社会開発調査部報告書
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)
No. 22

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF WATER RESOURCES

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

FEASIBILITY REPORT DUPTI

(Volume II-I)

FEBRUARY, 1996

SANYU CONSULTANTS INC.
KYOWA ENGINEERING CONSULTANTS CO., LTD.

GOVERNMENT OF JAPAN
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)
FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF WATER RESOURCES

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ON
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PREFACE

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

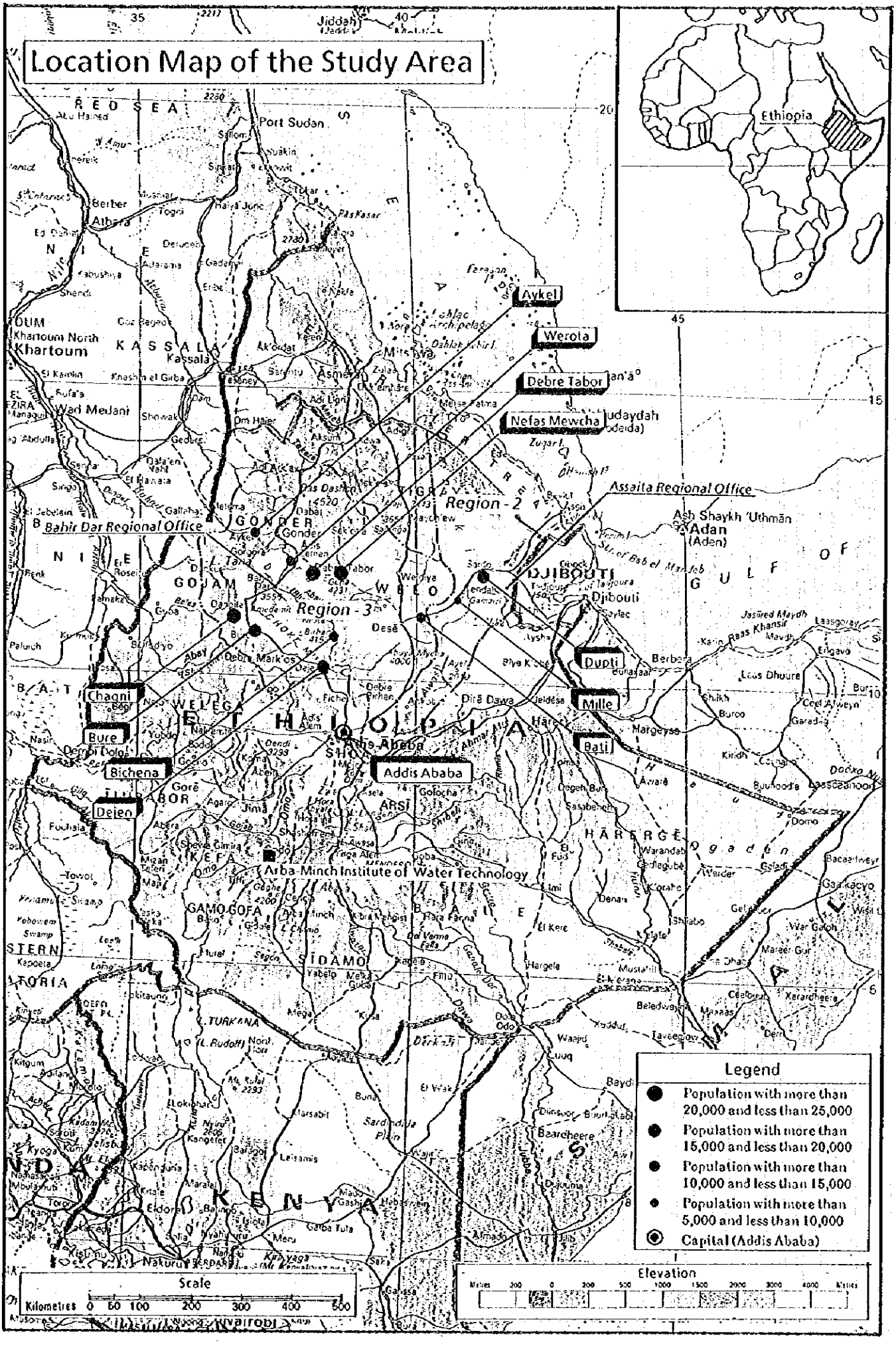
The major objectives of this Study are 1) to conduct a feasibility study on the water supply system in order to improve living condition of the population in the Study area by enhancing the level of the water supply services in terms of water quantity, water quality and its accessibility, 2) to formulate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

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

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

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

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


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

General Description of Current Condition in Dupti

Items	Description
Administration	Afar Region, Zone 1, No. of Kebele : 2
Residents	Total population : 14,737 (9.2 persons/ha) Average family size : 4.5 persons Amhara : 83% Oromo : 3% Tigre : 6% Christians : 42% (1 church) Afar : 6% Moslems : 58% (4 mosques)
Educational Conditions	Kinder garden / Elementary school / Junior & Senior high s. No. of school: 0 / 5 / 1 No. of teachers: 0 / 88 / 43 No. of students: 0 / 1844 / 1338
Medical Conditions	Hospital : 1 Doctor : - Health center : - Nurse : 6 Health clinic : 1
Economic Conditions	Hotels/restaurants : 331 Shops : 764 Cottage industry : 10 : Average monthly household income : 334 birr
Water Supply Condition	The source of WSS : Borehole (2) Major other sources : River Domestic consumption : 114.8 cum/day (17.4 lpcd) Other consumption : 21.4 cum/day (total 136.2) Water service coverage : 45% House connection : - lpcd (0%, 1.5 birr/cum) Yard connection : 61.0 lpcd (5%, 1.5 birr/cum) Neighbors : 20.2 lpcd (15%, 1.5(1.7) birr/cum) Public fountain : 5.8 lpcd (25%, 1.25(2.1) birr/cum)
Sanitary Condition	Septic toilet : 5/100HH Dry pit toilet : 83/100HH Community toilet : 9/100HH Open field : 3/100HH Toilet condition : Most pit latrines need to be improved. 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 : 72% ORS awareness : 35% Sanitary behaviors score : 1035/1600 (65%) Needs : Adequate Water, Upgraded Latrine
Remarks	1. Water charge in bracket is actually paid. 2. HH means "household". 3. ORS means Oral Rehydration Solution. 4. Water quality is not acceptable in terms of chloride, nitrate, fluoride and sulfate.

Project Description of Dupti

Items	Description
Project Title	Eleven Centers Water Supply and Sanitation
Executing Agency	Water Supply and Sewerage Service Department(WSSD)
Objectives	To supply domestic water which meets people's demand and to improve sanitary condition in the center.
Population Projected	in 1995 2000 2005 2010 14,737 (5.0%) 18,809 (4.5%) 23,439 (4.0%) 28,517
Water Demand Projected in cum/day	in 1995* 2000 2005 2010 Domestic : 115 397 841 1.636 Non Domestic : 21 132 184 253 Losses : 56 59 140 333 Total : 192 588 1,164 2,222
Dimensions of Water Supply System	Target Service Coverage: 100% (45% at present) Target Year of 2005 Shallow Wells : 2 (37m) Rising Main : ϕ150 (2.1km) ϕ100 (0.5km) Booster of Rising : — Reservoir : 360m^3(180×2) Distribution : ϕ300(350m),ϕ200(515m),ϕ150(1,295m), ϕ100(650m),ϕ75(4,410m),ϕ50(10,576m) Booster of Dist'n : ϕ300mm,Q=2.0m^3/min,H=34.0m Target Year of 2010 Water source : Shallow Well 2 Rising Main : ϕ100(1.00km) ϕ75(0.8km)
Water Tariff Structure & Accounting System	Introduction of Progressive Water Tariff** HC: 3.26 birr/m^3,YC: 2.03 birr/m^3,PF: 1.51 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 42 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 Program
UNICEF	- United Nations Children's Fund
TADE	- Tendaho Agricultural Development Enterprise
WAB	- Women's Affairs Bureau
WHO	- World Health Organization
WRDA	- Water Resources Development Authority
WSS	- Water Supply Service
WSSA	- Water Supply and Sewerage Agency
WSSD	- Water Supply and Sewerage Service Department (former WSSA)
WWCE	- Water Works Construction Enterprise
WWDE	- Water Well Drilling Enterprise

[OTHERS]

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

Exchange Rate

1 US Dollar = 6.3 Birr

1 US Dollar = 94.5 Yen

1 Birr = 15.0 Yen

GLOSSARY

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

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

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Chapter 1 Introduction

1.1 Background

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

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

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

In Dupti, water service coverage is 45 % only and the water consumption per capita per day is extremely low with the amount of 17.4 lpcd. Water quality of the sources is not accepted with reference to WHO drinking water guideline in terms of some physico-chemical aspects, and many faecal coliforms have been detected in samples collected from connections and household containers. This means the contamination is expected in such ways of through cross-connections, leaking and back-siphonage associated with aged facilities.

Although toilet coverage shows very high figure of 93 %, 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). Dupti is the one, located in Afar Region, among the Eleven Centers along with Mille, Bati, Nefas Mewcha, Debre Tabor, Werota, Aykel, Chagni, Bure, Bichena and Dejen as shown on the attached Location Map.

1.2 Overall Progress of the Study

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

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

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

For the geological part, geo-electric prospecting (GEP) survey had been conducted to identify the hydrogeological condition to be required for designing water supply systems. The 25 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

Dupti is located along Awash river in its delta. There are no other rivers in this area except for intermittent rivers (Wadis).

Dupti has a meteorological station of National Meteorological Service Agency (NMSA) and a river gauging station of WRDA. Awash river at Tendaho has a catchment area of 66,308 km^2. See Figure 2.1.1 for the locations and the watershed around Dupti.

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

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

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P(mm)	4.9	19.7	28.9	53.7	8.0	1.0	51.2	33.2	17.9	3.8	3.3	0.8	226.4
ETo(mm)	230	220	231	244	256	252	246	241	245	252	254	243	2,914
A.Temp.(°C)	25.0	26.9	28.7	30.3	32.5	34.4	33.4	32.3	32.0	28.5	26.5	25.4	28.0

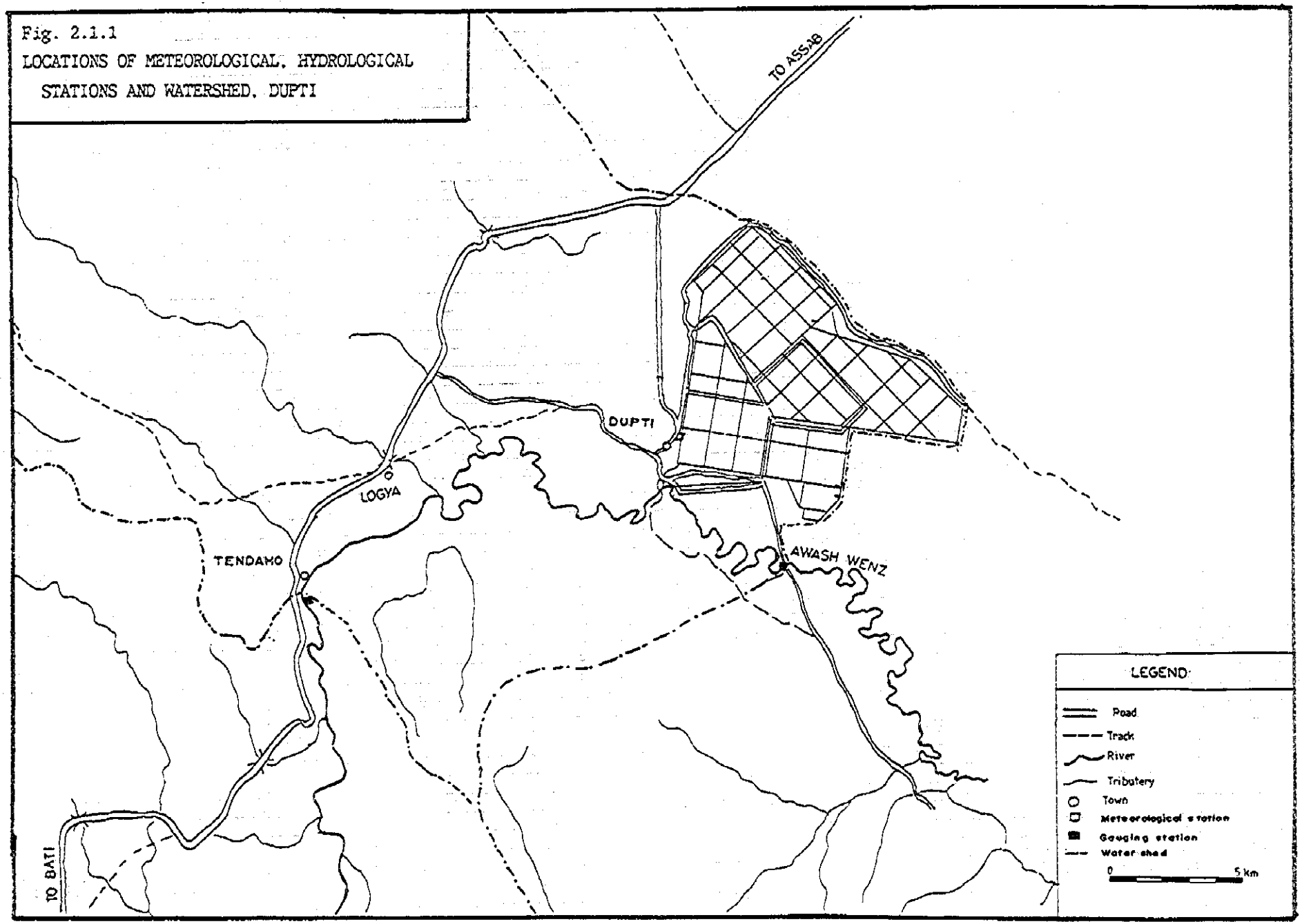
Note: P = Precipitation
ETo = Potential Evapotranspiration
A.Temp. = Air Temperature

The distribution of the monthly precipitation through year shows two weakly pronounced rainy seasons, one in April and the other in July and August. The monthly potential evapotranspiration reflects hot climate ranging from 220 mm in February to 256 mm in May.

The monthly mean air temperature ranges from 25.0°C in January to 34.4°C in June, exceeding 30°C from April to September.

Since potential evapotranspiration exceeds precipitation every month, all the precipitation will evaporate. Moreover, there is a thick silty clay layer above the aquifer which is the water source of the town water supply. This layer does not allow infiltration of rain water to the aquifer. It is considered that only the recharging unit for the aquifer is Awash river and the ground water flow from the highlands.

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



2.2 Hydrogeology

2.2.1 Geology

The Dupti plain is situated in the lower Awash Valley (Tendaho graben) with approximately 70 km long and 30 km wide. The plain dips gently down from the northwest to southeast. The basaltic lava accompanied with intense volcanic activity widely flows out trending to NW-SE in the Afar depression. The outcrops in the vicinity of New Dupti (Addis Ketema) are highly fissured and broken into blocks as boulder breccias having a brown color due to the high solar radiation. Underneath the basaltic lava, interbedded layers of volcanic ash, silt and sand are underlain. In the south of Dupti town (Old Dupti), where is occupied by the extensive Awash flood plain, thick and unconsolidated recent alluvial sediments composed of clay, silt, sand and gravel predominate widely.

As the result of analysis of aerial photographs and topographical maps, lineations trending to NW-SE are extremely remarkable. This direction is formed by the basaltic lava flow which coincides the faulting direction of the Afar depression.

2.2.2 Hydrogeology

(1) Groundwater

In Dupti, it is observed that there are nine boreholes drilled, six of them are in the old town and the other three are in New Dupti. At present, Borehole No.2, WRDA Borehole and RRC Borehole are used to supply water for the town and the Russian Camp Borehole is used only for this organization purpose, after all, four boreholes are functional. The borehole at the Commercial Bank compound in New Dupti was abandoned due to its small yield and Borehole No.1 near the mosque in the old town was abandoned due to salinity problems. Besides, Borehole No.3 drilled up to 128 m depth in the old town with no locality record was also abandoned due to high temperature and non potable mineralized water. Two boreholes were drilled in 1994. They are not operated yet, but one of them will be operational in near future as the pump has been installed.

According to the lithology data of boreholes available, the top 20-25 m is clayer sediments, and the underlying layer is gravel and sand with 20-30 m thick which is the economical aquifer zone. The pumping test data shows that SWL is 17-20 m below the ground surface, the yield ranges between 3-7 l/s and transmissivity ranges between 370-700 m^2/day. It is generally said by the people that the ground water has a saline nature. As seen about half of the children in the town have discolored teeth and the area is located in the rift valley, a high fluoride content is reported.

(2) Other Water Source

The only surface water available in the Dupti area is Awash River. This river carries a huge amount of water. Until some years ago, this water had been utilized as a source for the water supply of Tendaho plantation compound with performing the sedimentation and chemical treatment. However, epidemic disease prevailed due to the lack of chemicals, therefore, it is not utilized at present.

No spring outcrop is observed in the Dupti area.

Table 2.2.1 Boreholes in Dupti

BOREHOLE No.	LOCATION	DEPTH (m)	YIELD (l/s)	YEAR DRILLED	REMARK
WSS BH1	Old Town	66	5.62	1976	abandoned in Feb. 1995.(#1)(#2)
WSS BH2	Old Town	65.5	5.62	1976	productive, supply water for Old Town.(#2)
WSS BH3	Old Town	128	7	1987	abandoned due to high temperature.
WSS BH4	Old Town	68.25	6-8	1994	Productive, supply water for Old Town
WSS BH5	Old Town	68.25	6-8	1994	not operated yet.
WRDA BH1	Old Town	80	3.6	1988	productive, supply water for TADE.
WRDA BH2	New Town	?	?	?	productive, used only for Russian Camp.
RRC BH1	New Town	28-30	?	1989	productive, supply water for New Town.
BANK BH1	New Town	36	?	1972	abandoned due to its small yield.

Note: #1- This borehole was rehabilitated in July 1994. Even after rehabilitation, water was not clean and hole got empty in 20 minutes of pumping.
#2- The lithology of the borehole is shown in Appendices.

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

Five (5) samples had been undertaken for physico-chemical test during this Study. Among those, four (4) samples are groundwater including from the source of WSS Borehole No.2 and one (1) sample is surface water collected from Awash River. Also, results tested by Ministry of Health are referred to in line with those obtained by the Team. The samples carried out by the ministry are from Borehole No.1 located near a mosque at the center of the town, Borehole No.4 (another source of WSS, started functioning in April 1995), and Borehole No.2 same as the borehole tested by the Team.

Those representative constituents, which are above WHO drinking water quality guideline values, are summarized below. The first five (5) samples were tested by the Team and the last three (3) samples by the Ministry of Health. The population of Dupti are served piped water by the Borehole No.2 and No.4.

Table 3.1.1 Summary of Chemical Aspects in Dupti

Place	Sodium	Iron	Chloride	Nitrate	Fluoride	Sulfate	Remarks
Borehole No.2	-	2.20*	215.0	0.40	2.10*	2.1	JICA
Russian camp	-	0.13	125.0	1.76	1.70*	475.0*	JICA
Tendaho	-	0.01	375.0*	2.20	1.34	900.0*	JICA
RRC	-	0.01	150.0	4.84	1.37	500.0*	JICA
Awash River	-	0.30	35.0	33.40	0.67	15.0	JICA
Borehole No.1	550.8*	0.14	382.9*	88.60*	2.50*	248.5	May '93
Borehole No.4	347.0*	0.06	269.4*	1.00	1.90*	141.6	
Borehole No.2	380.8*	0.24	249.6	2.30	2.10*	178.0	Apr '93
WHO guideline	200.0	0.30	250.0	50.00	1.50	250.0**	

Note: * The value is above the WHO guideline.
** Value set in 1993 guideline (400 in 1984 guideline).
Borehole No.2 & No.4 are the source of WSS.
Unit is mg per liter unless otherwise stated.

Although sodium concentration had not been tested for the samples collected by the Team, the groundwater indicates high concentration of sodium according to the results obtained by Ministry of health. The WHO guideline says there is some evidence that drinking water with moderate sodium levels (100mg/l) may be associated with an elevation of blood pressure in children. However it is unknown that if the small blood pressure increases are

significant in terms of the development of early hypertension. At present, there is insufficient evidence to justify a guideline value for sodium in water based on health-risk considerations. However, it can be said that the intake of sodium may be of great significance for persons suffering from hypertension or congestive heart failure.

Iron content of 2.2 mg/l detected for Borehole No.1 is above the guideline value. Although high iron content gives no harmful effect for health, this causes stain in laundry and sanitary ware and an undesirable taste in beverages. The presence of high concentration of iron may also lead to deposits in water distribution pipes and increase maintenance cost.

Three (3) samples from Tendaho Plantation borehole, Borehole No.1 and No.4 show chloride concentration of 375, 383 and 269 mg/l respectively, which are above the guideline value of 250 mg/l. High concentration of chloride gives an undesirable taste to water and beverages, and the taste thresholds is experienced in the range of chloride ion concentration of 200 to 300 mg/l. High concentration of chloride is also known to be corrosive to metals in the distribution system, and may suggests the water is salty. According to the medical doctor of Tendaho Plantation Hospital, kidney problem probably associated with the salinity was reported to be ranked at 6th among the top ten diseases in the hospital record.

The nitrate concentration in the sample from Borehole No.1 is 88.60 mg/l, while the WHO guideline recommends the value of 50 mg/l. Since the well is located at almost center of the town, it is expected that the well is probably contaminated with sewerage and/or body disposal discharged from the residential area. Although the borehole is not serving for the population, excessive amount of nitrate in drinking water causes methaemoglobinaemia in bottle-fed infants in most cases and occasionally in some adults.

Fluoride problem is well known in Rift Valley area. WHO guideline sets the fluoride value at 1.5 mg/l, and at levels above the 1.5 mg/l, mottling of teeth has been reported very occasionally. Table 3.1.1 carries such five (5) samples collected from four (4) places with values of between 1.7 and 2.5 mg/l above the guideline value, each of which are from Borehole No.2, Russian Camp borehole, Borehole No.1 and Borehole No.4 respectively. In physical observation carried out in February 1995, between 40 to 50% of children had been found with mottling of their teeth. Since Dupti is very hot place, their water consumption must be more than that of other centers. This gives more effect of fluoride to the population and a scheme be introduced to avoid the fluoride problem. On the other hand, there were much less adults observed with the mottling teeth because they used to drink Awash River's water which contains less fluoride as shown in the Table 3.1.1.

Except Borehole No.1, No.2 and No.4, other three (3) samples of groundwater show high concentration of sulfate; namely 475 mg/l in Russian Camp, 900 mg/l in Tendaho, and 500 mg/l in RRC, while the guideline value is set at 250 mg/l. Sulfate generally has less effect on taste than chlorides. The taste thresholds vary according to the associated cation, and it has been reported to range from 250 for sodium sulfate to 1,000 mg/l for calcium sulfate (Generally taste impairment is minimal at levels below 250 mg/l). It is also known that high sulfate concentration shows laxative effect specially for new users and children. In addition, metal corrosion may be increased.

3.1.2 Bacteriological Aspects

Twenty one (21) samples from three (3) water sources had been undertaken for faecal coliforms test. The sources are borehole No.2, Tendaho plantation borehole and RRC borehole. The samples were collected from the water sources, public fountains, private connections, household containers and private containers such as Jerry-can or clay pot. The results indicate that all samples are contaminated with faecal coliforms. Even the borehole No.2, which is one of the major water sources of Dupti, has shown 2 number of faecal coliforms per 100ml. Also, containers employed for fetching and storing water in household have shown much contamination in most cases.

The result above 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 mostly improper handling of the household containers with poor awareness of sanitation of the consumers.

3.2 Current Water Consumption and Demand

3.2.1 Current Water Consumption Production

The data of the production and the billed consumption for two years were given by WSSs staff and summarized in Table 3.2.1. Total consumption and production are given as blow.

Total production	90,925 m^3
Total consumption	64,967 m^3
Losses	about 29 %

According to those data, the large scale consumers such as commerce connection and governmental connection are included in individual connection. Individual connection accounted for about 70 % of the total consumption, and public fountain accounted for about 30 %.

Concerning the consumption of individual connection, there is no large variation due to seasonal change. On the other hand, it seems that the consumption of public fountain varies seasonally.

3.2.2 Water Users

According to the water consumption census conducted by the Team, it was found that the population served by the currently operated systems, i.e. WSS borehole #2, Tendaho Plantation and RRC borehole in New Dupti was 5,600, 4,088 and 157 respectively. The population by service modes is summarized in Table 3.2.2.

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	1808	6614	(100)	114.8	(12.3)	272.1	(26.6)
House Connection	-	-		-		-	
Yard Connection	139	759	(11.5)	46.3	(61.0)	48.6	(64.0)
Public Fountain	991	3695	(55.9)	24.8	(6.7)	116.8	(33.0)
Neighbors	678	2160	(32.7)	43.6	(20.2)	101.5	(47.0)
Institutional	15			4.5			
Commercial	276			14.5			
Industrial	5			0.5			
Total	2104			134.3			

Since WSS abandoned borehole #1 due to salinity problem in September 1994, water supply situation has become critical. Many of the public fountain and private connection users who relied on the water supply system had to buy water from vendors. As a result, people is queuing in front of vendors houses and vendors are fetching water even from the houses of Tendaho Plantation compound. Those who got water from the Tendaho Plantation compound through vendors were also counted and the number is included in the number of public fountain users (Tendaho). The total number of the consumers were 4,088, which accounted to 41.5% of the population surveyed could not be checked, because the water supply system does not equip water meters.

Concerning the Wss system of borehole #2, it had 65 yard connections and one (1) public fountain at Sar Terra. Among the yard connection customers, there were 60 private customers. Many of them sold water to their neighbors and used water for their businesses such as hotels (lodgings), restaurants and shops.

15 customers of ordinary houses and shops were selected in order to estimate the domestic lpcd of yard connection. The lpcd was obtained at 61.0.

The institutional customers were namely Telecommunication, Awash Valley elementary school the church and kebele 01 office. Their consumption was not recorded except for the church.

The users of the public fountain at Sar Terra were counted at 100 houses with the population of 463. Although there were 49 houses which engaged in businesses, their businesses were so small that their consumption for their businesses was negligible. Their domestic consumption was directly calculated at 20.4 m^3 with the population lpcd and the consumption record of Jan. 1995, i.e. 245m^3.

Those who borrowed and bought water from the neighbors who possess private connections were counted at 674 houses with the population of 2,160. Their consumption was obtained by the census survey and checked with the consumption records of those who gave water. IN order to estimate the domestic lpcd, 189 ordinary houses of which consumption met the consumption of those who gave water reasonably were selected. The lpcd is estimated at 20.2, which is almost equal to the lpcd of public fountain (Sar Terra) users. There were 116 houses which engaged in businesses. However, it was not possible to estimate the

consumption for their businesses, because the total consumption of those who borrowed water from neighbors could not be estimated.

In New Dupti, there is one public fountain. There were 38 users with the population of 157 excluding the nomad who stayed nearby. Since the public fountain was not metered, their consumption reported could not be checked. 29 ordinary houses were selected to estimate the domestic lpcd. The lpcd was obtained at 28.5. Although there were tea rooms, their commercial consumption was negligible. There were three (3) institutions namely the commercial bank, EDDC and the district administration office. Their institutional consumption was summed to 2.6 m^3/day.

3.2.3 Current Demand

The demand of those domestic categories was calculated, applying the lpcd figures given in Table 3.2.1. The water required by the users of different mode of service for different domestic purposes was estimated by WSSA and listed. There were following five categories of users.

- Traditional source users (TSU)
- Public Fountain users (PTU)
- Neighbor hood tap users (NTU)
- Yard Connection users (YTU)
- House Connection users (HTU)

Since there are no neighbor hood tap users in Dupti, it is considered that they are equivalent to those who borrow and buy water from neighbors.

Table 3.2.1 Water Production and Consumption in Dupti

	Consumption (m3)								Production (m3)			Unaccounted Losses	
							Sub	Grand	Well				
	IC	PF1	PF2	PF3	PF4	PF5	Total	Total	No.1	No.2	Total	(m3)	(%)
Jul-93	2,152	1,560	62	980	936	59	3,597	5,749					
Aug-93	2,479	194		160	123	27	504	2,983					
Sep-93	2,480	320	11	265	95	32	723	3,203	3,440	3,233	6,673	3,470	52
Oct-93	2,145	1,186	81	905	301	77	2,550	4,695		2,836	2,836	-1,859	-66
Nov-93	2,027	520	16	487	98	31	1,152	3,179		1,810	1,810	-1,369	-76
Dec-93	1,866	851	15	590	104		1,560	3,426	584	3,325	3,909	483	12
Jan-94	1,901	382	7	232	124	68	813	2,714	419	3,009	3,428	714	21
Feb-94	2,256	563		71	128	27	789	3,045		3,915	3,915	870	22
Mar-94	2,208	444		77	246		767	2,975		3,891	3,891	916	24
Apr-94	2,103	358			96	21	475	2,578	209	3,881	4,090	1,512	37
May-94	2,290	621		136	364	24	1,145	3,435	728	3,981	4,709	1,274	27
Jun-94	2,290	815			207	10	1,032	3,322	673	3,491	4,164	842	20
Jul-94	2,114	535			70		605	2,719		3,415	3,415	696	20
Aug-94	1,745	580			139	21	740	2,485		3,594	3,594	1,109	31
Sep-94	2,141						0	2,141		3,207	3,207	1,066	33
Oct-94	2,141						0	2,141		3,588	3,588	1,447	40
Nov-94	2,141						0	2,141		2,274	2,274	133	6
Dec-94	2,141						0	2,141		3,049	3,049	908	30
Jan-95	2,141				245		245	2,386	3,211		3,211	825	26
Feb-95	2,141	665	24		475		1,164	3,305	2,836	1,329	4,165	860	21
Mar-95	2,142	366			369		735	2,877	2,905	3,195	6,100	3,223	53
Apr-95	3,256						0	3,256	2,747	2,973	5,720	2,464	43
May-95	2,752				667		667	3,419	1,584	4,543	6,127	2,708	44
Jun-95	2,753	631					631	3,384	2,275	4,775	7,050	3,666	52
Total	53,805						19,894	73,699	21,611	69,314	90,925	25,958	29
Average								3,071			4,133		
Maximum								5,749					

* Recorded in Ethiopian Calendar IC: Individual Connection PF: Public Fountain *Unaccounted loss is sumed up from Sep. '93 to Jun. '95.

3.3 Water Supply Facilities Condition

3.3.1 General

Dupti town is classified as a satellite town of Asayta in Region 2. The water supply for Dupti town is under the control of Regional office in Asayta. The town is divided into two parts: Old and New town. Administrative offices are being transferred from Old town to New town.

These two parts of the town has two independent water supply system. Each part has a piped water system with a borehole as water source. No hydroelectric supply is available in this town, so that the power for the water supply is served by the on-site generators.

The existing water supply system has been composed of boreholes, distribution (transmission) pipelines and reservoirs. The schematic existing water supply system is shown in Figure 3.3.1.

In addition, Tendaho Cotton Plantation has their own water supply system. They also supplies the water to the old town of Dupti with one public fountain.

3.3.2 Old Town

(1) Water Source

There are three operational boreholes. Of three operational boreholes, only one production borehole serves water supply for this part of the town.

The production borehole, constructed by previous EWWCA in 1976, is located southwest of the town near Awash Valley Elementary School. This borehole is with a depth of 65m , and its head is fitted with a check valve, a pressure gauge and a flow meter. The pumping rate is reportedly around 0.3 l/sec. No technical data on the submersible pump is available. This submersible pump is driven by the on-site generator, English-made with the capacity of 50KVA.

One of the remaining two boreholes, which is located near the Telecommunication Office, is going to be connected with the pipeline network. The pipeline between the borehole and the reservoir near the Mosque is almost completed by the Waterworks Construction Section in Region 3. And the submersible pump has been installed already. Concerning the remaining one borehole, there is no plan to install submersible pump and unconnected with the pipeline.

(2) Transmission and Distribution Facilities

The pumped water is delivered to the individual connections and the public fountains, through the distribution pipeline.

The distribution pipeline is branched system with a galvanized steel pipes. The pipeline data is summarized as follows:

Table 3.3.1 Existing Pipeline Data

Diameter (mm)	Length (m)	Material
25	435	G.S.
40	1690	-do-
50	1741	-do-
65	2077	-do-

There are three elevated tanks in Old town. Among those tanks, two tanks at the center of town and near the mosque are operational, and one tank located in the compound of the production borehole is not operational.

The elevated tank at the center of old town is with the capacity of 3m3, but utilized for only public fountain. The elevated tank near Mosque is with the capacity of 20m3, but not used due to the abandonment of Borehole No.1. The elevated tanks are made of steel, and those supports are concrete made.

Another tank at Borehole No.2 is under repair, and it will serve a public fountain at the borehole.

(3) Service Level

There are two modes: individual connection and public fountain. There is no demarcation between house connection and yard connection with the WSS.

There are 98 individual connections in this town. Of these 98, 66 connections are operational, and the remaining 32 connections are interrupted due to water shortage.

There are 9 public fountains in old town. Among these public fountains, 8 fountains are in the town water supply system, and another public fountain is in the Tendaho plantations own system.

Concerning 8 fountains in the town water supply system, only one fountain is operational. The other fountains are interrupted due to water shortage or not used due to the inconvenient location of fountain. Actually, some of the fountains are located in the private compound, it is difficult to fetch the water by this reason. The public fountains are usually opened twice a day in the morning and the afternoon.

3.3.3 New Town

(1) Water Source

The water is served by the shallow well with the mono-pump at present, but this water source is owned by RRC. No technical data on this mono-pump is available.

(2) Distribution Facilities

The system has a single distribution pipeline and a reservoir with the capacity of $50m^3$. It is reported that this reservoir is not operational. The diameter of the distribution pipeline is DN50 with the length of 100m.

(3) Service Level

There is one operational public fountain owned and managed by RRC. The administrative offices have own individual connections. The public fountain is utilized by nomadic people as well.

3.3.4 O & M

The water supply id under the control of regional office in Asaita, Afar Region. There is no WSS office in Dupti. No monthly and daily regular check up is made for the water supply facilities, and maintenance works is made by former EWCCA in Kombolcha occasionally on contract basis.

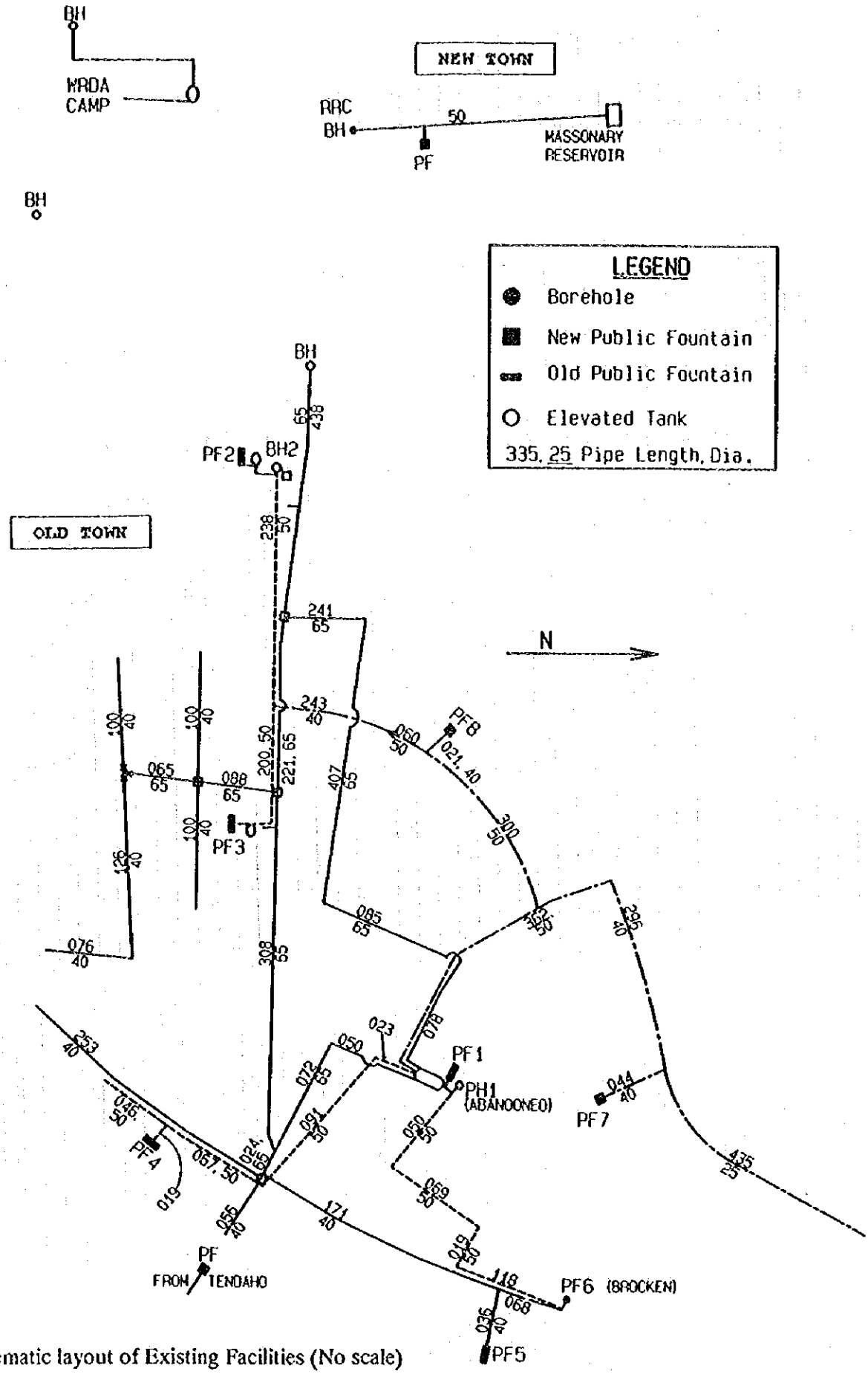


Figure 3.3.1 Schematic layout of Existing Facilities (No scale)

3.4 Sanitary Facilities Condition

3.4.1 Toilet Facilities

The people of Dupti use traditional pit latrines, open-field and flush toilets as toilet facilities. Those who use flush toilets, they can use them only when there is water. Since Dupti has, at present, critical shortage of water, the use of this type of toilet is very minimal. The majority of the people use pit latrines and open-field defecation. There is no sewerage system in Dupti.

The Population and Housing Censing of 1984 as updated in 1993 has reported the distribution of household units by type of toilet facility of Dupti as follows.

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

Number and percentage	Flush		Dry pit		None	Other	Total
	Private	Shared	Private	Shared			
• Number	174	89	661	665	776	17	2,382
• Percentage (%)	7.3	3.7	27.8	27.9	32.6	0.7	100.0

Since Dupti is satellite to Tendaho Cotton Plantation, the above figures include also the toilet facilities of the plantation. But when one looks into the Dupti proper alone, excluding the Plantation, the figures of the toilet facilities would be completely different, specially when it comes to flush toilets. Talking all, still a very large majority of the people use dry pit latrines; and open-area mostly near St. Mary Church, the Christian and Muslim Cemeteries and the Air Strip area.

During this Study, the Team has carried out a field survey using questionnaires of 100 households, the survey results on toilet facilities are shown in Table 3.4.2.

Table 3.4.2 Results of the Survey of 100 Households Pertaining to Toilet Facilities

Percentage	Type of Toilet Facility					
	Septic Tank	Dry Pit Latrine	Community Toilet	Open field	Other	Total
%	5	83	9	3	-	100

The above tabulation indicates that out of 100 households 92% use pit latrines and 5% have flush toilets. It is very striking to note that out of 100 households surveyed, only 3 households do not have toilet facilities. This may be due to small number of samplings; whereas the 1993 updated Census Report covers the sanitation survey of the whole Dupti. From field observation by the sanitation group, the feeling is that the reality supports more and comes closer to what is revealed in Table 3.4.1.

The most frequently used toilet facility (pit latrine) gets usually filled up in about 2-3 years. If the owners have space they dig new ones; if they have no space they will either empty them if they can get a vacuum truck or totally abandon them if they cannot get

one. Then these owners do not have any other alternative except go for open-field for disposing their excreta.

Dupti does not have sites for dumping sludge evacuated from pit latrines. The Tendaho Plantation has a vacuum truck and sometimes it assists in emptying pit latrines. They do this after making quite sure that the pit latrines do not collapse or cave-in while emptying. Since practically all the pit latrines in Dupti are not lined, chances of collapsing have been reported to be frequent.

The 1984 Population and Housing Census as updated in 1993 has surveyed the distribution of housing units in Dupti by type of materials used in the construction of walls, roofs and floors. The survey results are shown in Table 3.4.1.3.

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

Wall			Roof		Floor		
Wood & Mud	Stone & Mud	Stone & Cement	Corrugated Iron Sheet	Thatched (Grass)	Earth/Mud	Cement/ Concrete	Wood Tile
84%	<1%	8%	15%	21%	79%	10%	6%

The results of the survey indicate that 84% of households in Dupti have the walls of their houses built out of wood sticks and mud, 8% out of stone and cement, and less than 1% out of stone and mud. When it comes to roofing 21% are made of thatched grass; but these are usually covered with mud or earth to keep the house cool. As it can be seen most of the floors of the houses are made of earth or mud (79%); while the second popular flooring is cement and concrete. The construction of toilet facilities use similar materials as that used in building the housing units.

3.4.2 Other Sanitary Facilities

Dupti has two sites for dry solid waste disposal called <Ganga>. But they are not properly used. The Municipality of Dupti is rather new and has not functioned effectively yet. The Gangas near the Dupti Air Strip and near the St. Mary Church have now become open defecation areas. These Gangas are mostly used by the people that live closely. The people take their refuse by carrying themselves; and those that can get wheel barrows, they use them to haul the refuse to the dumping site. People who live far away from these sites dump their dry solid wastes at any convenient places. The results of the survey of the 100 households indicate that 38 households throw their refuse anywhere; other 38 households dump in open pit; 6 households in covered pit; and only 18 households out of 100 burn their refuses.

Most of the people in Dupti dump their sullages everywhere, mostly in front of their houses or along the streets. The survey of 100 households carried out pertaining to sullage shows that 65 households out of 100 dump their sullage anywhere; 33 households in pits and 2 households in drains.

There are no industries as such in Dupti and consequently no industrial wastes exist.

Abattoir does not exist in the town; and people kill their meat animals everywhere. They dispose the wastes at any convenient places they find.

There are no adequate storm drainage facilities in Dupti. Whatever few there are, they are very small and capacities are low. Practically all the available drainage facilities are earth channels. The drainage ditches along the main roads are the ones considered better.

3.5 Organization and Management

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

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

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

The number of personnel for the satellite water supply service of Dupti is 10 and its breakdown by position/function is shown below.

Table 3.5.1 Number of Personnel and Positions/Functions

Positions/Functions	Gender		Type of Employment		
	M	F	Permanent	Contract	Temporary
1. Administration					
Guards	3	0	0	3	0
2. Finance					
Water sellers	4	1	0	5	0
3. Technical					
Motor operators	2	0	0	2	0
Total	9	1	0	10	0

Because of absence of water meter no solid data are available regarding the production and consumption of water. However, based on the water price annual water consumption in 1993/1994 is estimated at something like 35,565 m^3. Leakage ratio is not known. But, supposing that it is 15%, then annual water production in 1993/1994 works out to 41,841 m^3. When it is divided by the number of personnel, one gets 4,184 m^3, which is an estimated annual production of water per employee.

This labor productivity indicator of the town is one of the highest among the 11 towns. It may suggest that the number of personnel is at a reasonable level. The monthly remuneration per worker is 129 birr. It is one of the lowest. It follows from the above that one can cite a curtailment of workforce and personnel cost as an advantage of satellite water supply operations.

The female worker is only one. The average share of females in water supply workers of the 11 towns is 27%. In this meaning female participation in water supply activities in Dupti is low.

3.6 Financial Condition of WSS

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

The price of water per m^3 is 1.5 birr for owners of connections and 1.25 birr for users of public fountains. The water price for connection owners is the highest among the 11 towns concerned. The water price for public fountain users is the same as in Mille and Bichena and it is higher than in other towns except Aykel, where it is 5 birr per m^3.

Consumption of water in the last fiscal year (Jul. 1993 to Jun. 1994) is calculated at something like 35,565 m^3. The daily water consumption as divided by population comes to 6.6 liter. This is rather on the high side. Water production is not known because there is no water meter.

Income for the last year was 51,262 birr. Major sources of income were yard connections customers (67.9%), public fountains users (30.2%) and service charge (1.7%). Income per m^3 of water consumed works out to 1.44 birr, which is on the low side. Bill collection rate is 85.7%, which is on the low side.

Expenditures for the same year were 60,188 birr. Major items of expenditures were fuel (49.7%), salary (25.6%) and per diem (8.3%). The income-expenditure ratio comes to 85.2%. This is on the low side.

The number of personnel is 10. It is the smallest among the 11 towns. Annual income per worker is 5,126 birr, which is the second highest, next to 4,246 birr in Bati. Expenditures per worker is 6,019 birr, which is the highest. Average monthly income of WSS employees is 129 birr. It is one of the lowest among the 11 towns.

It follows from the above that low bill collection rate, low income per unit consumption of water (limited number of clients may be responsible for it) and high level of cost (high fuel cost is responsible) combinedly make WSS financially in the red. A lack of managerial discipline and motivation seems to lie behind this state of affairs.

3.7 Social Background and People's Awareness

3.7.1 Population and social composition

The population of Dupti was estimated to be around 14,737. According to the household survey the ethnic mix was 84% Amhara, 3% Oromo, 6% Tigre and 6% Afar while the proportion of Christians to Muslims was 42% to 58% and the ratio of female to male household heads was 57% to 43%. In the recent past there has been a handing over of administrative power to the Afar. This change of responsibilities and authority was

regarded by some with trepidation. This issue will have to be adequately addressed by any development program which requires community participation or management. Laboring in the Tendaho Plantation occurs from June to October and October to January. 90% of the town population were involved. Other business activities centered on trading and retailing from wood, tea and chat and some items from Djibouti. There was also a considerable income for a few water vendors from private connections.

3.7.2 Sanitary conditions

Many households had and used reasonable simple pit latrines, but when asked the majority reported that they used "open fields". Responses to the household survey indicate that there was significant dissatisfaction with the type of latrines in use. Those using latrines did not necessarily dispose of children's excreta in the latrine if the child was too small to use the facility properly by his/her self.

Where households were in rented accommodation near to the edge of town there were fewer latrines. Women used the same open site as men but went either very early in the morning or late at night for privacy. Anal cleansing was with water for females but males also used paper or stones. Afar tradition suggests that Afar cover their excreta with soil after defecating.

People prefer household latrines but in areas where the soil was unstable or land not available people reported that they would like community latrines and could manage them themselves. Separate cubicles would be required for males and females. Water seal latrines were the preferred option for PC users but not for PF users as people have seen them blocked and dysfunctional in the town.

Water supply was such a priority need that any sanitation program would fail without adequate improvements in water supply. Since the field survey was carried out some improvements have been made to the water situation in Dupti. The effect this has had on the elements outlined in this report are unknown.

3.7.3 Water situation

Of all the PFs and PCs once installed in the main town water supply system, only two PFs and 65 PCs were in operation at the time of the field survey. These were controlled by water vendors who sold water at inflated prices to the rest of that part of the town. It is not clear who determined which PFs and PCs were operated.

There was constant queuing at the water points, with long rows of 30 liter jerry cans. Water flowed at different times due to a series of management problems, including no water on Sundays. The generator battery had no power and other offices from which batteries could be borrowed were closed on Sundays. When water was flowing it flowed very slowly. At times of shortage people paid water vendors up to one birr for 30 liters or took water directly from the Awash river or via vendors with donkeys.

The Tendaho plantation provided the southern part of the town with most of it's water supply. Although intended for plantation workers, other towns folk requested friends in

the plantation to supply them with water from their PF or yard connections. This supply was free of charge.

New Dupti also had a borehole which it managed itself including the servicing of the pump and generator. Free use by nomadic Afar without payment was tolerated but had a potential for tensions.

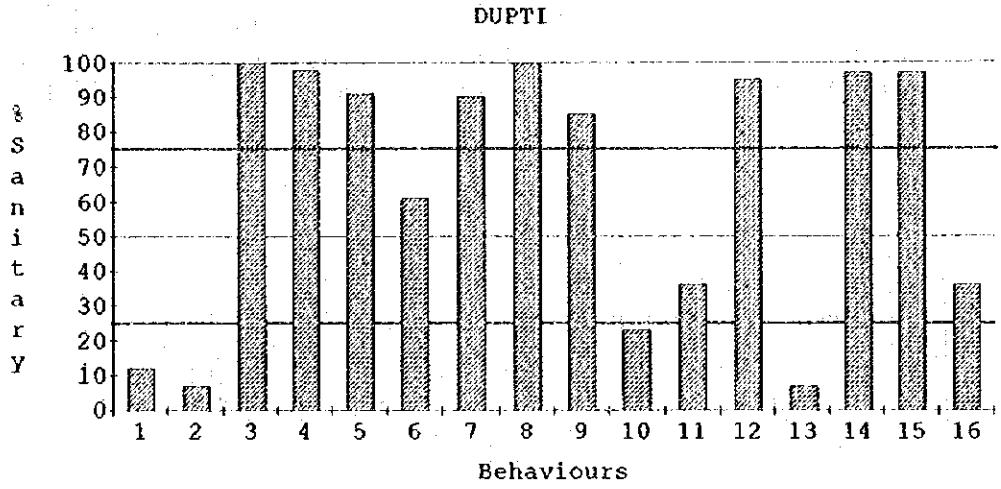
Most water was carried round the town on the backs of rented donkeys or on roughly made hand carts. 40% of households in the household survey also carried water themselves. The large size (30 liter) of the jerry cans and excessive queuing had meant that women were not the only major collectors and carriers of water. This task fell on men and boys and to a lesser extent on girls from public fountains and mostly on men from other sources. Reducing the time and energy spent on water collection would enable men, women, boys and girls to spend more time on other things including relaxation, income generation and study.

Water users could be divided into those with PCs and those without PCs. The difference in gender roles between the two groups was not great between these two groups but the activities profiles and needs analysis were very different. All agreed on the priority need for more water points, greater reliability, less queuing and a fair price. In the household survey people preferred PCs but during group discussions PFs were preferred because of affordability. However the strategic needs are very different, with the PC users keen on a government managed system while the PF and vendor users would be ready to take the responsibility for managing the improved water system and to put additional money aside for maintenance and spare parts.

Water quality problems associated with high mineral content of ground water may require extensive treatment and be too expensive. Selection of water sources other than boreholes would need to be done in full consultation with the community. There may be a reluctance to use Awash River water as a permanent source as residents are fully aware of the river's contamination and prefer the taste of borehole water.

3.7.4 Health indicators

Health services are provided by a government clinic and the former plantation hospital (now government run). Health education is provided to patients by both of these health facilities, and they both expressed willingness to assist in any campaign for sanitary education. Diseases which were common include malaria, TB, diarrhea (both amebic dysentery and giardia). The Health Clinic reported a higher incidence of diarrhea in the area served by the Dupti water supply system compared with the area served by the Tendaho plantation. This is probably because of the supplement of river water in the former. There is also significant mottling of teeth among the youth and kidney disorder in the whole community. This is consistent with high levels of dissolved minerals.



No.	SANITARY BEHAVIOURS	%Sanitary
1	Access to piped water	12
2	Use piped water supply always	7
3	Covered water container	100
4	Water scoop kept off the floor	98
5	Handwashing with soap after defecating	91
6	" after handling childrens stools*	61
7	Covering cooked food during storage	90
8	Not eating unwashed raw fruit and vegetables	100
9	Kitchen utensils stored off the floor	85
10	Rubbish burried or burned	23
11	Wastewater disposed in pit/drain/veg. garden	36
12	No animals kept in the house	95
13	Home not infested with flies	7
14	Latrine in use by household	97
15	Latrine in use by all household members	97
16	Infant's excreta disposed of in latrine*	36
TOTAL SCORE FOR SANITARY BEHAVIOURS		1035

*As proportion of households with young children

Figure 3.7.1 Indicator Sanitary Behaviours

According to the group meetings and the household questionnaires, people in Dupti had a relatively high level of sanitary awareness, but a relatively low level of ORS awareness compared with other towns in the Study. Practices of indicator sanitary behaviors are also comparatively high (See Figure 3.7.1).

Only one household in the household survey had access to a PC, then there was no discernible difference between the user groups for sanitary scores. However the group discussions did identify different access to water and to other resources in general. No differences were found between ethnic groups, gender of heads of households or between the two religions present according to the results of both the group discussions or the household survey.

The indicator sanitary behaviors suggest the areas where sanitary improvements are required. These are applicable to the majority of the town regardless of ethnicity or religion. The highest priority area are access to piped water and use of piped water always, sanitary refuse disposal and fly control. The high-middle level priorities are sanitary waste water disposal and sanitary disposal of children's excreta. The middle-low level priorities are only washing of hands after handling of children's excreta. All other sanitary behaviors are reasonable.

3.7.5 Education

Dupti has one high school. The school had 43 teachers including science teachers. The school had a 2:1 ratio of boys to girls with a higher dropout rate for girls. The number of pupils was in the region of 1330. An HIV/Health Club had been set up as part of the anti-Aids campaign. This club could be used for hygiene promotion activities. For this the school would require some financial assistance and possibly some approval from the Regional Education Authority.

The school had neither water nor adequate sanitation facilities. Students beg water from the village of New Dupti but in the hot season the school pupils have sometimes been overcome and feint with the heat.

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

It is especially to be noted in this regard that there is Tendaho Agricultural Enterprise. This governmental farm produces more than 100,000 quintals of cotton every year, the proceeds from it amount to some 20 million birr and the number of employees reaches 1,155.

The number of government employees is estimated at something like 500. It is rather on the large side among the 11 towns. The number of them per 1,000 population works out to 34, which is on low side. Their average monthly salaries are 311 birr, which is also on the low side.

This town has two Kebele. It has no NGO.

3.8.2 Population

The population of the town is estimated at 14,737 according WSSA. It belongs to the medium size group along with that of Bure, Bichena and Bati, all falling under the 14,000

to 15,000 bracket. Ethnically, Amhara is predominant, occupying 83.6% of the population, followed by Afar and Tigre both with 5.8 % and Oromo with 2.9%. Religion-wise, 58% of the population is Moslems and 42% Christians. There are 4 mosques and 1 church.

This town is ethnically mixed although Amhara leads others. Also, it is an Islamic center.

The average family size is 4.5 persons. This is the smallest among the 11 towns. The area of the town is observed to be 1,600 ha, which is the largest. The population density is calculated at 9.6 persons/ha. It is the lowest among the 11 towns.

3.8.3 Educational Conditions

here are 5 elementary schools and one high school with up to 12th grade. The total number of pupils/students is 3,182. It is on the small side. The number of pupils/students per 100 population is calculated at 22, which is on the low side.

Literacy ratio and primary school enrollment ratio were 70% and 62% respectively according to the 1984 population census. The former is on the high side, while the latter is on the low side.

3.8.4 Medical Conditions

There are 1 hospital, 1 health clinic, 1 health station and 1 Malaria Control and Eradication Office. Also, there are 11 private drug stores. The total number of medical personnel in both the hospital and the clinic comes to 36, which is one of the largest among the 11 towns. It means that there are 2.4 medical personnel for every 1,000 population. It is one of the highest.

The types of diseases people suffer most are water-borne diseases such as malaria, diarrhea, dysentery and skin diseases, and respiratory tract infections such as T.B., bronchitis and pneumonia. It seems that it has something to do with the shortage of piped water and climatic conditions in the town. The number of top ten disease cases treated in both Dupti Hospital and Dupti Clinic in 1993/94 was 14,943.

The estimated total number of cases treated last year in the hospital and the clinic was divided by the estimated service population. It came to 30.4%, which is one of the highest.

Under 5 mortality rate and life expectancy were 213/1000 and 47 years respectively according to the 1984 population census. They are both the worst among the 11 towns.

Ratio of households more or less using septic tanks and pit latrines is 86%. This is the highest among the 11 towns.

It follows from the above that medical/sanitary measures in the town are one of the most advanced. Also, in spite of it, people of Dupti suffer from illness and early death more than those of most of the 11 towns.

3.8.5 Economic Conditions

The number of hotels and restaurants is 331 (30.0%), that of shops 764 (69.1%) and that of cottage industry 10 (0.9%), adding up to 1,105. This total number of commercial/industrial establishments is the second largest among the 11 towns, next to 1,672 in Debre Tabor. The total number per 1,000 population comes to 75 which is the highest. The number of hotels and restaurants per 1,000 population is 22, which is the second highest, following 42 in Mille. Debre Tabor has the same number as Dupti in this connection.

Dupti is characterized as a big and busy commercial town.

Major occupations in the town are government employees, merchants and day laborers. Major marketable items are vegetables, fruit, oil and other household items, crops such as cotton and maize, and animals such as ox, cow, sheep and goat. There is no major market day in a week.

The average monthly household income is 334 birr. This is the highest among the 11 towns.

3.9 Town Planning and Development

The master plan for town planning has not been formulated, and there is no plan to formulate the master plan according to the officials in Regional office of Region 2.

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

Chapter 4 Plan of Water Supply System

4.1 Water Demand Projection

4.1.1 Population Projection

The population of Dupti was 8,995 in 1984 according to the results of the 1984 Population Census. The census is the first one the Ethiopian government has ever took. No population figures are available for Dupti before 1984.

Since 1984 Central Statistical Authority (CSA) published its own estimates of population. According to them population of the town in 1992 and 1993 was 6,081 and 6,370 respectively. They are not commensurate with the 1984 census figures. Also, the JICA Study Team has the Cartographic Census population figures of the town for 1994, which are 9,845. The census was conducted by CSA using its own staff. CSA told the team that the figures are the most dependable.

On the other hand, the team conducted its own census of Dupti population on the site. As a result it was found that it is almost 15,000. WSSA has similar figures as 1994 estimates, which are 14,737.

Dupti has the Tendaho Farm with the number of workers and their dependents reaching 1,155. Also, The geo-thermal project is now underway. If it is successful, industry such as brick, cement, oil and soap factories is expected to mushroom using the newly developed electric power. Besides, Dupti has an estimated area of 1,600 ha, which is the largest among the 11 towns. All these things give hope for future population growth for the town.

Eventually the WSSA figures were adopted as the 1995 population of the town. And as the average annual population growth rate 1995 to 2000 5.0% was adopted based on the average annual population growth rate 1984 to 1994, which is 5.06%. 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 4.5% and 4% respectively.

As a result the projected population of the town for 2000, 2005 and 2010 works out to 18,809, 23,439 and 28,517 respectively (Refer to Table 4.1.1).

Table 4.1.1 Population of Dupti

1. Past Population

1984 Population Census	1994 Estimates by WSSA	Average Annual Growth Rate 1984 to 1994
8,995	14,737	5.06%

2. Population Projection

1995	2000	Average Annual Growth Rate 1995 to 2000
14,737	18,809	5.0%
2000	2005	Average Annual Growth Rate 2000 to 2005
18,809	23,439	4.5%
2005	2010	Average Annual Growth Rate 2005 to 2010
23,439	28,517	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.

100% of the population is targeted at the year of 2010 to be served by the piped water system. Based on the the ratio of the households who are payable for the mode-wise water charge, target ratio of the sum of house and yard connections (YC) at the year of 2010 is 97%, and 41% of this ratio is house connection (HC).

Table 4.1.2 Population Forecast by Service Modes

	Population (%)							
	1995		2000		2005		2010	
HC	0	(0.0)	1,279	(6.8)	4,781	(20.4)	11,691	(41.0)
YC	2,919	(19.8)	4,871	(25.9)	8,930	(38.1)	15,969	(56.0)
PF	3,695	(25.1)	7,236	(38.5)	7,005	(29.9)	857	(3.0)
Sub total	6,614	(44.9)	13,386	(71.2)	20,716	(88.4)	28,517	(100.0)
TSU	8,123	55.1	5,423	28.8	2,723	11.6	0	0.0
Total	14,737	100.0	18,809	100.0	23,439	100.0	28,517	100.0

b) Projection of Domestic Water Demand

Water demand figure by service modes formulated by WSSA is applied for the projection, i.e, House Connection 60 lpcd, Yard Connection 35 lpcd, Public Fountain 15 lpcd. In addition, these figures multiply by 1.1, considering the natural condition (annual mean rainfall is less than 900 mm). Based on these conditions, the domestic water demands at the years of 2000, 2005 and 2010 are obtained as follows:

Table 4.1.3 Domestic Water Demand by Mode

	m^3/day (lpcd)							
	1995		2000		2005		2010	
HC	0.0	(0.0)	84.4	(66)	339.5	(71)	900.2	(77)
YC	89.9	(30.8)	190.0	(39)	375.1	(42)	718.6	(45)
PF	24.8	(6.7)	123.0	(17)	126.1	(18)	17.1	(20)
Total	114.7		397.4		840.6		1636.0	
Average	38.2	(17.3)	132.5	(30)	280.2	(41)	545.3	(57)

(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 Non Domestic Water Demand in 1995

Item	Unit	Nos.	Demand (m^3/day)	Remarks
School	5 l/person	3,182	15.9	
Hospital	20 l/staff	12	0.2	
Hotel	100 l/bed	132	13.2	6 beds/place × 22 places = 132 beds
Bar...	200 l/bar	295	59.0	
Mosque	5 l/visitor	600	3.0	200 visitors/place × 4 places = 600
Offices	5 l/person	202	1.0	
Total			92.3	

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	15.9	20.3	25.3	30.8	Population growth rate
Hospital	0.2	0.3	0.4	0.5	-do-
Hotel	13.2	19.4	27.9	39.1	Population growth rate +3%
Bar, Tea shop	59.0	86.7	124.5	174.6	-do-
Mosques	3.0	3.8	4.7	5.7	Population growth rate
Offices	1.0	1.3	1.6	1.9	-do-
Total	92.3	132	184	253	

(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	115	397	841	1,636
Non Domestic	21	132	184	253
Losses	56	59	140	333
Total	192	588	1,164	2,222

* Actual consumption

(4) Maximum Day Demand and Peak Day Demand

Taking the seasonal difference into account, the factor 1.5 is adopted for the projection of maximum day demand. Furthermore, the factor 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)		192	588	1,164	2,222
Maximum Day Demand (m^3/day)	1.5	288	882	1,746	3,333
Peak Day Demand (m^3/hour)	1.6	19	59	116	222

4.2 Water Resources Development

4.2.1 Evaluation of Water Resources

Dupti has annual precipitation of 226.4 mm but no ground water recharge occurs in an average year, which means all the precipitation evaporates. However, Dupti has Awash river flowing near the town in the south. Awash river is one of the largest rivers in

Ethiopia in terms of the watershed area which extends to Addis Ababa. The river water is used for irrigation of cotton plantation by TADE in the area. It was also used for water supply to the TADE compound. TADE now has a deep well as a source for the water supply. There is no other perennial river nor spring in the area.

In Dupti, there are many deep wells in which the WSS has five (5) wells but two (2) of them were abandoned due to water quality problem. BH No.1 had salinity problem with its water and the well was abanboned in Feb. 1995. BH No.3 yielded hot water. High concentration of salinity, fluorine and minerals is a common problem with the deep wells in the area.

The geology of the area is categorized as alluvium deposited by Awash river although lava flow is seen in the western end of the area. Since the area is a flood plain, layers with mixture of gravel, sand, silt and clay are dominant but gravel layers are rare.

Geoelectrical survey was conducted at 25 points as shown in Drawing including the existing borehole sites. In most of the VES stations, the interpretation show low values which are less than 2 ohm-m appears at about 20 m deep. From the data of existing borehole, it is known that the ground water table lies at this depth around the Dupti area. According to the data of water quality analysis and the report "Aid Bank Underground Water Resources Development Project", ground water in the Dupti area have very high values of conductivity over 1.0 mS/cm. Since saline water shows such conductivity and resistivity, it is most probable that saline water exists in this area.

However, VES station No.8 and No.11 have different apparent resistivity curves which rise upto 10-30 ohm-m. As a result of the interpretation, the layers having 15-40 ohm-m in specific resistivity are underlain at the depths between 10 and 30 m. They are estimated to bear fresh water being replenished by Awash river since the locations are nearer to the river. These aquifers are expected to be composed of sand and silt with gravel. Since the permeabilities of such aquifers are as low as 0.1 m/day if silt is rich, it must be developed by radial collector wells. The aquifers are underlain by clay rich layers, so these wells are sorted to shallow wells.

The water from these aquifers requires treatment to eliminate colloid but the treatment plant is less facilitated than the one which treats the river water.

4.2.2 Strategy of Water Resources Development

Since RRC BH No.1 and the borehole of Russian Camp are scheduled to be transferred to the WSS and WSS No.5 is ready for operation, the plan includes these wells. The characteristics of the major aquifers of the operational wells of WSS including the aforementioned 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.15	20 - 40 40 - 55	Clayey Sand and Gravel Clay with Volcanic Aggregates	35	2	WSS BH No.2
2	VES St.4	13 - 37	Sand and Silt with Clay	24	2	WSS BH No.4
3	VES St.2	23 - 32	Sand and Silt with Gravel	9	4	WSS BH No.5
4	VES St.19	24 - 33	Gravel and Sand	9	20	RCC BH No.1
5	VES St.8	9 - 21	Sand and Silt with Gravel	12	4	New Shallow Well
6	VES St.11	12 - 26	-Ditto-	14	4	-Ditto-
7	St.26	9 - 21	-Ditto-	12	4	-Ditto-
8	St.27	9 - 21	-Ditto-	12	4	-Ditto-
9	VES St.24	9 - 35	-Ditto-	26	4	Russian Camp BH

The depths of the major aquifers of Well No.1 are obtained from the geological log. The others are detected by the geoelectrical survey. For the site of Well No.7 where the geoelectrical survey was not done, the data of the adjacent site i.e. Well No.5 is referred.

The permeability of the aquifers of Well No.1 is obtained from the report of the pumping test conducted by NWRC in 1976. The permeability of the aquifers of Well No.4 is referred to the report of the pumping test for WSS BH No.1, because those aquifers have similar lithology. The permeability of sand and silt with gravel is estimated from the values of those forementioned aquifers.

The optimal yields of the deep wells are estimated with the formula listed in the design criteria with a drawdown of 20 m. For Well No.4, the drawdown is assumed at 14 m considering the pump position, because the depth of the well is only 28-30 m. The optimal yields of the shallow wells are estimated with same formula as the one for deep wells as shown below.

$$Qopt = 2\pi \cdot K \cdot H \cdot Sd \cdot Ew / \ln\left(\frac{R}{re}\right)$$

where Qopt: Optimal Yield (m^3/day)
π: 3.14
K: Permeability (m/day)
H: Thickness of Aquifer (m)
Sd: Design Drawdown 10m (as per the design criteria)
Ew: Well Efficiency 0.8 (as per the design criteria)
R: Radius of Cone of Depression 300m (as per the design criteria)
re: Equivalent Well Radius (m)

Equivalent well radius (re) is calculated from the following formula if the well points are situated at half the aquifer depths.

$$re = 0.37 \cdot L \left(\frac{\pi t}{H}\right)^{\frac{H}{4L}}$$

where L: Length of Well Points 12 m (assumed)
t: Diameter of Well Points 0.2 m (assumed)

It is assumed that the well is equipped with eight (8) well points. The optimal yields of the wells are shown in Table 4.2.2.

Table 4.2.2 Optimal Yields and Water Levels of the Wells

Well No.	Dia. of Well (m)	Optimal Yield (m^3/day)	Static Water Level (GL-m)	Dynamic Water Level (GL-m)	Remarks
1	0.15	231	8.8	28.8	WSS BH No.2
2	0.15	159	8.0	28.0	WSS BH No.4
3	0.15	218	8.0	28.0	WSS BH No.5
4	0.15	416	7.4	21.4	RRC BH No.1
5	2.0	487	1.0	11.0	New Shallow Well for Year 2005
6	2.0	549	2.4	12.4	-Ditto-
7	2.0	487	1.0	11.0	New Shallow Well for Year 2010
8	2.0	487	1.0	11.0	-Ditto-
9	0.20	328	7.4	27.4	Existing Russian Camp BH

The optimal yields of Well No.1 to No.6 totaling to 2,060 m^3/day cover the demands of year 2005. The total yield of all the wells will cover the demands of year 2010.

The water from the deep wells is diluted with the water from the shallow wells, then the water quality problem will be eased off.

4.2.3 Design of Water Source Facilities

The shallow wells are designed as follows.

(1) Casing

Reinforced concrete ring is adopted. The diameter of casing is decided at 1.2 m in order to have enough space for a man to work for the installation of well points using a hydraulic jack. The length of the ring is one (1) m per piece.

(2) Well point

A Johnson type screen is adopted. It is decided that the opening ratio is more than 20 % and the diameter is 200 mm, taking into consideration the large pumping rates. The total screen length is longer than the calculated by the following formula.

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

where Ls: Length of screen (m)
Q: Pumping rate (l/s) (assumed equal to the optimal yield)

n: Number of well points
A: Surface area of screen 0.666 m^2/m
N: Opening ratio 0.2
V: Inflow velocity 0.2 cm/s (assumed)
α: Safety factor 3

The length of well point becomes longer than the screen length adding a blank pipe as shown in the Drawings.

Table 4.2.3 Dimensions of New Shallow Wells

Well No.		5	6	7	8
Pumping Rate	(m^3/day)	487	549	487	487
	(l/s)	(5.6)	(6.4)	(5.6)	(5.6)
Diameter of Well	(mm)	2.0	2.0	2.0	2.0
Well Depth	(m)	16.5	20.5	16.5	16.5
Number of Well Points		8	8	8	8
Length of Well Points	(m)	12	12	12	12
Diameter of Well Point	(mm)	200	200	200	200
Screen Length	(m)	8	9	8	8

4.3 Plan of Water Supply System

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

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

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

4.3.1 Water Supply System in 2005

(1) Boreholes

There are five existing boreholes and four potential sites for shallow wells as stated in chapter 4.2. Among these proposed sites, two shallow wells will be constructed in the first phase. The groundwater pumped up is transferred to the new reservoir directly. The production rate planned is summarized as follows.

W1 (existing)	231 m^3/day
W2 (existing)	159 m^3/day
W3 (existing)	218 m^3/day
W4 (existing)	416 m^3/day
W5 (proposed)	487 m^3/day
W6 (proposed)	549 m^3/day
Total	2,060 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:

Q = 0.28 ~ 0.4 m^3/min
H = 25 m
P = 10 kW
Generator : 2 sets + one standby = 3 sets

(3) Rising Mains

Rising mains will range between 100 mm and 150 mm and transferred water to the new reservoir and total length is about 2,600 m.

(4) Reservoir

The existing reservoirs is replaced to new reservoirs due to the lack of capacity of existing reservoirs. The capacity of the reservoir is required to meet the water demand at the year of 2005, and the required capacity is about 360 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.75mm is adopted as the minimum dia., and the pipe with dia.50mm 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)
300	350
200	515
150	1,295
100	650
75	4,410
50	10,576

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

(7) Administration Building

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

4.3.2 Water Supply System in 2010

(1) Borehole

Three shallow wells will be additionally constructed in the second phase to meet the water demand at the year of 2010. The production rate planned is summarized as follows.

W7 (proposed)	487 m^3/day	Shallow well
W8 (proposed)	487 m^3/day	Shallow well
W9 (proposed)	328 m^3/day	existing BH at Russian camp
Total	1,302 m^3/day	

(2) Borehole Pumps

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

P3 (proposed)	Q = 0.4 m^3/min., H = 20 m
P4 (proposed)	Q = 0.4 m^3/min., H = 20 m
P5 (proposed)	Q = 0.23 m^3/min., H = 80 m

(3) Distribution Network

The layout of distribution network for the target year of 2010 is not prepared in this Study. It is because a master plan of town planning is not formulated yet. It is preferable to design a layout of the distribution network after formulation of the 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 3.1 kg and necessary more than 0.11 PPM at the end of distribution pipe.

4.4 Implementation Schedule and Cost Estimation

4.4.1 Executing and Responsible Agencies

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

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

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

4.4.2 Construction Schedule

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

As this Project requires urgent intermediation to counteract the current deteriorating water supply condition, the aforementioned measure 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	10,682	9,059	19,741
2010		16,587	16,587

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	1,611
2010	455

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	3.26
2. Yard Connection Users	2.03
3. Public Fountain Users	1.51

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

(b) Projection of Revenues

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

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

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

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

Water price is already mentioned above.

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

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

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

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

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

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

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

Projected revenues by source are shown in Table 4.5.2.

(2) Estimation of Cost

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

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

(a) O & M Cost

Seven types of O & M cost can be identified.

The first is electricity cost. It is estimated that 43 birr, 85 birr and 162 birr will be daily required in 2000, 2005 and 2010 respectively.

The second is fuel cost. It is projected that it will not be required for pumps so far as Dupti is concerned.

The third is disinfection cost. It is estimated that 9 birr, 18 birr and 33 birr will be daily required in 2000, 2005 and 2010 respectively.

The fourth cost is personnel cost. It is estimated that 31, 42 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 92, 216 and 399 connections will be annually newly installed from 1999 to 2004, from 2005 to 2009 and from 2010 onward respectively. Installation cost per connection is estimated at 488 birr on average.

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

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

(b) Capital Cost

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

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

The summary of the estimated initial cost is as follows:

(Unit : thousand birr)

Item	Foreign Components	Local Components	Total
1. Phase 1			
1) Construction Cost	8,078	4,583	12,661
2) Engineering Cost (12% of 1))	1,520		1,520
3) Contingency (5% of 1) + 2))	480	229	709
Sub-Total	10,078	4,812	14,890
4) Buildings		3,369	3,369
5) WSSD's Management Cost (2% of 1) + 2) + 3) + 4))		365	365
Sub-Total		3,734	3,734
Total	10,078	8,546	18,624
6) Water Purification Units (included in total)	10	15	25
2. Phase 2			
1) Construction Cost			9,654
2) Engineering Cost (10% of 1))			965
3) Contingency (10% of 1) + 2))			1,062
Total			11,681
Grand-Total			30,305

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
   - 50% of Initial Cost

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

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

Further, inflation was not considered.

The results are shown in Table 4.5.3.

As it shows, WSS will be financially sound and stable in terms of earnings as well as solvency in 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 = 152.4%
Working Capital/Revenues = 40.7%

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

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

Table 4.5.1 Water Price and Ratio of Water Payment to Income

Item	1995	2000	2005	2010
1. Average Monthly Household Income (birr)				
1) House Connection Owners	-	1,142	988	847
2) Yard Connection Users	735	580	439	308
3) Public Fountain Users	352	299	242	203
2. Share of Households (%)				
1) House Connection Owners	-	6.8	20.4	41.0
2) Yard Connection Users	19.8	25.9	38.1	56.0
3) Public Fountain Users	25.1	38.5	29.9	3.0
3. Water Consumption/Household/Month (m^3)				
1) House Connection Owners	-	8.9	9.6	10.4
2) Yard Connection Users	4.2	5.3	5.7	6.1
3) Public Fountain Users	0.9	2.3	2.4	2.7
4. Water Price (birr/m^3)				
1) House Connection Owners	1.50	3.26	3.26	3.26
2) Yard Connection Users	1.50	2.03	2.03	2.03
3) Public Fountain Users	1.25	1.51	1.51	1.51
5. Payment for Water Supply/Household/Month (birr)				
1) House Connection Owners	-	29.0	31.2	33.9
2) Yard Connection Users	6.3	10.7	11.5	12.3
3) Public Fountain Users	1.1	3.5	3.7	4.1
6. Ratio of Water Payment to Income (%)				
1) House Connection Owners	-	2.5	3.2	4.0
2) Yard Connection Users	0.9	1.8	2.6	4.0
3) Public Fountain Users	0.3	1.2	1.5	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	28,765	15,775	6,719	880	-	130	52,269
1997	29,340	16,091	6,854	880	-	133	53,297
1998	29,927	16,413	6,991	880	-	136	54,345
1999	137,182	37,883	86,883	18,001	9,435	8,033	297,417
2000	229,148	64,402	149,213	18,001	10,543	9,426	480,733
2001	312,879	64,727	160,970	42,126	13,135	11,877	605,713
2002	396,611	65,051	172,726	42,126	15,728	13,845	706,086
2003	480,343	65,376	184,482	42,126	18,320	15,813	806,459
2004	564,075	65,700	196,238	42,126	20,912	17,781	906,832
2005	647,806	66,025	207,995	42,126	23,505	19,749	1,007,205
2006	822,928	54,611	223,594	77,716	28,287	24,143	1,231,279
2007	998,050	43,196	239,194	77,716	33,070	27,825	1,419,050
2008	1,173,172	31,782	254,793	77,716	37,852	31,506	1,606,821
2009	1,348,293	20,368	270,393	77,716	42,635	35,188	1,794,592
2010	1,523,415	8,953	285,992	77,716	47,417	38,870	1,982,364
2011	1,523,415	8,953	285,992	0	47,417	37,316	1,903,093
2012	1,523,415	8,953	285,992	0	47,417	37,316	1,903,093
2013	1,523,415	8,953	285,992	0	47,417	37,316	1,903,093
2014	1,523,415	8,953	285,992	0	47,417	37,316	1,903,093
2015	1,523,415	8,953	285,992	0	47,417	37,316	1,903,093
2016	1,523,415	8,953	285,992	0	47,417	37,316	1,903,093
2017	1,523,415	8,953	285,992	0	47,417	37,316	1,903,093
2018	1,523,415	8,953	285,992	0	47,417	37,316	1,903,093
2019	1,523,415	8,953	285,992	0	47,417	37,316	1,903,093
2020	1,523,415	8,953	285,992	0	47,417	37,316	1,903,093
2021	1,523,415	8,953	285,992	0	47,417	37,316	1,903,093
2022	1,523,415	8,953	285,992	0	47,417	37,316	1,903,093
2023	1,523,415	8,953	285,992	0	47,417	37,316	1,903,093
2024	1,523,415	8,953	285,992	0	47,417	37,316	1,903,093
2025	1,523,415	8,953	285,992	0	47,417	37,316	1,903,093

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	52	53	54	297	481	606	706	806	907	1007
Operation and Maintenance	61	63	64	266	295	417	435	453	471	490
Depreciation	0	167	334	334	334	334	334	334	334	334
Payment of Interest	0	0	0	0	0	0	0	0	0	0
Expenditure	61	230	398	600	629	752	770	788	806	824
Profit before Tax	-9	-176	-344	-302	-149	-146	-64	19	101	183
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	-9	-176	-344	-302	-149	-146	-64	19	101	183
Funds Statement										
Profit after Tax	-9	-176	-344	-302	-149	-146	-64	19	101	183
Loans	797	5191	5191	0	0	0	0	0	0	0
Subsidies	797	3324	3324	0	0	0	0	0	0	0
Depreciation	0	167	334	334	334	334	334	334	334	334
Sources	1586	8505	8505	32	186	188	271	353	435	518
Capital Works	1595	6648	6648	0	0	0	0	0	0	0
Payment of Principal	0	0	0	0	0	0	0	0	0	0
Working Capital	-9	1858	1857	32	186	188	271	353	435	518
Applications	1586	8505	8505	32	186	188	271	353	435	518
Loan Liabilities	805	6056	11359	11473	11588	11704	11821	11939	12058	12179
Cash Balance	-18	1840	3697	3729	3915	4103	4374	4727	5162	5680

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	1231	1419	1607	1795	1982	1903	1903	1903	1903	1903
Operation and Maintenance	666	689	711	734	757	421	421	421	421	421
Depreciation	334	334	423	511	511	511	511	511	511	511
Payment of Interest	9	66	120	114	109	103	97	91	85	79
Expenditure	1009	1089	1254	1360	1377	1036	1030	1024	1018	1012
Profit before Tax	222	330	353	435	606	868	873	879	885	891
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	222	330	353	435	606	868	873	879	885	891
Funds Statement										
Profit after Tax	222	330	353	435	606	868	873	879	885	891
Loans	0	531	2655	2655	0	0	0	0	0	0
Subsidies	0	531	2655	2655	0	0	0	0	0	0
Depreciation	334	334	423	511	511	511	511	511	511	511
Sources	556	1726	6085	6256	1117	1379	1385	1391	1396	1402
Capital Works	0	1062	5310	5310	0	0	13	13	0	0
Payment of Principal	40	301	564	570	576	581	587	593	599	605
Working Capital	516	364	211	376	542	798	785	785	798	798
Applications	556	1726	6085	6256	1117	1379	1385	1391	1396	1402
Loan Liabilities	12252	12544	14666	16810	16294	15773	15246	14714	14177	13634
Cash Balance	6197	6560	6772	7148	7690	8487	9272	10057	10855	11652

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	1903	1903	1903	1903	1903	1903	1903	1903	1903	1903
Operation and Maintenance	421	421	421	421	421	421	421	421	421	421
Depreciation	511	511	511	511	511	511	511	511	511	511
Payment of Interest	73	73	96	117	108	99	89	80	70	61
Expenditure	1006	1006	1028	1050	1041	1031	1022	1012	1003	992
Profit before Tax	897	897	875	853	862	872	881	891	900	910
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	897	897	875	853	862	872	881	891	900	910
Funds Statement										
Profit after Tax	897	897	875	853	862	872	881	891	900	910
Loans	0	0	0	0	0	0	0	0	0	0
Subsidies	0	0	0	0	0	0	0	0	0	0
Depreciation	511	511	511	511	511	511	511	511	511	511
Sources	1409	1409	1386	1364	1374	1383	1392	1402	1412	1421
Capital Works	0	0	0	0	0	0	0	0	0	0
Payment of Principal	611	644	783	924	934	943	952	962	972	981
Working Capital	798	765	603	440	440	440	440	440	440	440
Applications	1409	1409	1386	1364	1374	1383	1392	1402	1412	1421
Loan Liabilities	13087	12501	11746	10822	9888	8945	7993	7031	6060	5078
Cash Balance	12450	13215	13818	14258	14698	15138	15578	16018	16458	16898

Source: JICA

Chapter 5 Improvement of Health and Sanitation

5.1 Plan for Sanitary Facilities

Dupti'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 Dupti

Item	HC			YC			PF		
	1995	2005	2010	1995	2005	2010	1995	2005	2010
• Water demand (lpcd)	0	71	77	30.8	42	45	6.7	18	20
• Waste water generation rate (%)	0	77	78	66	70	70	60	63	64
• Waste water production (lpcd)	0	55	60	20	29	31	4	11	13

Form the water demand and waste water production per capita per day for Dupti 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 Dupti 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 Dupti are grouped into four major categories.

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

These technologies are related to the types of water supply services; and the proposed toilet facilities are considered for residential or domestic households as well as for non-domestic households taking the water supply services of HC, YC and PF into account.

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

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

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

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

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

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

5.1.2 Plan of Sullage, Dry Solid Waste and Drainage

(1) Sullage

Sullage is the waste water which does not contain excreta but comes out from each household. Sullage always contains some pathogens though the concentration is much lower than that in sewage. In Dupti, 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

Dupti has two places for dumping dry solid waste called <Ganga> which are not properly utilized. These Gangas should be re-activated. The Dupti Municipality need to enforce their proper use; and the refuse should be burnt occasionally. In addition to the existing Gangas, at least three additional Gangas are proposed at the outskirts of the city. Refuse collecting bins are required to be placed at the strategic locations for the use of the communities to place their respective refuses. The contents of the bins have to be carried to the Gangas using Refuse Collecting and Disposal Truck or animal-drawn cart. This work has to be administrated by the close working relationship of the communities, the Kebeles and the Municipality.

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

Target Year	Households		
	HC	YC	PF
• 2005	1,060	1,980	1,550
• 2010	2,600	3,550	190

5.2.2 Estimate of Costs

(1) Capital Costs per Unit

For each type of toilet facility that is considered appropriate for Dupti 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)	9,500
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 Dupti by the Year 2005 and 2010

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

- By the year 2005

  - All schools in Dupti will have, at least, VIP collective toilets.
  - The Dupti Hospital toilet facilities will be rehabilitated; and the clinic and possibly a health center will have VIP collective toilets.
  - Dupti 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 Dupti 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 Dupti 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	1,060	7,500	7,950*
• 75% households with YC to have VIP shared toilets or higher	1,485	15,000	22,275*
• 75% households with PF to have VIP toilets	1,163	2,000	2,326*
• Vacuum truck	1	250,000	250
• Refuse disposal truck	1	180,000	180
• Sludge dumping site	2	10,000	20
• Refuse disposing site	2	6,500	13
• Refuse collecting bins	70	250	18
Total			34,162
Excluding Households' (*)			1,611

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

Facilities	No	Unit Cost (birr)	Total Cost (1,000 Birr)
• 50% of households with HC to have flush toilets	1,300	7,500	9,750*
• 50% of households with YC to have VIP toilets or higher	1,775	3,000	5,325*
• 100% households with PF to have VIP toilets	190	2,000	380*
• Replacement of vacuum truck	1	250,000	250
• Replacement of refuse disposal truck	1	180,000	180
• Replacement of refuse collecting bin	100	250	25
Total			15,910
Excluding Households' (*)			455

(5) Total Operating and Maintenance Cost

Indicative operating and maintenance cost for sanitary facilities for Dupti 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	1,060	1,250	1,325.00*
• VIP shared toilet for households with YC	1,485	400	594.00*
• VIP toilets for households using PF	1,163	300	348.90*
• Vacuum truck	1	7,500	7.50
• Refuse disposal truck	1	8,500	8.50
• Sludge dumping site	2	2,000	4.00
• Refuse disposing site	2	2,500	5.00
• Refuse collecting bins	70	50	3.50
Total			2,315.80
Excluding Households' (*)			47.90

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	1,300	1,250	1,625.00*
• VIP or higher toilets for households with YC	1,775	1,000	1,775.00*
• VIP toilets for households using PF	190	300	57.00*
• Vacuum truck	1	7,500	7.50
• Refuse disposal truck	1	8,500	8.50
• Refuse collecting bins	100	50	5.00
Total			3,478.00
Excluding Households' (*)			21.00

(6) Summary of Costs

- Capital Costs

Year	Cost in 1,000 Birr (Total)	Excluding Households'
2005	34,162	1,611
2010	15,910	455
Total	50,072	2,066

- Annual Operating & Maintenance Costs

Year	Cost in 1,000 Birr (Total)	Excluding Households'
2005	2,315.80	47.90
2010	3,748.00	21.00
Total	5,793.80	68.90

5.3 Application of sanitary education program

In line with the approach and methodologies recommended in the main report, the following specific recommendations have been drawn up for sanitary education in Dupti based on the findings of the field survey:

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 are being made as required. Suggestions of ways to plan and carry out such a programme are included in the sanitary education manual produced by this Study.

Table 5.3.1 Sanitary Education Priorities in Dupti

Priority level	Type of Behavior	Blocks to Improved Practice
High	Piped water access and use always	Piped water not always available in sufficient quantities (many PFs and PCs not functioning) (WSS role) and not available when required by people (WSS role) at sites convenient for collection (WSS role).
High	Solid waste disposal in covered pits or burned	Sites not allocated for public waste disposal sites or not managed strictly (Municipality/Woreda role) Individuals must be informed of where they can dispose of waste (Municipality/Woreda role) and shown safe disposal techniques (CPP/all)
High	Fly Control	Associated with climate but also related to solid and liquid waste disposal and excreta disposal (Municipality/Woreda /All role) Behaviors like covering of food and water pots during storage should be maintained (CPP/All)
Medium -High	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 -High	Waste water disposal in pits, drains or vegetable gardens	Drainage insufficient and disposal into drains not strictly managed (Municipality/Woreda role) Individuals must be informed of where they can dispose of waste water (Municipality/Woreda role) and shown safe disposal techniques (CPP/all)
Medium -Low	Handwashing after handling children's stools	Domestic hygiene (mostly women, sometimes boys and girls roles) made more easy by improving access to water and soap/ash nearer to latrine (women's role) and improving the status of such behavior (All)
Medium -Low	Handwashing after handling children's stools	Domestic hygiene (mostly women, sometimes boys and girls roles) made more easy by improving access to water and soap/ash nearer to latrine (women's role) and improving the status of such behavior (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 drastically under the proposed plan from 192 m^3/day in 1995 to 588 m^3/day in 2000, 1,164 m^3/day in 2005 and 2,222 m^3/day in 2010.

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

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

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

Considering all the above factors, it is proposed that the number of employees will increase from 10 in 1995 to 31 in 2000, 42 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 29, 39 and 50 in 2000, 2005 and 2010 respectively.

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

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

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

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

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

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

6.3 Organization and Management of Sanitation

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

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

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

Public Relations Section will be in charge of the provision of information and public relations services to help people to install septic tank toilets and dry pit latrines. Loan Service Section will provide loan/subsidy to clients for the installation of septic tank toilets and keep related records. Maintenance Section will have a vacuum truck to regularly empty toilets and will regularly clean and maintain drainages.

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

Table 6.1.1 Personnel Requirements

1. Total No. of Personnel

Item	1995	2000	2005	2010
1. Total Production of Water (m^3/day)	192	588	1,164	2,222
2. Water Production per Worker (m^3/day/worker)	19.2	20	30	40
3. Coefficient	1.0	1.0	1.0	0.9
4. No. of Personnel	10	29	39	50
5. Additional Personnel for Sanitation	0	2	3	4
6. Final No. of Personnel	10	31	42	54

2. Breakdown of Personnel by Position/Function

Positions/Functions	1995	2000	2005	2010
1. Manager	0	1	1	1
2. Customer Services	0	0	0	1
3. Internal Audit	0	1	1	1
4. Administration Service				
1) Head	0	1	1	1
2) General Administration Section				
Secretaries/Typists/Clerks	0	1	1	1
Guards	3	5	6	7
Sweepers/Janitors	0	0	1	1
Drivers	0	0	1	1
Sub-Total	3	6	9	10
3) Personnel Section				
Recruitment and Assignment	0	0	0	1
Training	0	0	0	1
Remuneration	0	0	0	1
Sub-Total	0	0	0	3
4) Storage Section				
Store Keepers	0	1	1	1
Purchase of Materials/Supplies	0	0	0	1
Sub-Total	0	1	1	2
5) Legal Section	0	0	0	1
Total	3	8	11	17

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

Positions/Functions	1995	2000	2005	2010
5. Financial Service	0	1	1	1
1) Head	0	0	0	1
2) Budgeting Section				
3) Accounting Section				
Accountants	0	1	1	2
Cashiers/Treasurers	0	0	0	1
Sub-Total	0	1	1	3
4) Financial Management Section				
Financial Analysts	0	0	0	1
5) Operation Section				
Meter Readers	0	0	1	3
Bill Distributors/Collectors	0	0	1	3
Water Sellers	5	7	9	1
Sub-Total	5	7	11	7
Total	5	9	13	13
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	1
Motor Operators	2	4	4	4
Plumbers	0	1	2	2
Sub-Total	2	7	8	8
4) Inspection Section				
Water Meter Technicians	0	1	1	1
Leakage Detectors	0	0	1	1
Water Quality Analysts	0	0	0	1
Sub-Total	0	1	2	3
5) Workshop	0	0	1	2
6) Works Section				
Contracting	0	0	0	1
Designing/Drafting	0	0	0	1
Sub-Total	0	0	0	2
Total	2	10	13	17
7. Sanitary Service				
1) Public Relations Section	0	1	1	1
2) Loan Service Section	0	1	1	1

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

Positions/Functions	1995	2000	2005	2010
3) Maintenance Section				
Technicians	0	0	0	1
Drivers	0	0	1	1
Sub-Total	0	0	1	2
Total	0	2	3	4
Grand-Total	10	31	42	54

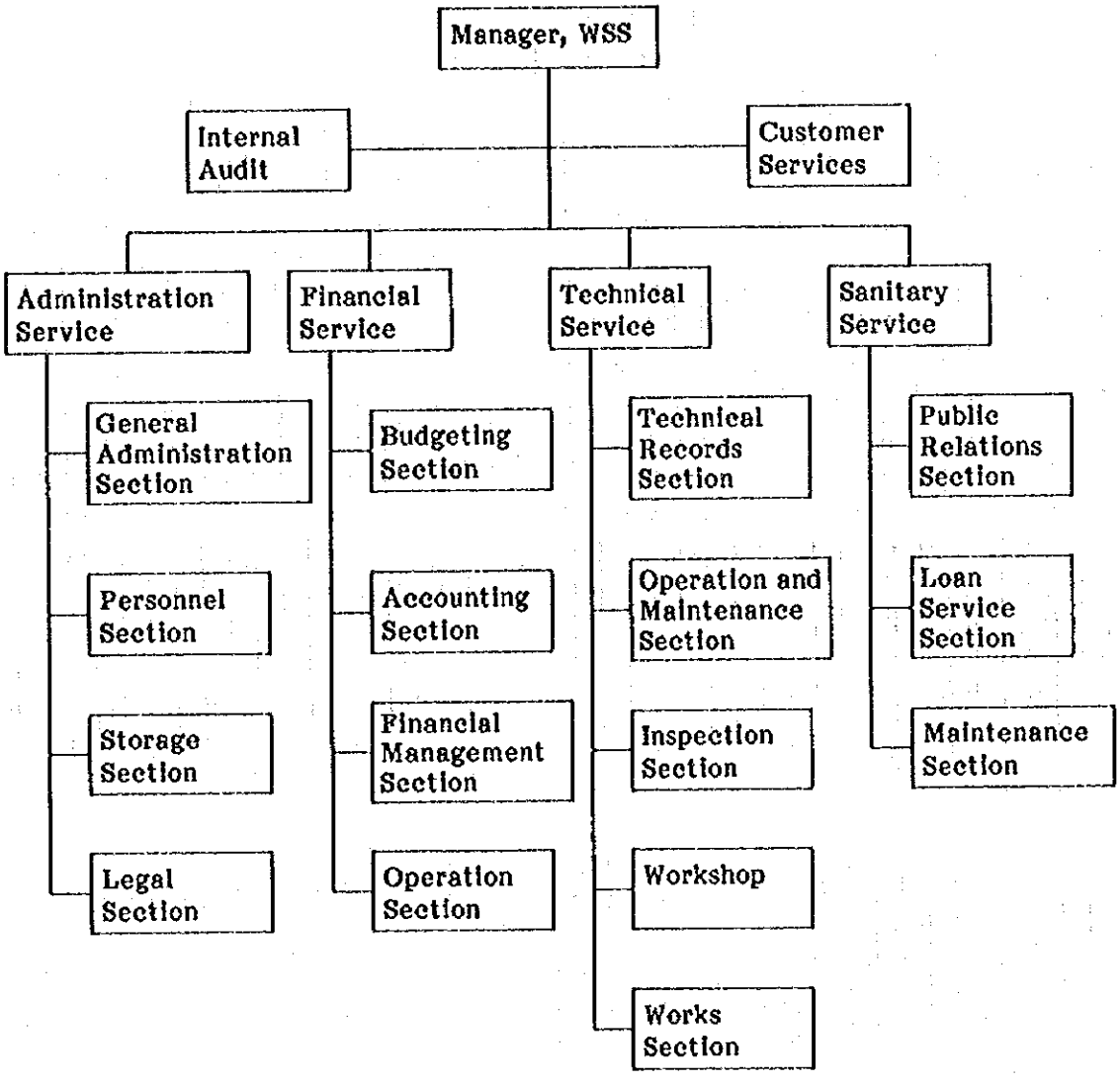


Figure 6.1.1 Proposed Model Organization Set-up of WSS

6.4 Community Building / Participation and WID

In line with the approach outlined in the Main Report, the following additional points are being made with specific reference to the findings of the field survey work relating to Dupti:

- Dupti was in urgent need of water interventions, particularly PFs because PCs were not affordable. Groups and households interviewed and discussed with would like to see the project implemented and not merely studied. To a lesser extent sanitation was a priority need. Sanitation should not be considered without improvements to the water supply situation.

- The majority of the population, in particular the PF and vendor users were ready to participate in the management of the PF facilities. This should be facilitated by involving men, women boys and girls on the exact locations and designs of water points and opening times required.

- Schools and health centers should be consulted and encouraged to participate in the program. The most likely areas of involvement are in the sanitary education program.

- Men, women, boys and to a lesser degree girls will benefit most from the water supply intervention leaving them more time for other activities including income generation and study.

- Attention should given to ensure that men and boys continue to assist in the tasks of water collection and carrying after the implementation of the program. This will promote the release of more time for girls and women and make sure that they also realize savings in time and energy from improved water supply.

- Ethnic misunderstandings need to be carefully considered in the project planning and implementation if the full benefits of a community managed water and sanitation program are to be realized.