have their walls constructed out of wood and mud (89%); their roofs of corrugated iron sheets (69%) and thatched grass (28%); and their floors mostly of earth and mud (91%). The superstructures of the toilet facilities specially pit latrines use similar materials to that of the housing units.

3.4.2 Other Sanitary Facilities

There are no allocated places for disposing refuses or dry solid wastes in Chagni. The town people throw their refuses at nearby open-spaces and along the streets. It is only the schools that collect their solid wastes, dig pits and burn them using student labor. From the survey of 100 households carried out by the Team, 64 households out of 100 throw their dry solid wastes everywhere, 21 dump in open pit, 12 in covered pit and only 3 burn the refuse. This station has created environmental pollution and health hazards.

Domestic households, hotels, restaurants, drinking places, etc. dump their sullage in front of their houses, along the streets and open-spaces nearby creating environmental pollution and health hazards. The same household survey of 100 households has also revealed the way people dispose sullage. 61% of the households dump their sullage anywhere i.e. in front of their houses, along the streets, in nearby open areas, etc. 10% throw in pits, 15% in drains and 14% in vegetable garden. The indiscriminate dumping of sullage in the open has created unhygienic situation, specially for children.

Chagni has one abattoir outside the town on the Pawe Road. It is well-designed, and properly kept. It is very clean and is one of the best abattoir among the eleven centers. The waste material is kept in a prepared pit for sometime and drained into the gulley nearby.

Chagni does not have as such industries and three are no industrial wastes.

3.5 Organization and Management

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

The number of personnel for the Water Supply Service of Chagni is 17, which is on the small side 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. Administration					
Store keepers	2	0	0	2	0
Guards	4	0	4	0	0
Sub-total	6	0	4	2	0
3. Finance					
Accountant	1	0	1	0	0
Bill collector	0	1	1	0	0
Water sellers	1	5	6	0	0
Sub-total	2	6	8	0	0
4. Technical					
Motor operator	1	0	1	0	0
Plumber	1	0	1	0	0
Sub-total	2	0	2	0	0
Total	11	6	15	2	0

As the table shows, out of the total 15 persons or 88% are permanent workers and 2 or 12% are contract workers. Female workers are 6 in number or 35%. It is more 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 being included in technical functions, their respective shares work out to 35%, 47% and 18%. On the other hand, their 11 town averages are 37%, 41% and 22%. It means that the share of financial functions is higher and that of technical 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 4,366 m^3. It is on the high side. The monthly remuneration per worker is 143 birr, which is on the low side.

It follows from the above that female participation in the workforce is marked, there may be a shortage of technical personnel, and both the total number of personnel and remuneration level are well controlled.

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 is 1 birr per m^3 for all clients.

Production and consumption of water in the last fiscal year (Jul. 1993 to Jun. 1994) were 74,219 m^3 and 55,045 m^3 respectively. Both are the second largest among the 11 towns. Bati is the No. one producer and consumer of water. Leakage ratio works out to 25.8%, which is the second highest, next to 26.1% in Nefas Mewcha. The daily water consumption as divided by population comes to 5.6 liter. This is one of the lowest.

Income for the last year was 68,590 birr. The major sources of income are water sales (64.3%), public fountains (20.7%) and service charge (9.1%). Income per m^3 of water consumed works out to 1.25 birr, which is the second lowest, next to 1.21 birr in Bure. Bill collection rate is 85.8%, which is on the low side.

Expenditures for the same year were 72,172 birr. Major items of expenditures were salaries (40.4%), fuel (37.1%), lubricant (4.9%) and office supply (3.9%). Expenditures per m^3 of water produced work out to 0.97 birr, which is the second lowest, next to 0.91 birr in Werota. The income-expenditure ratio comes to 95.0%. This is rather on the high side.

The number of personnel is 17. It is on the small side among the 11 towns. Annual water production per worker is calculated at 4,366 m^3, which is on the high side. Annual income per worker is 4,035 birr, which is on the high side. Expenditures per worker are 4,245 birr, which is also on the high side. Average monthly salaries are 143 birr. It is on the low side.

It follows from the above that the limited size of workforce and the controlled level of remuneration brought the financial status near the break-even point. If managerial disciplines are added to lower leakage ratio and raise bill collection rate, then WSS can get financially solvent and sustainable.

3.7 Social Background and People's Awareness

3.7.1 Population and Social Composition

Chagni had a population of 26,823 at the time of the field survey. According to the responses to the household survey the 77% of the population were Amhara, 18% Agew, 4% Shinasha and 1% Guragie. Of them, 88% them spoke Amharic, 17% Agew and 2% Shinasha as their first language. 44% of the respondents were Christians and 56% were Muslims. The land ownership level of the respondents was only 19%, 26% were female headed households and the average family size was 6.1. The town had a number of independent EDERs serving the Muslim and the Christian Societies. There were two Kebeles, of which 02 was larger and contained a higher proportion of Muslims.

The center of Chagni was based on a grid system which was designed when the town was planned. Some of the suburbs were not planned and people had settled on Government land

without allocation and without planning. The business people and the more wealthy sectors were in the town center.

3.7.2 Sanitation Situation

The household survey suggested that 44% of people in Chagni practice open defecation. Group discussions suggested that people without latrines tended to live in Kebele rented housing or those illegally squatting. For these people, the lack of control over land for latrine construction seems to prevent them from constructing latrines. This seemed to relate better to land availability with Christians rather than with Muslims (See Chart 17). For some people there was a lack of affordability (possibly more of an issue for Muslims than for Christians). The results of the household survey in Chagni also indicate some differences in sanitation facilities between religious groups. Muslims tended to have lower access to latrines than Christians (50% of Muslims and 79% of Christians). Lack of health awareness was not a significant factor.

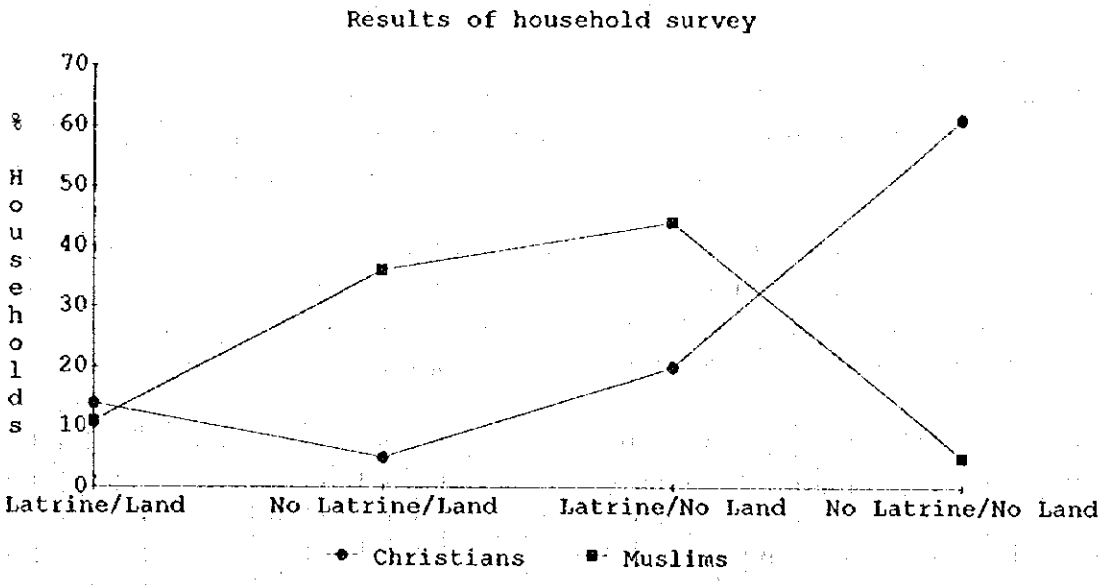


Figure 3.7.1 Land/Latrine Ownership and Religion

There was a public shower facility in the center of Chagni, but most people consider it to be too expensive to use at 1.50 Birr a time. Garbage disposal was not organized and people were disposing of their waste indiscriminately. Those people who consider this a problem would like some collection and sanitary disposal mechanism organized by the Municipality. Some people believe that the present situation was causing some health problems.

3.7.3 Water Situation

The majority of town people used piped water. Those some distance from PFs use water from PC vendors, and sometimes from the river for laundry or from hand dug wells. Most of the handdug wells were not used any more because of problems with water quality. Both water collection and laundry were undertaken by women most of the time.

The center of the town was well served with public fountains and private connections. However, there were some areas of the town which were not covered by the water supply system and where water was a priority need. The area formerly served by the disconnected public fountain requires additional facilities. Allegedly this PF was disconnected because of misuse. Vandalism was still likely in that area and reconnection of this PF was unwise. Residents requested extra PFs to be located away from the main road among their houses so that they could care for and manage them effectively. People were also willing to assist with labor for the construction of these PFs. (They were apparently forced to help in the construction with the previous PF.) PFs did not operate on Sundays as water sellers were not contracted to work on Sundays. Additional private connections have been requested but have not yet been granted to some members of the community.

The price of water was fixed at 10 cents for three average size clay pots from public fountains and for 10 cents for one or two clay pot from private connection vendors. Most of the groups were prepared to pay more for a better water supply service. Women in areas not currently served by the piped water system would benefit most from an extended water system.

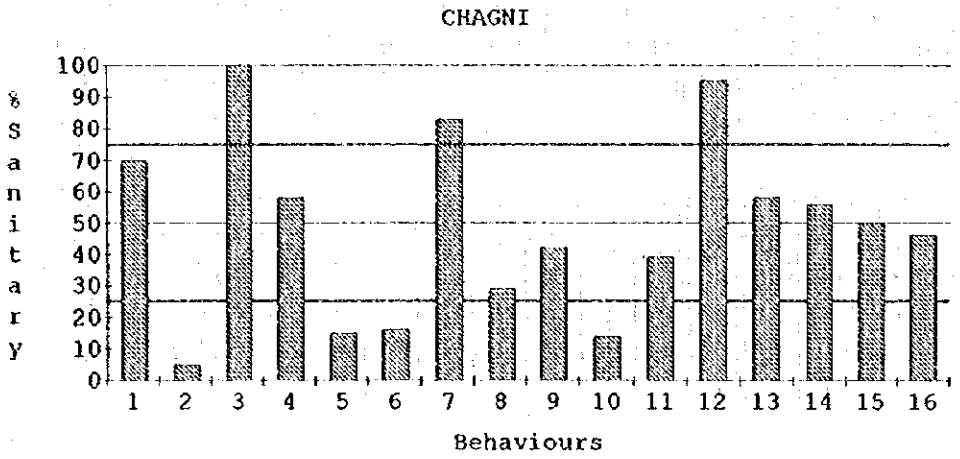
3.7.4 Health indicators

The town population had a relatively low level of health awareness as compared with other towns in the study (See Graphs 14 to 16 in Volume I). In the household survey, 28% of the population were aware of the cause of diarrhea and 20% knew how to prepare ORS correctly, however the responses for Muslims were significantly lower than those for Christians (eg ORS Awareness of 31% of Christians and 11% of Muslims).

Chagni's Health Center serves a population of 138,601 within the Woreda. Among the staff, there was one sanitarian who had been working there for over 20 years, and a new sanitarian had just joined. The sanitation program was having problems due to a lack of budget. Intestinal Parasites were the most common cause of people presenting at the health center, the next most common diseases were Respiratory infections, Skin disease, Diarrhea, Malaria and Rheumatism. Malaria was under reported as the patients tended to go the Malaria Control Center for treatment.

People were aware of the health education program being carried out at the health center to in-patients, but compared to other towns, a relatively few households had attended sessions (28% of households surveyed, of which 64% said the sessions were satisfactory). Despite this the health center staff thought they would be more effective if they had materials to make the health education inputs more interesting. At that time, all health education was oral. The school had had inputs from the health center for the Anti-AIDS and Red Cross Clubs. Also some AIDS education had been attempted through Churches.

The level of indicator sanitary behaviors reported in the household survey have been recorded in Figure 3.7.2 below:



No.	SANITARY BEHAVIOURS	%Sanitary
1	Access to piped water	70
2	Use piped water supply always	5
3	Covered water container	100
4	Water scoop kept off the floor	58
5	Handwashing with soap after defecating	15
6	" after handling childrens stools*	16
7	Covering cooked food during storage	83
8	Not eating unwashed raw fruit and vegetables	29
9	Kitchen utensils stored off the floor	42
10	Rubbish burried or burned	14
11	Wastewater disposed in pit/drain/veg. garden	39
12	No animals kept in the house	95
13	Home not infested with flies	58
14	Latrine in use by household	56
15	Latrine in use by all household members	50
16	Infant's excreta disposed of in latrine*	46
TOTAL SCORE FOR SANITARY BEHAVIOURS		776

*As proportion of households with young children

Figure 3.7.2 Indicator Sanitary Behaviours

There was little variation in the score between water user groups, by ethnicity, by land ownership or by religion. This summary of indicator behaviors suggested areas where sanitary improvement was required. The highest priority areas were use of piped water always, Handwashing with soap after defecation and after handling children's stools and burial or burning of solid waste. The high-middle priorities were keeping kitchen utensils off the floor, sanitary disposal of waste water and the safe disposal of infant's excreta. Low-middle priorities were access to piped water, keeping water scoops off the floor, fly control, access to latrines and use of latrines by all family members.

3.7.5 Education

Chagni had two elementary schools, one junior school and one high school. The percentage of female staff at the schools in the questionnaire survey was 47% for elementary schools and only 3% at the high school. There were 888 pupils at the high school of which 479 were boys and 409 were girls. The school operated a shift system. In most classes there were a similar number of girls but there were many less girls in Class 12. Some girls did equally well as boys, but girls tended to have a higher drop out rate than boys and did less well at their studies. Girls tended to have more work to did in the home and thus have less study time. Parents tended to encourage boys to study more than girls and girls were more shy to participate in class. Of the 28 high school teachers, 2 were women.

There were two taps at the school which functioned adequately. There was one latrine building for boys and girls, and although cubicles were separated girls tended not to use the latrine. This was probably a tradition where girls did not want to be seen by boys or teachers to be needing to excrete.

Among 12 school clubs, there was the HOPE Anti-AIDS Club and Red Cross Club for health. These were occasionally supported by the staff of the health center on request. Health education was given to these clubs at flag ceremonies, including occasional sessions by the health center staff. It was hoped that the Anti-AIDS messages promoted in the clubs would be passed on to the wider community. Aspects of sanitary education were covered in biology and home economics subjects, including hookworm and giardia.

3.7.6 Religious Institutions

There were three Churches and two Mosques in Chagni. The Church was not already involved with sanitary education, although they had been involved with HIV and Anti-AIDS education. The Church was willing to become involved with sanitary education. They were promoting some messages about malaria prevention, including some points about avoiding malaria made in the addresses at the funerals of victims of the recent malaria epidemic. The Priests felt that community latrines would be a good option for communities outside the center of the town. For latrines in the center of town, they felt that these should be managed by the Municipality, i.e. public facilities.

The Mosque had a private water connection and a latrine. The elders considered that community latrines would be a solution to the problem of lack of land for latrines. The Mosque had not been involved in health education to date but was willing to get involved. Females attend the Mosque as well as males and therefore the Mosque would give access to both sections of the Muslim community. Female health workers should be used to give sessions to women at the Mosque.

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 22 governmental organizations excluding schools dealing with general administration, finance, education, health, water supply and sanitation, communications, police, justice, water resources development, agriculture, animal husbandry, commerce, road construction and municipal affairs.

The number of government employees is 727. It is on the large side among the 11 towns. The number of them per 1,000 population works out to 27, which is on the low side. Their average monthly salaries are 368 birr, which is on the high side.

The town is fastly growing, and it appears that the growth tempo of administrative workforce is not commensurate with the rapid growth of population.

This town has two Kebele. There is one NGO.

3.8.2 Population

The population of the town is estimated at 26,823 according to the preliminary results of the 1994 population census. It is the largest among the 11 towns. Ethnic composition of the population is quite varied with Amhara sharing 73.9%, Agew 18.9%, Shinasha 3.6%, Gurage 1.8%, Oromo 0.9% and Tigre 0.9%. Religion-wise, 56% of the population is Moslems and 44% Christians. There are 3 mosques and 1 church.

This is a multi-tribal islamic town.

The average family size is 6.1 persons. This is medium among the towns concerned. The area of the town is 920 ha. It is on large side. The population density is calculated at 29.2 persons/ha. This is on the low side.

3.8.3 Educational Conditions

There are 2 kindergartens, 2 elementary schools, and 1 junior high school, 1 senior high school and 1 adult education center. The total number of pupils/students is 5,339. It is the second largest, next to 7,950 in Debre Tabor. The number of pupils/students per 100 population is calculated at 20, which is one of the lowest. This is due to a rapidly growing population.

Literacy ratio and primary school enrollment ratio were 73.5% and 76.5% respectively according to the 1984 population census. They are both on the high side (No.3) among the 11 towns.

Chagni can be labeled as an educational town.

3.8.4 Medical Conditions

There are 1 health center and 2 drug vendors. The total number of medical personnel in the health center comes to 25, which is on the large side among the 11 towns. It means that

there is 0.9 medical personnel for every 1,000 population. It is one of the lowest. This is due to a rapidly growing population.

The types of diseases people suffer most are water-borne and sanitation-related diseases such as malaria, intestinal parasite, dysentery, skin diseases and amoebiasis, and respiratory tract infections. The number of top ten disease cases treated in the medical institutions in 1993/94 was 11,782, which is on the small side among the 11 towns.

The estimated total number of cases treated last year in the hospital was divided by the estimated service population. It came to 13.2%, which is one of the lowest.

Under 5 mortality rate and life expectancy were 144.4/1,000 and 54.4 years respectively according to the 1984 population census. The former is on the low side, while the latter is on the high side.

Ratio of households more or less using septic tanks and pit latrines is 61%. This is on the high side.

It follows from the above that Chagni's medical/sanitary environment is comparatively good among the 11 towns.

3.8.5 Economic Conditions

The number of hotels and restaurants is 209 (16.7%), that of shops 629 (73.4%), that of cottage industry 42 (7.7%) and that of others 12 (2.2%), adding up to 546 (100.0%). This total number of commercial/industrial establishments is on the large side among the 11 towns. The total number per 1,000 population comes to 20, which is one of the lowest. The number of hotels and restaurants per 1,000 population is 3, which is at the lowest level along with Bichena.

It appears that the growth tempo of economic activities cannot catch up with the rapidly growing population.

Major occupations in the town are trade, day laborers, government employees and agriculturalists.

Major products are edible oil and flour. Major marketable items are agricultural products such as tef, maize and sorghum, livestock such as oxes, cows, sheep, goats, donkeys, and mules, etc.

The market is held on Monday, Thursday and Saturday. 10,000 people are said to gather on a market day.

The average monthly household income is 202.8 birr. This is the second lowest, next to 202.3 birr in Nefas Mewcha.

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 50 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 on-site by EELPA, and there is no plan to supply hydroelectric power so far. Thus, water supply facilities proposed will be operated by the on-site generators.

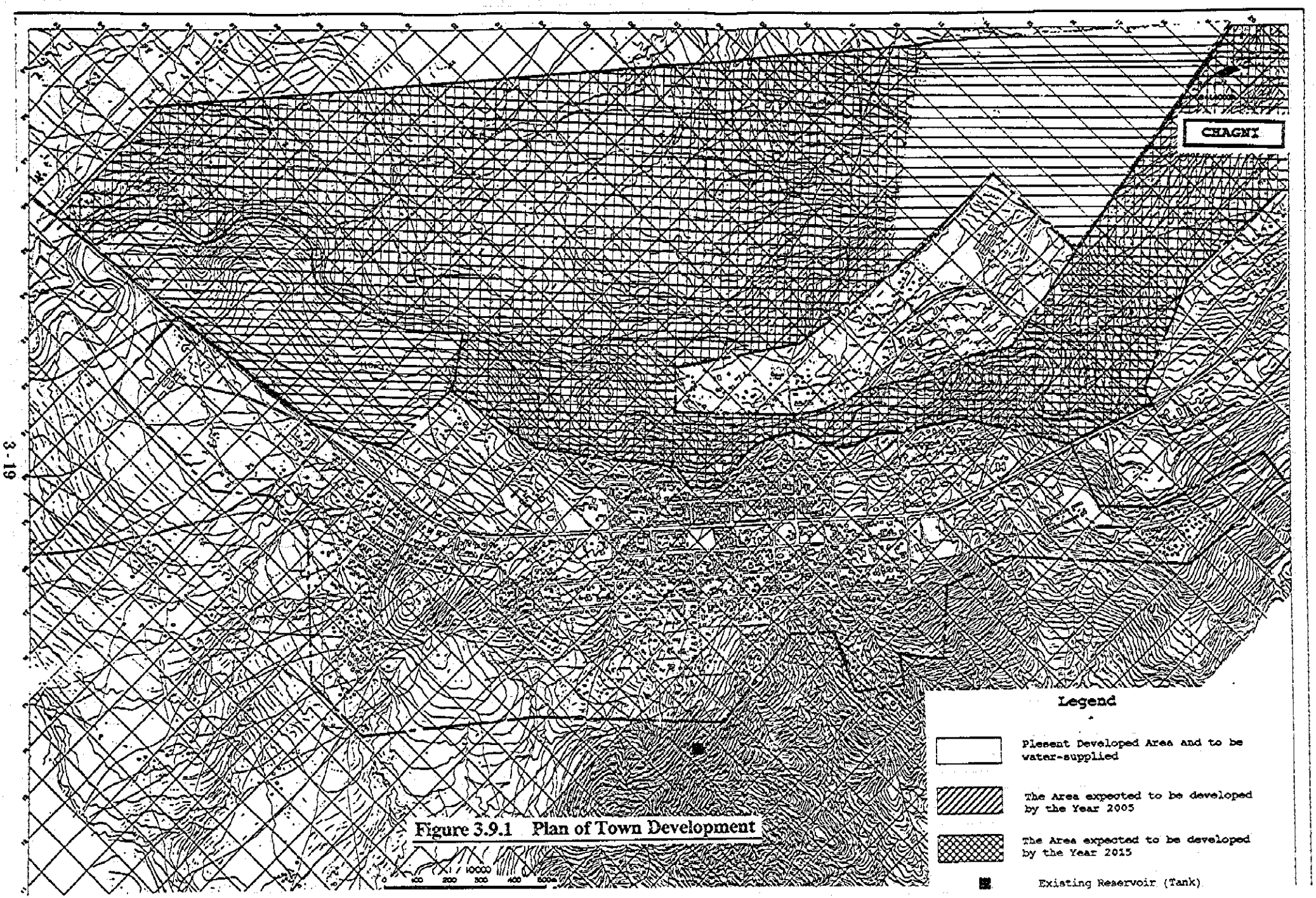


Figure 3.9.1 Plan of Town Development

Chapter 4 Plan of Water Supply System

4.1 Water Demand Projection

4.1.1 Population Projection

The population of Chagni was 8,586 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 population figures are available so far as those of Chagni are concerned. Central Statistical Authority (CSA) published 1974 population estimates for those towns whose population was supposed to be more than 2,000. The population of Chagni was considered to be below 2,000 in that year.

Since 1984 also CSA published its own estimates of population. According to them population of the town in 1992 and 1993 was 16,099 and 17,085 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 18,992 in 1994. When one uses the figures, the average annual population growth rate during the 10 years from 1984 to 1994 works out to 8.26%. 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 Chagni during the field survey. They are 26,823. The team adopted them for the 1995 population of the town.

Chagni has already a substantial number of cottage industry including oil factories, flour mills and stone & sand producers, reaching 42.

The Dangla - Pow - Chagni Hydro-Electric Power Project with the capacity of 15 kwh will be completed next year. In anticipation of it one governmental match factory, two oil factories, one traditional medicine factory and brick factories will be constructed.

As the average annual population growth rate 1995 to 2000 6.0% was adopted based on the average annual population growth rate 1984 to 1993. 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 5.0% and 4.0% respectively.

As a result the projected population of the town for 2000, 2005 and 2010 works out to 35,895, 45,812 and 55,737 respectively (Refer to Table 4.1.1).

Table 4.1.1 Population of Chagni

1. Past Population

1984 Population Census	1994 Cartographic Census	Average Annual Growth Rate 1984 to 1994
8,586	18,992	8.26%

2. Population Projection

1995	2000	Average Annual Growth Rate 1995 to 2000
26,823	35,895	6.0%
2000	2005	Average Annual Growth Rate 2000 to 2005
35,895	45,812	5.0%
2005	2010	Average Annual Growth Rate 2005 to 2010
45,812	55,737	4.0%

4.1.2 Water Demand Projection

(1) Domestic Water Demand

a) Population Projection by Service Modes

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

The house connection and yard connection are estimated, based on the ratio of the households who are payable for the mode-wise water charge. Target ratio of the sum of house connection and yard connection at the year of 2010 is 52%, and 13% of these ratio is house connection.

The ratio of the population served by the piped water at the target year of 2010 is 75%, and the ratio served by the traditional water source is estimated at 25%, considering the current ratio.

Table 4.1.2 Population Forecast by Service Modes

	Population (%)							
	1995		2000		2005		2010	
House Connection	330	(1.2)	1,149	(3.2)	3,252	(7.1)	7,245	(13.0)
Yard Connection	7,086	(26.4)	10,230	(28.5)	14,980	(32.7)	21,737	(39.0)
Public Fountain	4,959	(18.5)	10,241	(28.5)	13,477	(29.4)	12,821	(23.0)
Sub total	12,375	(46.1)	21,620	(60.2)	31,709	(69.2)	41,803	(75.0)
TSU	14,448	(53.9)	14,275	(39.8)	14,103	(30.8)	13,934	(25.0)
Total	26,823	(100.0)	35,895	(100.0)	45,812	(100.0)	55,737	(100.0)

b) Projection of Domestic Water Demand

Water demand figure by service modes formulated by WSSA is applied for the projection, i.e, House Connection 60 lpcd, Yard Connection 35 lpcd, Public Fountain 15 lpcd. In addition, these figures multiply by 0.9, considering the natural condition (annual mean rainfall is more than 900mm).

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	21	(63.8)	62	(54)	189	(58)	456	(63
Yard Connection	107	(15.1)	327	(32)	509	(34)	804	(37)
Public Fountain	24	(4.9)	143	(14)	202	(15)	205	(16)
Total	152		532		900		1,465	
Average	51	(12.3)	178	(25)	300	(28)	489	(35)

(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	5,309	26.5	
Hospital	20 l/staff	27	0.5	
Hotel	100 l/bed	280	28.0	10 beds/place × 28 places = 280 beds
Bar...	200 l/bar	63	12.6	
Mosque	5 l/visitor	1,200	6.0	400 visitors/place × 3 places = 1,200
Offices	5 l/person	727	3.6	
Total			77.2	

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	26.5	35.5	45.3	55.1	Population growth rate
Hospital	0.5	0.7	0.9	1.1	-do-
Hotel	28.0	43.1	63.3	88.8	Population growth rate +3%
Bar, Tea shop	12.6	19.4	28.5	40.0	-do-
Mosques	6.0	8.0	10.2	12.4	Population growth rate
Offices	3.6	4.8	6.1	7.4	-do-
Total	77.2	112	154	205	

(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	153	533	900	1,466
Non Domestic	36	112	154	205
Losses	102	72	144	295
Total	291	716	1,198	1,966

* 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)		291	716	1,198	1,966
Maximum Day Demand (m^3/day)	1.2	349	859	1,438	2,359
Peak Day Demand (m^3/hour)	1.6	23	57	96	157

4.2 Water Resources Development

4.2.1 Evaluation of Water Resources

Chagni has the mean annual precipitation of 1,687.6 mm and the ground water recharge of more than 228.3 mm in an average year. Since the town is located along Ardi river and near Dura river, the river water is accessible for the water supply. However, it is not recommended at this stage to utilize the water because treatment is necessary for the water.

In Bati, ground water development is also feasible. The WSS has an operational well near Ardi river. Its yield is reported at 5 l/s (432 m^3/day) for 12 hour pumping a day. On the other hand, recharge of an average year is estimated at 137 × 10 m^3/day for the watershed area of Ardi river.

The geology is basalts 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 18 points as shown in Drawing including the existing operational well and the dry well. The apparent resistivity values range from 50 to 500 ohm-m and they indicate higher values than other study areas. Considering the steep basalt peaks overlying scattered in this area, basalt weathering might not so intensive.

Major linearments which is formed along the Donder, the Chewatam and the Ardi trends east-northeastward from south of the town. VES station No.3, No.4, No.5 are located along this linearment and their resistivity curves show bumpy shapes and apparent resistivity values decrease as the depth becomes deeper. Moreover, another major linearment along Donder river is observed in the southeast of the town trending to southeastward. The measurement at VES station No.1 along this linearment resulted in suitable resistivity curve for obtaining ground water.

Considering the lineation and the result of VES, eight (8) borehole sites are selected. They are VES st. No.1, No.3, No.4, No.6 and No.8 as well as the points where linearments intersect i.e. St. No.19, No.20 and No.21. The results of VES are shown in Appendices.

4.2.2 Strategy of Water Resources Development

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

Table 4.2.1 Characteristics of Aquifers

Well No.	Locations	Depths of Major Aquifers (GL-m)	Lithology of the Aquifers	Total Thickness of the Aquifers (m)	Permeabilities (m/day)	Remarks
1	VES St.9	30 - 52 68 - 76	Weathered Basalt Vesicular Basalt	30	1	WSS BH No.1
2	St.19	assumed to be same as above		15	1	New Well
3	VES St.1	25 - 100※	Weathered and Fractured Basalt	37.5	1	-Ditto-
4	VES St.3	27 - 72	Weathered and Fractured Basalt	22.5	1	-Ditto-
5	VES St.4	12 - 64	Weathered and Fractured Basalt	26	1	-Ditto-
6	St.20	assumed to be same as above		26	1	-Ditto-
7	St.21	assumed to be same as above		25	1	-Ditto-
8	VES St.6	50 - 100※	Weathered and Fractured Basalt	25	1	-Ditto-
9	VES St.8	8 - 31	Weathered and Fractured Basalt	11.5	1	-Ditto-

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

The depths of major aquifers of WSS BH No.1 is obtained from the geological log. The others were detected by the geoelectrical survey. For the sites where the geoelectrical survey was not done, the data of their adjacent sites is referred. Excluding the existing borehole, 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 drawdown of 20 m and diameters of wells to be 200 mm. The optimal yields of the wells are shown in Table 4.2.2.

Table 4.2.2 Optimal Yields and Water Levels of the Wells

Well No.	Optimal Yield (m^3/day)	Static Water Level (GL-m)	Dynamic Water Level (GL-m)	Remarks
1	91	2	25	WSS BH No.1
2	182	5	25	New Well for Year 2005
3	454	5	25	-Ditto-
4	273	3	23	-Ditto-
5	315	5	25	-Ditto-
6	315	5	25	-Ditto-
7	303	5	25	New Well for Year 2010
8	303	5	25	-Ditto-
9	144	3	23	-Ditto-

The optimal yields of Well No.1 to Well No.6 summed at 1,630 m^3/day covers the demands of year 2005. The total optimal yield of all the wells will cover the demand of year 2010.

It is recommended to drill those five (5) wells from Well No.2 to No.6 before year 2005 because the locations are nearer to the roads.

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 hole is not straight. The diameter of casing is decided at 200 mm, taking into consideration the outer diameter of the submersible pump (standard 80 - 140 mm) and the allowance. The length of the pipe is six (6) m long per piece.

(2) Screen

Corresponding with the casing, FRP screen is adopted. The Opening ratio is 12 % and the length is four (4) m long 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 0.66 m^2/m
- N: Opening ratio 0.12
- V: Inflow velocity 0.5 cm/s (assumed)
- α: Safety factor 3

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

Table 4.2.3 Dimensions of Wells

Well No.		2	3	4	5	6	7	8	8
Pumping Rate	(m^3/day)	182	454	273	315	315	303	303	144
	(l/s)	(2.1)	(5.3)	(3.2)	(3.6)	(3.6)	(3.5)	(3.5)	(1.7)
Diameter of Well	(mm)	200	200	200	200	200	200	200	200
Casing Length	(m)	60	48	42	36	36	72	72	24
Screen Length	(m)	24	56	32	36	36	36	36	16
Well Depth	(m)	84	104	74	72	72	108	108	40
Drilling Diameter	(mm)	300	300	300	300	300	300	300	300

4.3 Plan of Water Supply System

The water supply system proposed for the center of Chagni 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 eight potential sites for borehole as stated in chapter 4.2, and five sites of these will be constructed in the first phase. The groundwater pumped up is transferred to the reservoir directly. The production rate planned is summarized as follows.

W1 (Existing Well)	91 m^3/day
W2 (proposed)	182 m^3/day
W3 (proposed)	454 m^3/day
W4 (proposed)	273 m^3/day
W5 (proposed)	315 m^3/day
W6 (proposed)	315 m^3/day
Total	1,630 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 (Existing Well)	Q = 0.06 m^3/min., H = 58 m
W2 ~ W6	Q = 0.28 m^3/min., H = 100 m, P = 5 kW 5 set

(3) Rising Mains and Boosting Pump

Diameter of rising mains will range from 100 mm to 200 mm. The total length is about 8,140 m. And the boosting pump with the capacity of Q=100 m^3/min., H=70 m, P=30 kW will be installed at the collecting chamber site.

(4) Reservoir

The existing reservoirs is used, therefore, the additional capacity of the reservoir is required to meet the water demand at the year of 2005, and the required capacity is about 330 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	760
150	3,785
75	7,230
50	7,670

(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 1.7 kg and necessary more than 0.11 PPM at the end of distribution pipe.

(7) On-site Generator

In order to operate the water supply system, the generator with the capacity of about 3 set of 50 KVA will be installed.

4.3.2 Water Supply System in 2010

(1) Boreholes

By the target year of 2010, the following boreholes will be constructed additionally.

W7 (proposed)	303 m³/day
W8 (proposed)	303 m³/day
W9 (proposed)	144 m³/day
Total	750 m³/day

(2) Borehole Pumps

The following submersible motor pumps will be installed additionally, as well.

W7 ~ W9 Q = 0.21 m³/min., H = 100 m

(3) Distribution Network

The layout of distribution network for the year of 2010 is not prepared in this Study. It is needed to revise the current master plan of town planning to match up to current situation. It is, therefore, preferable to design a layout plan after revision of master plan.

(4) Disinfection

Disinfection will be performed by the injection system directly into the reservoirs. Daily consumption ratio of chemical will be estimated at about 2.7 kg and necessary more than 0.11 PPM at the end of distribution pipe.

(5) On-site Generator

The generator with the capacity of about 45KVA will be installed additionally, as well.

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 keeping 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	15,126	9,043	24,169
2010			12,155

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	1,626
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/m³)
1. House Connection Owners and Non-Domestic Clients	2.93
2. Yard Connection Users	2.14
3. Public Fountain Users	1.33

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

(b) Projection of Revenues

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

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

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

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

Water price is already mentioned above.

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

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

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

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

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

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

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

Projected revenues by source are shown in Table 4.5.2.

(2) Estimation of Cost

There are two types of cost. One is capital cost and the other is operation and maintenance (O & M) cost.

Capital cost is required to construct and replace water supply facilities. O & M cost is an recurrent cost daily required for the proper functioning of water supply facilities.

(a) O & M Cost

Seven types of O & M cost can be identified.

The first is electricity cost. In Chagni, however, it is projected that electricity will be not available for pumps in the years to come.

The second is fuel cost. It is estimated that 273 birr, 456 birr and 749 birr will be daily required in 2000, 2005 and 2010 respectively.

The third is disinfection cost. It is estimated that 11 birr, 18 birr and 29 birr will be daily required in 2000, 2005 and 2010 respectively.

The fourth cost is personnel cost. It is estimated that 38, 44 and 54 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 113, 196 and 307 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 estimated 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	11,555	5,403	16,958
2) Engineering Cost (12% of 1))	2,035		2,035
3) Contingency (5% of 1) + 2))	680	270	950
Sub-Total	14,270	5,673	19,943
4) Buildings		2,726	2,726
5) WSSD's Management Cost (2% of 1) + 2) + 3) + 4))		453	453
Sub-Total		3,179	3,179
Total	14,270	8,852	23,122
6) Water Purification Units (included in total)	10	15	25
2. Phase 2			
1) Construction Cost			7,074
2) Engineering Cost (10% of 1))			708
3) Contingency (10% of 1) + 2))			778
Total			8,560
Grand-Total			31,682

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
   - 85% 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 the before-tax income in case the income is over 50 thousand birr.

Further, inflation was not considered.

The results are shown in Table 4.5.3.

As it shows, WSS will be financially sound and stable in terms of earnings as well as solvency in 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 = 133.3%
Working Capital/Revenues = 31.6%

Generally, it will be all right if the ratio of revenues to expenditures is equal to or more than 100%, or preferable 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	880	945	845	844
2) Yard Connection Users	391	397	401	362
3) Public Fountain Users	219	209	198	194
2. Share of Households (%)				
1) House Connection Owners	1.2	3.2	7.1	13.0
2) Yard Connection Users	26.4	28.5	32.7	39.0
3) Public Fountain Users	18.5	28.5	29.4	23.0
3. Water Consumption/Household/Month (m^3)				
1) House Connection Owners	11.7	9.9	10.6	11.5
2) Yard Connection Users	2.8	5.9	6.2	6.8
3) Public Fountain Users	0.9	2.6	2.7	2.9
4. Water Price (birr/m^3)				
1) House Connection Owners	1.00	2.93	2.93	2.93
2) Yard Connection Users	1.00	2.14	2.14	2.14
3) Public Fountain Users	1.00	1.33	1.33	1.33
5. Payment for Water Supply/Household/Month (birr)				
1) House Connection Owners	11.7	29.0	31.1	33.8
2) Yard Connection Users	2.8	12.5	13.3	14.5
3) Public Fountain Users	0.9	3.4	3.7	3.9
6. Ratio of Water Payment to Income (%)				
1) House Connection Owners	1.3	3.1	3.7	4.0
2) Yard Connection Users	0.7	3.2	3.3	4.0
3) Public Fountain Users	0.4	1.6	1.8	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	35,132	14,449	9,873	6,247	-	4,128	69,829
1997	35,835	14,738	10,071	6,247	-	4,202	71,093
1998	36,552	15,033	10,272	6,247	-	4,278	72,382
1999	185,441	38,603	68,843	22,080	18,148	9,173	342,288
2000	305,936	66,133	113,789	22,080	19,507	10,549	537,994
2001	358,656	71,556	122,324	38,181	21,856	12,251	624,825
2002	411,376	76,980	130,858	38,181	24,206	13,632	695,233
2003	464,097	82,403	139,392	38,181	26,556	15,013	765,641
2004	516,817	87,827	147,926	38,181	28,905	16,393	836,049
2005	569,537	93,250	156,461	38,181	31,255	17,774	906,457
2006	667,733	93,518	166,824	59,893	34,941	20,458	1,043,366
2007	765,930	93,785	177,186	59,893	38,626	22,708	1,158,129
2008	864,126	94,053	187,549	59,893	42,312	24,959	1,272,892
2009	962,323	94,320	197,912	59,893	45,998	27,209	1,387,654
2010	1,060,519	94,588	208,275	59,893	49,683	29,459	1,502,417
2011	1,060,519	94,588	208,275	0	49,683	28,261	1,441,327
2012	1,060,519	94,588	208,275	0	49,683	28,261	1,441,327
2013	1,060,519	94,588	208,275	0	49,683	28,261	1,441,327
2014	1,060,519	94,588	208,275	0	49,683	28,261	1,441,327
2015	1,060,519	94,588	208,275	0	49,683	28,261	1,441,327
2016	1,060,519	94,588	208,275	0	49,683	28,261	1,441,327
2017	1,060,519	94,588	208,275	0	49,683	28,261	1,441,327
2018	1,060,519	94,588	208,275	0	49,683	28,261	1,441,327
2019	1,060,519	94,588	208,275	0	49,683	28,261	1,441,327
2020	1,060,519	94,588	208,275	0	49,683	28,261	1,441,327
2021	1,060,519	94,588	208,275	0	49,683	28,261	1,441,327
2022	1,060,519	94,588	208,275	0	49,683	28,261	1,441,327
2023	1,060,519	94,588	208,275	0	49,683	28,261	1,441,327
2024	1,060,519	94,588	208,275	0	49,683	28,261	1,441,327
2025	1,060,519	94,588	208,275	0	49,683	28,261	1,441,327

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

Table 4.5.3(1) Financial Statement

(Unit: thousand birr)

No.	1	2	3	4	5	6	7	8	9	10
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Income Statement										
Revenue	70	71	72	342	538	625	695	766	836	906
Operation and Maintenance	74	75	77	410	450	543	566	589	612	635
Depreciation	0	90	180	180	180	180	180	180	180	180
Payment of Interest	0	0	0	0	0	0	0	0	0	0
Expenditure	74	165	257	590	630	723	746	769	792	815
Profit before Tax	-4	-94	-184	-248	-92	-98	-51	-3	44	92
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	-4	-94	-184	-248	-92	-98	-51	-3	44	92
Funds Statement										
Profit after Tax	-4	-94	-184	-248	-92	-98	-51	-3	44	92
Loans	321	2925	2925	0	0	0	0	0	0	0
Subsidies	1816	7568	7568	0	0	0	0	0	0	0
Depreciation	0	90	180	180	180	180	180	180	180	180
Sources	2133	10489	10488	-68	88	82	129	177	224	272
Capital Works	2137	8903	8903	0	0	0	0	0	0	0
Payment of Principal	0	0	0	0	0	0	0	0	0	0
Working Capital	-4	1586	1585	-68	88	82	129	177	224	272
Applications	2133	10489	10488	-68	88	82	129	177	224	272
Loan Liabilities	324	3281	6268	6331	6394	6458	6523	6588	6654	6720
Cash Balance	-7	1578	3163	3096	3184	3266	3395	3572	3796	4068

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	1043	1158	1273	1388	1502	1441	1441	1441	1441	1441
Operation and Maintenance	765	802	839	876	913	655	655	655	655	655
Depreciation	180	180	199	219	219	219	219	219	219	219
Payment of Interest	4	36	66	63	60	57	54	50	47	44
Expenditure	949	1018	1105	1158	1192	931	928	925	921	918
Profit before Tax	95	140	168	229	310	510	513	517	520	523
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	95	140	168	229	310	510	513	517	520	523
Funds Statement										
Profit after Tax	95	140	168	229	310	510	513	517	520	523
Loans	0	117	584	584	0	0	0	0	0	0
Subsidies	0	661	3307	3307	0	0	0	0	0	0
Depreciation	180	180	199	219	219	219	219	219	219	219
Sources	275	1098	4259	4339	529	729	732	736	739	742
Capital Works	0	778	3891	3891	0	0	13	13	0	0
Payment of Principal	16	163	311	314	318	321	324	327	330	334
Working Capital	259	157	56	134	211	408	396	396	408	408
Applications	275	1098	4259	4339	529	729	732	736	739	742
Loan Liabilities	6768	6755	7034	7316	7012	6704	6393	6080	5763	5443
Cash Balance	4327	4484	4541	4674	4886	5294	5690	6086	6494	6903

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	1441	1441	1441	1441	1441	1441	1441	1441	1441	1441
Operation and Maintenance	655	655	655	655	655	655	655	655	655	655
Depreciation	219	219	219	219	219	219	219	219	219	219
Payment of Interest	41	38	41	44	40	36	32	27	23	19
Expenditure	915	913	916	918	914	910	906	902	897	893
Profit before Tax	527	529	526	523	527	531	536	540	544	548
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	527	529	526	523	527	531	536	540	544	548
Funds Statement										
Profit after Tax	527	529	526	523	527	531	536	540	544	548
Loans	0	0	0	0	0	0	0	0	0	0
Subsidies	0	0	0	0	0	0	0	0	0	0
Depreciation	219	219	219	219	219	219	219	219	219	219
Sources	746	748	745	742	746	750	754	759	763	767
Capital Works	0	0	0	0	0	0	0	0	0	0
Payment of Principal	337	346	379	412	416	420	425	429	433	438
Working Capital	408	401	366	330	330	330	330	330	330	330
Applications	746	748	745	742	746	750	754	759	763	767
Loan Liabilities	5119	4786	4413	4001	3585	3164	2739	2310	1877	1440
Cash Balance	7311	7712	8078	8408	8737	9067	9397	9727	10056	10386

Source: JICA

Chapter 5 Improvement of Health and Sanitation

5.1 Plan for Sanitary Facilities

Chagni's sanitation situation is very poor. The critical shortage of water supply aggravates even more the sanitary condition. The general use of open-area for defecation, the filled-up traditional pit latrines, the indiscriminate dumping of sullage and refuse have created environmental pollution and serious health hazards. The traditional pit latrines that are being used at present are not properly designed and constructed; and when they are filled up and emptied practically all of them cave- in and collapse.

Waste water production in liters per capita per day was estimated using water demand data for each type of water supply service.

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

Item	HC			YC			PF		
	1995	2005	2010	1995	2005	2010	1995	2005	2010
• Water demand (lpcd)	63.8	58	63	15.1	34	37	4.9	19	21
• Waste water generation rate (%)	75	74	75	63	67	68	60	64	64
• Waste water production (lpcd)	49	43	47	9	23	25	3	12	13

Form the water demand and waste water production per capita per day for Chagni as seen form Table 5.1.1, introduction of conventional sewerage system cannot be justified in any of the target years due to blockage of the system when the total water use is less than about 75 liters per capita per day. Therefore, the sanitary technologies proposed for Chagni are those that are on-site technologies such as drainage and waste water disposal pit.

5.1.1 Plan of Toilet Facilities

The sanitary technologies envisaged for Chagni 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-pit 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 Chagni, 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. If the waste water or sullage is too much for the soakaway pits to handle, then drainage field channels should be used.

(2) Dry Solid Waste

The indiscriminate dumping of dry solid wastes has to be curtailed by allocating and preparing proper dumping sites. Four dry solid waste dumping sites have been proposed for Chagni on the north, east,south and west side of the town. Based on the general agreement or consent of Chagni Municipality, the Kebeles and the communities, strategic sites for placing the collecting bins should be located so that the households can place their refuse in the collecting bins without going long distances. The contents of the bins should be transported to the refuse dumping sites by refuse disposal truck or animal-drawn cart. The Chagni Municipality should take the responsibility and the supervision of regular burning of the refuse at the dumping sites.

(3) Drainage

Two types of drainage are considered here. The first is the use of drainage field channels for the areas where the soakaway pits have become ineffective due to excess of sullage or waste water. The sizes and numbers of the drainage field channels depend on the quantity of waste water to be drained after close follow up of the working of the soakaway pits. The second type of drainage is draining the storm water. Most of the drainage facilities that were prepared during the construction of the main roads have been blocked by outside rubbishes that have been dumped on them. The first action required is to open-up the blocked drainage facilities and maintain them regularly to remain open. This would considerably help to reduce the formation of stagnant water, and thereby reducing or eliminating the sources for breeding of insects and flies. There are roads within Chagni that do not have any means of drainage facilities. These roads should have side ditches and cross drainages to drain the water whenever storm (rainfall) occurs.

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

Target Year	Households		
	HC	YC	PF
• 2005	530	2,460	2,210
• 2010	1,190	3,560	2,100

5.2.2 Estimate of Costs

(1) Capital Costs per Unit

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

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

- By the year 2005

  - All schools in Chagni will have, at least, VIP collective toilets.
  - The Chagni Hospital toilet facilities will be rehabilitated; and the clinic and possibly a health center will have VIP collective toilets.
  - Chagni 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 Chagni 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 Chagni for Year 2005

Facilities	No	Unit Cost (birr)	Total Cost (1,000 Birr)
• VIP collective toilets for schools	10	65,000	650
• VIP collective toilets for clinics and health centers	3	65,000	195
• VIP public toilet for market area and bus terminal	3	95,000	285
• 100% households with HC to have PF toilets	530	7,500	3,975*
• 75% households with YC to have VIP shared toilets or higher	1,845	15,000	27,675*
• 75% households with PF to have VIP toilets	1,658	2,000	3,316*
• 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			36,592
Excluding Households' (*)			1,626

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

Facilities	No	Unit Cost (birr)	Total Cost (1,000 Birr)
• 50% of households with HC to have flush toilets	595	7,500	4,463*
• 50% of households with YC to have VIP toilets or higher	1,780	3,000	5,340*
• 100% households with PF to have VIP toilets	2,100	2,000	4,200*
• 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			14,453
Excluding Households' (*)			450

(5) Total Operating and Maintenance Cost

Indicative operating and maintenance cost for sanitary facilities for Chagni 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	10	800	8.00
• VIP collective toilets for clinics and health centers	3	800	2.40
• VIP public toilet for market area and bus terminal	3	3,000	9.00
• Flush toilets for households with HC	530	1,250	662.50*
• VIP shared toilet for households with YC	1,845	400	738.00*
• VIP toilets for households using PF	1,658	300	497.40*
• 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			1,951.30
Excluding Households' (*)			53.40

Table 5.2.7 Annual Operating & Maintenance Costs by the Year 2010

Facilities	No	Unit Cost (birr)	Total Cost (1,000 Birr)
• Flush toilets for households with HC	595	1,250	743.75*
• VIP or higher toilets for households with YC	1,780	1,000	1,780.00*
• VIP toilets for households using PF	2,100	300	630.00*
• Vacuum truck	1	7,500	7.50
• Refuse disposal truck	1	8,500	8.50
• Refuse collecting bins	80	50	4.00
Total			3,173.75
Excluding Households' (*)			20.00

(6) Summary of Costs

- Capital Costs

Year	Cost in 1,000 Birr (Total)	Excluding Households'
2005	36,592	1,626
2010	14,453	450
Total	51,045	2,076

- Annual Operating & Maintenance Costs

Year	Cost in 1,000 Birr (Total)	Excluding Households'
2005	1,951.30	53.40
2010	3,173.75	20.00
Total	5,125.05	73.40

5.3 Application of Sanitary Education Program

In accordance to the approach mentioned in the Main report, such as the use of materials outlined there, the following recommendations were made specifically regarding sanitary education in Chagni.

Using this table, priorities for sanitary education activities can be set. Changes in sanitary behaviors should be monitored to make sure that the required changes in behaviors and health risk were being made as required. Suggestions of ways to plan and carry out such a program were included in the sanitary education manual produced by this Study. Special considerations would have to be made to promote latrine availability among the Muslim community.

Health education and sanitation programs of the Health Center needs strengthening. The Church and the Mosque were keen to participate in these activities. Because of the relatively low level of access to health education generally and particularly for Muslims, the sanitary education programme would have to make special efforts to reach the Muslim community. Work with the Mosque would be a particularly effective route into this community group.

The language diversity in Chagni must be taken into consideration. Many of the households in the survey spoke Amharic but Agew and Shinasha were their first languages. The selection of CPPs to work in this area must also be able to speak at least one of these minority languages, to make sure that vulnerable minority groups were effectively reached by the project.

Table 5.3.1 Sanitary Education Priorities in Chagni

Priority level	Type of Behavior	Blocks to Improved Practice
High	Piped water used always	Piped water not always available in sufficient quantities (WSS role) and not available when required by people (WSS role) at sites convenient for collection (WSS role).
High	Handwashing with soap after defecation	Personal hygiene (all) made more easy by making access to water and soap/ash nearer to the latrine (women's role) and by improving the status of the improved behavior (all)
High	Handwashing with soap 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) and improving the status of such behavior (all)
High	Solid waste disposal in covered pits or burned	Sites not allocated for public waste disposal sites or not managed strictly (Municipality/ Woreda) Individuals (women) must be informed of where (Municipality/ Woreda) and how to dispose of waste (CPP/ all)
Medium-High	Not eating unwashed fruit or vegetables	Domestic hygiene (women's role in home but individual's role outside home) Individuals (mostly women) must be shown methods of washing such food and be motivated to wash raw fruit and vegetables before eating (CPP role)
Medium-High	Kitchen utensils kept off the floor	Domestic hygiene (women) although facilitated by shelf or similar available in kitchen to keep utensils on (women/ men) Construction of such shelves to be promoted (CPP)
Medium-High	Waste water disposal in pits, drains or vegetable gardens	Drainage insufficient and disposal into drains not strictly managed (Municipality/Woreda) Individuals (women) must be informed of where to dispose waste water (Municipality/Woreda) and shown safe disposal techniques (CPP/all)
Medium-High	Sanitary disposal of children's excreta	Small children should be encouraged to use the latrine as soon as they are able (all family members) Clearing up of children's excreta (women and girls role) must be encouraged and status of latrine users promoted (CPP/all))
Medium-Low	Access to Piped water	Improved access and level of piped water supply (WSS role) All use water but this depends mostly on opening times, location of supply sources and to a lesser extent to price (women/girls/boys roles)
Medium-Low	Water scoop kept off the floor	Domestic hygiene (women's role) although facilitated by item in kitchen to keep utensils on (women and men's role) Construction of such shelves to be promoted (CPP)
Medium-Low	Fly Control	Associated with climate but also related to solid and liquid waste disposal and excreta disposal (Municipality/Woreda /All role) Behaviors like covering of food and water pots during storage should be maintained (CPP/All)
Medium-Low	Latrine coverage for all households	Latrines to be built and maintained (Public - Municipality/Woreda and Community/private latrines -WSS/CPP/All (made easier with examples of low cost latrines and loans (WSS)
Medium-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)

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 291 m^3/day in 1995 to 716 m^3/day in 2000, 1,198 m^3/day in 2005 and 1,966 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 17 in 1995 to 38 in 2000, 44 in 2005 and 54 in 2010.

The organizational structure will get enlarged and more diversified. The ultimate organizational structure of WSS to be realized in the last target year of 2010 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 36, 40 and 49 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, 4 and 5 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)	291	716	1,198	1,966
2. Water Production per Worker (m^3/day/worker)	17.1	20	30	40
3. Coefficient	1	1	1	1
4. No. of Personnel	17	36	40	49
5. Additional Personnel for Sanitation	0	2	4	5
6. Final No. of Personnel	17	38	44	54

2. Breakdown of Personnel by Position/Function

Positions/Functions	1995	2000	2005	2010
1. Manager	1	1	1	1
2. Customer Services	0	0	0	1
3. Internal Audit	1	1	1	1
4. Administration Service				
1) Head	0	1	1	1
2) General Administration Section				
Secretaries/Typists/Clerks	0	1	1	1
Guards	4	5	6	7
Sweepers/Janitors	0	0	0	0
Drivers	0	0	0	1
Sub-Total	4	6	7	9
3) Personnel Section				
Recruitment and Assignment	0	1	1	1
Training	0	0	0	0
Remuneration	0	0	0	0
Sub-Total	0	0	1	1
4) Storage Section				
Store Keepers	2	2	2	2
Purchase of Materials/Supplies	0	0	0	0
Sub-Total	2	2	2	2
5) Legal Section	0	0	0	1
Total	6	10	11	14

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

Positions/Functions	1995	2000	2005	2010
5. Financial Service				
1) Head	0	1	1	1
2) Budgeting Section	0	0	0	1
3) Accounting Section				
Accountants	1	1	1	1
Cashiers/Treasurers	0	1	1	1
Sub-Total	1	2	2	2
4) Financial Management Section				
Financial Analysts	0	0	0	1
5) Operation Section				
Meter Readers	0	1	2	2
Bill Distributors/Collectors	1	1	1	1
Water Sellers	6	7	8	8
Sub-Total	7	9	11	11
Total	8	12	14	16
6. Technical Service				
1) Head	0	1	1	1
2) Technical Records Section	0	1	1	1
3) Operation and Maintenance Section				
Mechanics	0	1	1	1
Electricians	0	1	1	2
Motor Operators	1	4	4	4
Plumbers	1	1	2	2
Sub-Total	2	7	8	9
4) Inspection Section				
Water Meter Technicians	0	1	1	1
Leakage Detectors	0	0	0	1
Water Quality Analysts	0	0	0	0
Sub-Total	0	1	1	2
5) Workshop	0	1	1	2
6) Works Section				
Contracting	0	1	1	1
Designing/Drafting	0	0	0	0
Sub-Total	0	1	1	1
Total	2	12	13	16
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	1	2
Drivers	0	0	1	1
Sub-Total	0	0	2	3
Total	0	2	4	5
Grand-Total	17	38	44	54

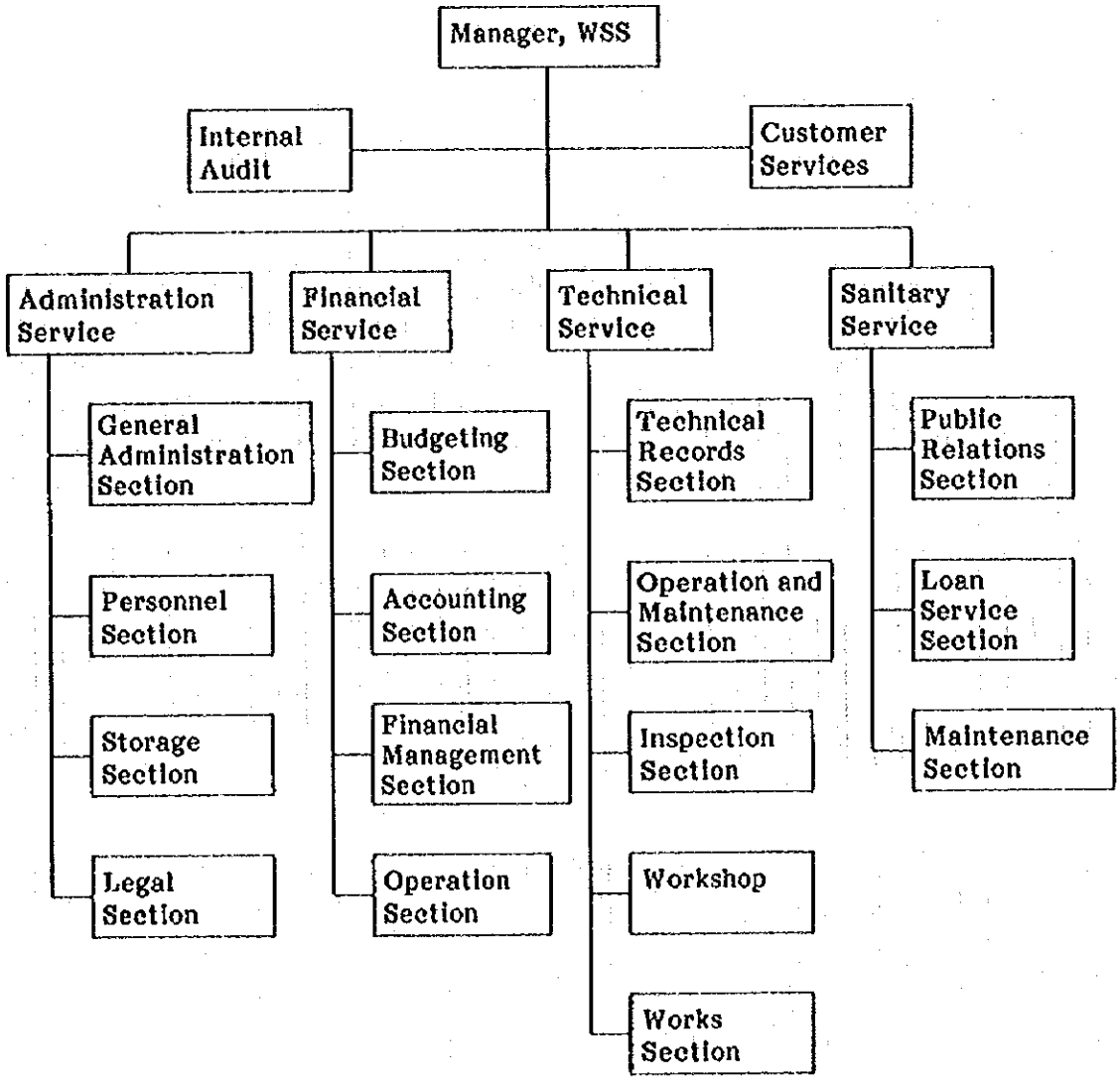


Figure 6.1.1 Proposed Model Organization Set-up of WSS

6.4 Community Building/Participation and WID

In addition to the recommendations outlined in the Main Report, the following were more specific to Chagni. Based on the findings of the field survey the following recommendations have been suggested for implementation:

- In areas where there was no piped supply there was a need for more public fountains. Potential users of these public fountains were mostly women and girls. They were willing to manage these PFs on a community basis and were also willing to participate in the construction. Women should be encouraged to participate in these ways by the project.

- In some areas people would like to have some private connections. Some of these households can afford these facilities.

- People with control over land for latrines have and use latrines. Where there was a lack of control over the land by the householders, there were no latrines. The need for allocation of land for community or for private latrines was of great importance for any sanitary improvement program. Sharing and management of community latrines must be determined by the users of those facilities in order to meet their needs fully. For example Muslim communities would prefer to share facilities with groups of people of the same sex rather than by groups of families. There must be opportunities for the community to participate throughout the implementation and longer term of the program. Those people with latrines already have other problems. There must also be a forum for their needs to be met through the project.

- Garbage disposal mechanism was required for the town. This should be managed by the Municipality. Smaller initiatives for women to use at household level could be initiated through the sanitary education program.

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	2.5	1.3
Springs/rivers	54	2.0	1.5

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 2% 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
203	6.1	16	0.0693

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 6,727 thousand birr and 5,187 thousand birr respectively. It means benefits are 77% 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 77% 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, comparable to the personnel cost of WSS.

Table 7.1.1 Saved Time and Benefit

Year	Saved Time (hours)	Benefit (birr)
1996	0	0
1997	0	0
1998	0	0
1999	436,704	30,277
2000	822,110	56,997
2001	1,021,194	70,800
2002	1,234,105	85,561
2003	1,461,554	101,330
2004	1,704,290	118,159
2005	1,963,081	136,102
2006	2,240,362	155,326
2007	2,528,747	175,320
2008	2,828,692	196,115
2009	3,140,676	217,745
2010	3,465,196	240,244
2011	3,465,196	240,244
2012	3,465,196	240,244
2013	3,465,196	240,244
2014	3,465,196	240,244
2015	3,465,196	240,244
2016	3,465,196	240,244
2017	3,465,196	240,244
2018	3,465,196	240,244
2019	3,465,196	240,244
2020	3,465,196	240,244
2021	3,465,196	240,244
2022	3,465,196	240,244
2023	3,465,196	240,244
2024	3,465,196	240,244
2025	3,465,196	240,244

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	164	164	30	-133
5	2000	0	187	187	57	-130
6	2001	0	194	194	71	-123
7	2002	0	200	200	86	-114
8	2003	0	206	206	101	-105
9	2004	0	212	212	118	-94
10	2005	0	219	219	136	-83
11	2006	0	229	229	155	-74
12	2007	0	240	240	175	-65
13	2008	0	251	251	196	-55
14	2009	0	262	262	218	-44
15	2010	0	273	273	240	-32
16	2011	0	273	273	240	-32
17	2012	0	273	273	240	-32
18	2013	0	273	273	240	-32
19	2014	0	273	273	240	-32
20	2015	0	273	273	240	-32
21	2016	0	273	273	240	-32
22	2017	0	273	273	240	-32
23	2018	0	273	273	240	-32
24	2019	0	273	273	240	-32
25	2020	0	273	273	240	-32
26	2021	0	273	273	240	-32
27	2022	0	273	273	240	-32
28	2023	0	273	273	240	-32
29	2024	0	273	273	240	-32
30	2025	0	273	273	240	-32

7.2 Financial Evaluation

7.2.1 Calculation of FIRR

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

(1) Initial Trial

Initially it was assumed that the central government would provide subsidy to the Chagni 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 3.3%.

The value was judged to be rather on the low side.

After repeated simulations, it was finally decided that the subsidy ratio of initial cost would be 85%.

(2) Final Results

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

Using the streams, FIRR was calculated. As a result, the value of 4.4% was obtained.

The value exceeds 1%, which is the assumed interest rate of external loan by 3.4%. It is judged to be sufficiently and reasonably high considering the nature and objective of the Project.

7.2.2 Sensitivity Analysis

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

Item	Conditions	Results	Difference from Base Case
1. Case 1	Benefits : -10%	FIRR: 2.7%	-1.7%
2. Case 2	Initial Cost : +10%	FIRR: 3.8%	-0.6%
3. Case 3	Progress of : 1997=70% Construction 1998=30%	FIRR: 4.8%	+0.4%
4. Case 4	Progress of : 1998=70% Construction 1999=30%	FIRR: 3.7%	-0.7%

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

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

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

Table 7.2.1 Cost Benefit Streams

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

(Unit:thousand birr)

NO.	YEAR	CC	OM	CS	BF	CF
1	1996	321	74	394	70	-324
2	1997	2925	75	3000	71	-2929
3	1998	2925	77	3002	72	-2929
4	1999	0	410	410	342	-68
5	2000	0	450	450	538	88
6	2001	0	543	543	625	82
7	2002	0	566	566	695	129
8	2003	0	589	589	766	177
9	2004	0	612	612	836	224
10	2005	0	635	635	906	272
11	2006	0	765	765	1043	278
12	2007	117	802	919	1158	239
13	2008	584	839	1423	1273	-150
14	2009	584	876	1460	1388	-72
15	2010	0	913	913	1502	589
16	2011	0	655	655	1441	786
17	2012	13	655	668	1441	774
18	2013	13	655	668	1441	774
19	2014	0	655	655	1441	786
20	2015	0	655	655	1441	786
21	2016	0	655	655	1441	786
22	2017	0	655	655	1441	786
23	2018	0	655	655	1441	786
24	2019	0	655	655	1441	786
25	2020	0	655	655	1441	786
26	2021	0	655	655	1441	786
27	2022	0	655	655	1441	786
28	2023	0	655	655	1441	786
29	2024	0	655	655	1441	786
30	2025	0	655	655	1441	786