ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
COLLEGE OF DEVELOPMENT STUDIES

PROBLEM ASSESSMENT IN DURAME TOWN WATER SUPPLY

A Thesis Submitted in Partial Fulfillment of the Requirement for
Degree of Master of Art in Environment and Development

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Title
Problem Assessment in Durame Town water supply

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Abstract

While conducting this research first, initial assessment and field observation, consultation with different officials and concerned bodies was carried out to visualize the status and shortage of water in Durame town. Based on walk over survey, measured data, and information from different stakeholders, it is observed that the town has critical water shortage and system problem in the distribution and ancillary works. This water shortage problem has hindered individual endeavors, micro-enterprises, hotels, institution and investments etc. which are without or meager water supply. In this paper institutional, socioeconomic, environmental and technical related problems are assessed and discussed in detail. In light of the major identified problems recommendation are suggested. It is proposed that redesigning the existing distribution system by considering the proposed source as input; managing the proposed and the existing well field from potential pollutant; developing and implementing appropriate organizational structure parallel to the system can correct the problem.

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List of Acronyms

AAU	Addis Ababa University
AGC	AG consultant
AWSOUI	Assessment of water supply option for urban India
BH	Borehole
CPWSDS	Committee on public water supply distribution system
CSA	Central Statistical Agency
DWSSM	Drinking water supply system management
DWSSO	Durame water supply service office
E.C.	Ethiopian Calendar
EWRMP	Ethiopian water resource management policy
FGD(s)	Focus group discussion (s)
HHs	Households survey
IRC	International Water and Sanitation Center, the Netherlands
KII	key informant interview
KTZoWRO	Kembata tembaro zone water resource office
MoWR	Ministry of Water Resources
nd	Not dated
RiPPLE	Research-inspired Policy and Practice Learning in Ethiopia and the Nile Region
SNNPR	Southern Nations, Nationalities and Peoples Regional State, Ethiopia
SPSS	Statistical Package for Social Science
UNDP	United Nations Development Programme
WHO	World Health Organization
WSM	Water supply management

CHAPTERONE

Introduction

1.1. Back Ground

Access to safe and adequate water is one of the top priorities for billions of people in the world. One billion people have no access to potable water and 2million people have no access to sanitation. Over 5 million deaths per year are attributed to water related diseases (De Regt 2005; Global Healths council 2008; Nigus 2009:1).

The problem is worse in poor countries; out of 1.4 billion people who do not have adequate drinking water, 450 million people are found in Africa. Average daily water consumption for an American is about 259 litters while a person in poor African countries use very low amount of water, for example, 4l/p/d in gambia,9.3l/p/d in Uganda and 19.3l/p/d in Ghana respectively (Gleick 1994;Nigus 2009:1).

Water supply situation in Ethiopia is not different from other poor countries in Africa. According to MoWR (2006:34) annual report, overall national water supply coverage is 47.3%. According to UNDP (2006) in Katy (2010:2) estimation, the figure is worse than this that is 39.4%. Even if service coverage is higher in urban areas, 25% of developed water supply schemes are found to be non functional at national level (MoWR 2006:30).

From the report of SNNPR Water Resource Development Bureau (2006) the overall water supply coverage of the Southern Nation Nationalities Peoples Region is also low which stands at 48%, further more (2009) Regional water resource inventoried data indicate that out of the total of 1553 hand dug wells, 474 are non functional; out of 616 deep wells, 150 are non functional; and there are also spring developments that are classified as on spot and with distribution

type. Thus, there are 4085 on spot spring, from these 1014 are non functional and from1281 springs with distribution 1014 are non-functional.

Scheme non functionality rate in the region was about 28%. This non functionality rate could be of different factor which affects the water supply system.

The study area Durame town, one of the rapidly increasing populations in SNNPR, is suffering from the shortage of water. Identifying the possible cause of water supply problem, Expanding the existing water supply infrastructure up to the year 2030 and recommending possible solution will solve the water shortage in the town.

1.2. Statement of the Problem

Inadequate potable water supply may result in many water related and water born diseases, which altimetly affect the health of society. In addition, it affects productivity of the community and the performance of social service.

Typically, large urban areas represent concentrated demands, both due to large populations and large per capita use and waste. Most urban area have depleted, polluted or have destroyed their local sources of water like rivers, lakes and tanks and in many cases even groundwater. The rainfall is generally seen as a bane rather than boon as it brings floods because the drainage systems are seriously ill designed (AWSOUI 1999:2).

The study area Durame town like many towns in Ethiopia doesn't have enough source of water as well as distribution net work; on top of that the water supply service office (WSSO) focus only on collecting bills and paying salaries for the workers. Other issue such as institutional arrangement, future capital recovery plane, future water supply expansion plan and present physical waters structure maintenance and repair system were not clearly articulated.

According to the researcher's experience of the study area, if the existing water source fails there is no other known option to serve the community. In the year 2008 the total daily production of water in the town was 579000 l/d but because of different reasons only 231000 l/d is consumed. This amount will give the total water consumption per capita per day of 9 l/c/day, leaving aside the demand for institution, commercial centers, hotel, restaurant and fire demand. This amount is far below the standard set by Ministry of water resource which is 20 l/c/d for yard connection and 50 l/c/d for house connection.

Currently, there are three water sources where the population of the town gets their water supply, but unfortunately, all three of them have problems of different magnitude.

The first source was constructed by development work in 1990, by capping three spring eyes on mount Ambaricho laying North West part of the town. These springs each having own capping structure, are collected at a single chamber and then gravitated to the town. The cumulative yields of the spring source was estimated to be 3.8 l/s. However, the amount of water which has been used from this source was persistently declining for unknown reason; owing to this, the researcher has a plan to explore the reason behind the decline.

The second source is Gocho bore hole which was drilled by south water construction enterprise. This borehole was drilled in 1997E.C. by the side of old Gocho bore hole in replacement of the abandoned old borehole due to electromechanical equipment stuck inside the well. The bore hole has a reported yield of 4.3l/s.

The third source to the town for the sake of supplement is Fulasa spring, which comes from 5km north eastern side of Ambaricho Mountain. This source

supplies only to Kembata Mentigezma (KMG) mother-child health center (MCH) and Durame hospital.

As it is known there has not been much research conducted in the study area that tried to describe the possible cause for the existing water supply system problems; therefore, it is the aim of this study to identify the existing water supply problem and recommend possible solutions.

1.3. General Objective

To assess the existing water supply problem

Specific Objective

- To look in to the existing water supply condition
- To assess the existing water supply system problem with regard to technical , institutional, and socio economical aspect

1.4. Research Questions

In this research the researcher wants to answer the following Questions

- What is the status of the major components of the water supply system?
- Is there technical related problem on the existing water supply?
- Is the water supply service office of the town capable to manage the water problem of the town?
- What are the socioeconomic factors which affect the town water supply?

1.5. Significance of the Study

The study area at present is under serious water supply problem in providing the required amount of water with acceptable quality. Identifying the cause for existing water supply problem and recommending sustainable solution is the concern of this research paper. In doing so it avails information on the best practices to improve the existing water supply system, and it also helps the concerned management bodies to refer this work on their future plan.

1.6. Scope of the Study

Water as a natural resource is utilized in two ways as consumptive and non consumptive use. Consumptive water use includes water for domestic activity such as drinking, washing and irrigation. Whereas non consumptive water use includes water use for power generation, navigation and recreation. However, due to the major global challenge with ever increasing proportions of the world's population, domestic water use must come first. Therefore, the scope of this study is limited to water use for the following purpose: domestic, commercial/industrial, public, business or trade and losses.

CHAPTER TWO

Literature Review

2.1. Overview of Water Supply in General

The available water sources throughout the world are becoming depleted and this problem is aggravated by the rate at which populations are increasing, especially, in developing countries. Currently, some 30 countries are considered to be water stressed, of which 20 are absolutely water scarce. It is predicted that by 2020, the number of water scarce countries will likely approach 35 (Rosegrant *et al.*, 2002). It has been estimated that, one-third of the population of the developing world will face severe water shortages by 2025 (Seckler *et al.,* 1998; Khatri & Vairavamoorthy 2007))

Consequently, in many low- and middle-income countries service providers have failed to provide consumers with adequate water supply. Despite some recent progress – between 1980 and 2005 where an additional 2.7 billion people have gained access to water supplies, more than 1.1 billion people have no access to safe water(WSM 2010:1).

The existing situation of inadequate service provision is exacerbated by the fact that population growth and increasing urbanization have offset much of the gains in service coverage. Many utilities, therefore, face new and increasingly difficult challenges in providing services to those living in peri-urban areas.

In addition to problems of service coverage and service expansion, many water utilities face variety of other problems. These include high unaccounted-for-water (UfW) loss rates (often averaging 40%-60%), financial problems, and human resources problems, including overstaffing (sometimes with five to seven times more staff than what is considered 'efficient'), lack of motivation, and lack of capacity to provide services(WSM2010:1).

Financial problems, for example, often appear to be due to a combination of low tariffs, poor customer record keeping, inappropriate technology choices, the fact that many urban poor are unable to pay for services, inefficient billing and collection systems, and subsidy schemes that benefit the richer rather than the poorer sections of society(WSM 2010:2).

2.2. Ethiopia's Water Supply Condition

Ethiopia faces a major water supply challenge. For many years, Ethiopia has remained at the bottom of the international league tables for access to clean and safe water. In response, the country has launched the universal access plan (UAP)-an ambitious plan to ensure access to safe water by all by 2012, which the government revised and reaffirmed (UNICEF/WHO 2008; Alan and Brighid 2009).

However, Ethiopia is one of the few countries with a constitutional provision to a formal right to water. This has not helped to achieve in increasing the water coverage of the countries. Only 39.4% of the population currently (2005 statistics) has access to safe drinking water, one of the lowest coverage levels worldwide (UNDP 2006; WSM 2010).

Ethiopia has abundant water resources, including 12 river basins and 22 natural and artificial lakes that make her as the water tower of Africa.Why then, do over 45 million people lack safe drinking water? According to WHO(2010b) reasons include only a minority of water resources are utilized, however, according to IRC (2003:3) it has also been suggested that lack of safe drinking water supply services is not related with the size of the project or on the number of beneficiaries of the schemes. But it depends on the level of involvement of the communities in setting up of the water supply system.

Water's unique properties as a finite but renewable resource lie at the heart of many of the problems associated with its management. Essentially, it is the rate at which water is used in a particular place in comparison with the rate at which it is replenished that determines whether there is scarcity or a surplus. In global terms and on accumulative basis, there is no shortage of fresh water. The world's fresh water crisis is one of water resource distribution in space and time (Joy and Christina 2002:81).

A uniform spatial water distribution system will help in distributing domestic water equally to all places with proper pressure (Durga 2004:1).However, according to Ethiopian water resource management policy (1999) the big and main water resources problem in Ethiopia is the uneven spatial and temporal occurrence and distribution. Between 80-90% of Ethiopia's water resources is found in the four river basins namely, Abay (Blue Nile), Tekeze, Baro Akobo, and Omo Gibe in the west and south-western part of Ethiopia where the population is no more than 30 to 40 per cent. On the other hand, the water resources available in the east and central river basins are only 10 to 20 percent whereas the population in these basins is over 60 percent.

The figures indicated above attempt to show the spatial uneven water distribution. The temporal distribution poses no lesser trouble. Ethiopia gets plenty of annual rainfall on the aggregate. It falls either ahead of time or comes too late or even sometimes stops short in the mid-season; the required amount is not available at the right time (EWRMP 1999:1).

Consequently, for all the water development activities achieved so far, the average access to clean and safe water supply is about 17% of the total population of Ethiopia. This can be cited as an example of a very low supply and coverage level even by Sub-Saharan African standards (EWRMP 19999).

In General, Ethiopia's water problem is thus essentially two-fold: low coverage levels and poor water quality. And to lessen associated health and social implications: Ethiopians are highly susceptible to numerous water-related diseases, from diarrhea and dysentery to schistosomiasis and malaria, accounting for the exceptionally high Infant Mortality Rate (UN data base 2006;Katy 2010). Moreover, women and children spend hours a day collecting water: time that would be better spent in education or employment. Therefore, the need to improve Ethiopia's water supply sector is obvious.

2.4 Urban Water Supply Problem

According to Bernad & Jone (1963) urban water supply problems include, limited national economic resource, shortage of investments capital, inept and inadequate operation and management, lack of training facilities, inadequate financial support of water system and insufficient action on the parts of the government. Lack of effective administrative machinery and of technical staff to promote and design new urban water supplies or to improve existing schemes are other factors to be added to the handicaps already listed. These result mainly from a lack of training facilities and they are frequently due to the influence of conflicting local interest and politics (Bernd and Jone 1963:11).

O and M Working Group (2002), in Water and Sanitation in the World's cities, (2003) summarized the key issues contributing to the poor performance of water supply facilities as follows: in adequate data on operation and maintenance and inefficient use of funds, poor management of water supply facilities, inappropriate system design, low profile of operation and maintenance, inadequate policy, legal frame works, overlapping responsibility and political interference. The constraint identified causing the failure of water supply system include poor organizational structure in responsible agency, lack of spare parts, inappropriate technology, lack of trained staff, lack of motivation by sector personnel, non involvement of the users, inadequate tariff collection system and negative political interference.

On the other hand, Arthur (2010:5) considers poor governance and low tariff as core problems to urban water. Degraded watershed results from illegal logging, human occupation of the catchments, lack of revenue that can be used to reforest the land and overexploitation of ground water which can be traced back to lack of monitoring and control.

In this respect Hndipuro & Indriyanti(2009:57) indicate on their study that more than 75% of the African population uses ground water as the main source of drinking water supply. To meet their demand users try to extract as much ground water as possible before the resource exhausted. Excessive pumping clearly has severe detrimental effect on ground water reservoir; water table drops significantly and alters ground water flow direction.

According to WUE (2006:172) technical problem such as unaccounted- for -water is a major water supply problem in many African cities. Most of this water is lost through leaking pipes or over flowing service reservoir, pumping or treatment, or during distribution.

Regarding this, Lynn (2006) reported that irrespective of whether these losses are due to leakage or due to theft, they translate into inadequate quantity of water being received by household. As a result, households are expected to be supplemented from other sources such as unprotected spring, ponds and unprotected dug wells, in doing so many urban poor are liable to water related disease. According to WHO(2010b) statistic out of 1.1billion people who do not have access to any type of water, 2 million people die every year due to water related diseases.

Khatri & Vairavamoorthy (2007) on their discussion draft paper explain that the causes for urban water supply problem include climate change, population growth, urbanization and the aging and deteriorating of existing infrastructure. But climate change in relation to water supply is out of the scope of this study.

United State population prospect report (2006) illustrates that there is higher rate of population growth in urban areas in developing countries. In less developed countries, urban population will grow from 1.9billoin in 2000 to 3.9 billion in 2030, averaging 2.3% per year. On the other hand, in developed countries, the urban population is expected to increase, from 0.9 billion in 2000 to 1 billion in 2030 over growth rate of 1% (Brockrhoff 2000; Khatri & Vairavamoorthy 2007).

Unfortunately, the development of urban water supplies has generally failed to keep pace with the rapid expansion of cities (Lifuo 2005:29). This is partly due to the fact that water resources have often been undervalued. Water is seen as a free commodity provided by governments, and is subsidized by governments through general taxation. This has led to a false sense of security with respect to the value and availability of water

It is estimated that there are almost a billion poor people in the world; of this over 750 million live in urban without adequate shelter and basic services. Population growth and rapid urbanization will create a sever scarcity of water as well as tremendous impact on the natural environment. Owing to this, cities in developing countries are already faced by enormous backlogs in shelter, infrastructure and service and confronted with insufficient water supply (Khatri & Vairavamoorthy 2007).

Concerning infrastructure aging; in most cities worldwide, there has been years of neglected maintenance to water storage, treatment, & distribution system. Poorly maintained water supply system can generally be traced to insufficient financial resource and poor management. This deterioration in the water infrastructure threatens the quality and reliability of all water services (Khatri & Vairavamoorthy 2007).A large proportion of this infrastructure is over 100 years old, placing it at increased risk for leaks, blockages and malfunctions due to deterioration.

These deterioration processes are more sever for developing countries, due to aging of the system, poor construction practice, little or no maintenance & rehabilitation activities due to the limited financial resource, operation at higher capacity than design,etc similarly,there is a little knowledge about specific classes of asset deterioration, the technical service life and insufficient database to know the extent and/or the value of their infrastructure assets. Further, there are not efficient decision support tools available to infrastructure manager and decision makers (Misiunas 2000; Khatri & Vairavamoorthy 2007).

As the review articles show different researchers studied problems of water supply in different urban cities. A problem which is significant in one urban city may not be significant to other. In addition to this, it is not possible to adapt their study without scaling down the problem and solution to local context. Therefore, this study will fill the gap in the study area by identifying the possible cause of the existing water supply problem and recommend sustainable solution.

2.5 Conceptual Frame Work

With increasing global change pressures (urbanization, climate change etc.), coupled with existing un-sustainability factors and risks inherent to conventional urban water supply, cities of the future will experience difficulties in efficiently managing scarce and less reliable water resources and reducing urban flood risk.

Therefore in order to develop solution to manage urban water more effectively with sufficient quantity and quality, this global and regional pressure must be recognized and used to drive the design and management processes of urban water supply system.

In cognizant of this, the following conceptual frame work considers engineering, environmental, socioeconomic and institutional factors as inputs for sustainable water supply

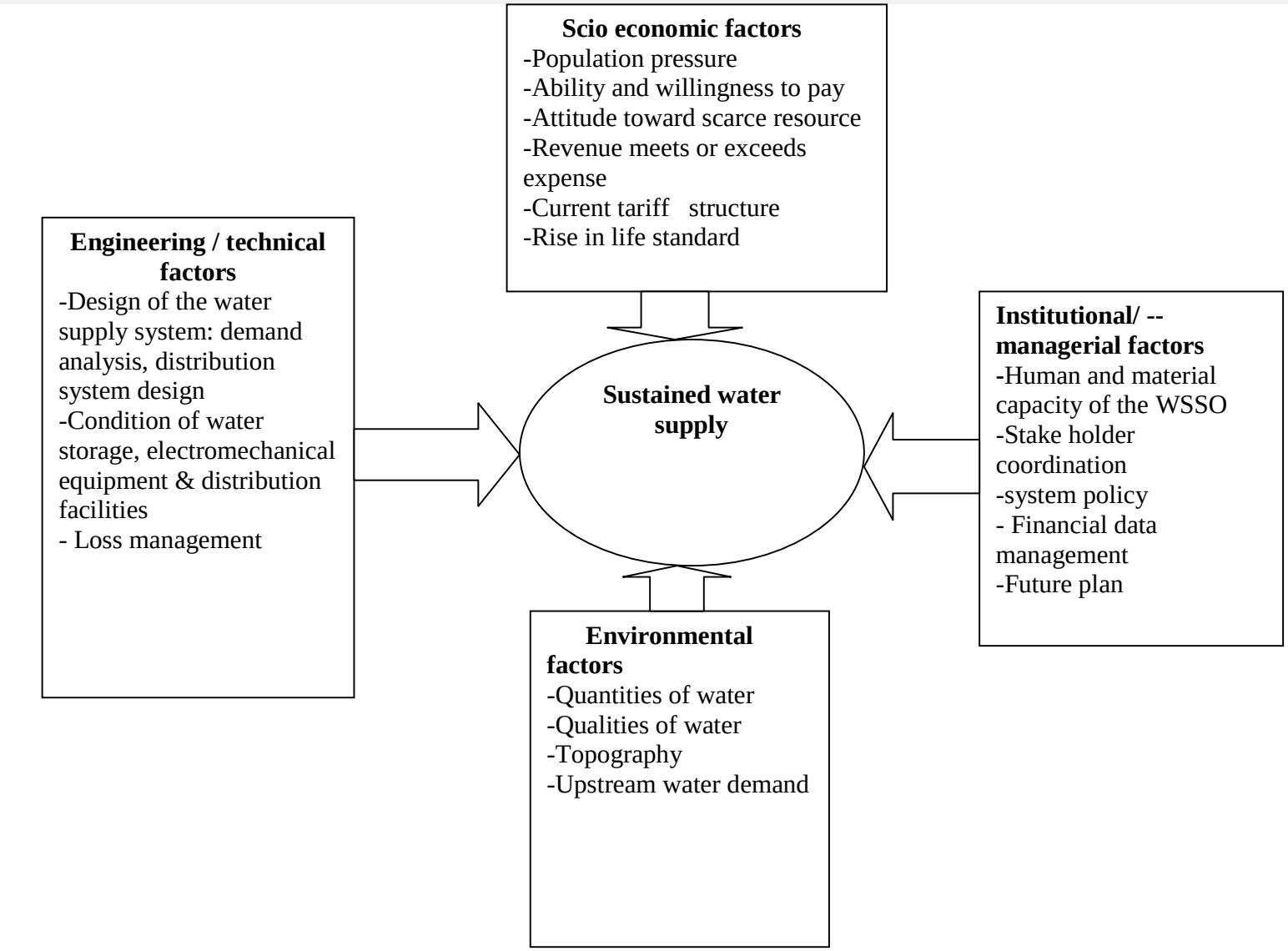


Figure 2: Conceptual frame work: for problem assessment in Durame water supply. Adopted from; Zegeye,(2010)

CHAPTER THREE

Methodology

3.1. Description of the Study Area

3.1.1. Durame Town

Durame town is located in southern nation, nationalities and people's regional state at a distance of 125km north west of Hwassa and south of Addis Ababa at a distance of 352km. It is the capital of kembata tembaro and a center of Kedida Gamela Wereda. The town has a latitude and longitude of 7°14'N37°55'E. With an elevation of 2101 meters above sea level. The town covers total area of 538 hectare and master plan supported area of 1600 hectare (ZOFED 2007:1).

Durame town is currently undergoing civil service reform program. It has public elected administration council, executive organs and town court. The town administration is divided into 5 kebeles. The area surrounding the town is potentially rich in agricultural products with proper routes for collection, marketing and distribution of this product.

Durame is moderate urban town with about 24,454 population CSA (2007:7) of which 12,162 male and 12,292 female. The main livelihood of the population is based on petty and small scale trading of agriculture products and merchandises for which the town council is currently supporting through trade extension development program

The climate of the study area is dominated by tropical climate with distinct dry winter to the western and southeastern part of the study area and warm temperature rainy climate with distinct dry month in winter in the central and north parts highlands of the project area (AGC 2008:7)

In general, the rain fall in the study area is bimodal type and the main rainy seasons are from June to October and March to May. The maximum rainfall over the northern high lands of the catchments area reaches as high as 200mm mostly in April/ September and over the southern –east portion reach 170mm in April / may.

3.1.2. Data Source

Both primary and secondary data are collected from different sources. For primary data house hold survey,FDG,KII and direct observation were employed.

On the other hand, the major source of secondary data include design document in DWSSO, inventories from Zonal Water Resource Office, Regional and Federal annual reports and related literature.

Information on financial records, organizational structure, manpower situation, design and water system detail were collected from design document and related literature.Policy and related information were collected from proclamation, regulation, guideline and strategies as a secondary document.

Data collected from House hold revealed attitude and knowledge towards scarce resource, willingness to pay for improved service, level of participation as stake holder and their satisfaction level toward the service.

3.1.4. Sampling Technique

In order to obtain the required information probability and non probability sampling techniques were employed.

Out of 5 kebeles found in the town, two of them were selected purposively due to high number of house connection and critical difference in topography. According to DWSSO more than 70% of the customers are found in 03 and 04 kebeles. Further selection was done using simple random sampling technique;

this method was selected since there were no significant differences within the house hold as long as their mode of water consumption is considered. From the selected kebele, with 90 % confidence interval and 10% margin of error sample size of 134 were calculated. To reconcile the available time of this studies with calculated sample size, 10% of targeted population was considered. Therefore, out of 900 beneficiaries in both kebeles 90 of them selected proportionally.

3.1.5 .Data Analysis

The study depends on both types of data i.e. qualitative as well as quantitative data. Therefore, depending on the nature of the data different data analysis methods were used. Data collected from house hold survey were entered into statistical Package for social science software and simple statistical computation such as frequencies, percentage and mean were produced.

On the other hand, data collected from FGD, KII, physical observation and secondary source were used to triangulate the survey information through different interpretation.

CHAPTER FOUR

4. Existing water supply condition

4.1. Water source

Durame town is served by 21 years old Ambaricho gravity springs, which are transmitted from Ambaricho mountain located 8km from the town and one borehole that is pumping 5.8l/s (measured at the mouth of the borehole).The scarcity of water in the town might be related to the location of the study area being between the watershed areas of Bilate and Omo river basin.

The past endeavors were largely limited in developing Ebala spring situated more than 10 Km distance from the town. The spring emerges at the boundary of Kedida Gamela wereda and Alaba special wereda and flows to the latter wereda. The spring construction work was in effect by Ethiopian orthodox Church Development and inter church aid commission (EOC-DICAC) for the three peasant associations. The preliminary design work carried out by KT zone water, mines and energy resource office was based on the outstanding spring flow which was estimated to be more than 10l/s. This project has not been commenced as it has cost and other implication resulting from its distance, appreciable head difference (more than 350m elevation difference without considering friction and other loses), management of the water supply system and unresolved social issues. EOC-DICAC was set to provide funds to construct this spring; however, it was reported that the fund they have at hand didn't match the estimated project cost.

Some percentages of population also collect water from one traditional pond mostly during wet seasons. It is also used for live stock watering. It is situated downstream of the town close to the existing borehole. It is open to contamination, during rain the water from parts of the town is directly

discharged to this pond and there is a high pollution threat from solid and liquid wastes generated in the town.

Currently, the total potable water sources and their yields are 4.3l/s (5.8l/s) from Gocho borehole, 3.7l/s from Ambaricho springs and 0.5l/s from Fulasa Deketa spring for Mother and Child health center in Durame.

The total current production from one borehole and spring is about579 m3/d. The existing aggregate output is not sufficient to satisfy the current and future demand.

4.2. Bore hole

Only one borehole owned by Town water supply service office is found in Durame town. This borehole was drilled in 1997E.C. by the side of old Gocho bore hole in replacement of the abandoned old borehole due to electromechanical equipment stuck inside the well. This bore hole has a reported yield of 4.3l/s; however, discharge measurement at the mouth of the borehole using bucket of known volume yielded about 5.8l/s.

The borehole operates 19 hours a day producing an average of 296m3 of water considering reported yield of 4.3l/s, that is pumping to booster station and then to 150 m3 concert reservoir.

Figure 2: Generator at Gocho Bore hole booster station

Table 1: Summary table of DWSSO bore hole (Gocho)

No	Name of BH	Location		Altitude (m)	Depth (m)	Casing Diameter & type	Test Q (l/s)	SWL (m)	DWL (m)	Measured Q (m/s)	Remarks
		UTM E	UTM N								
1	Town BH	377491	799312	2016	246	6" steel	4.3			5.8	cold water

Source: DWSSO & field visits

The supply from borehole is boosted on its way to the main reservoir. In the middle there is a booster station with vertically installed submersible pump and 30m3 steel wet well. This pump transfers water to the main reservoir. It is observed that a low level electrode is installed in the steel tank to avoid dry running of the pump, and to make the system functional.

No data is available for the pump installed in the borehole, except that is 30 Kw and is supplied from regional water bureau.

4.3. Spring source

Development works were done in 1990 by capping three spring eyes on Mount Ambericho which is lying North West of the town. These springs, each having own capping structure, were collected at a single chamber and then gravitated to the town. The detail of the springs is shown in table 2.

Table 2: summary table of spring at mount Ambericho.

No	Name	Location		Altitude (m)	Measurd Q(l/s)	Remark
		UTM E	UTM N			
1	We'name	374842	803000	2303	1.5	Concentrated in one locality
2	Mulu'lega proper	374730	803883	2301	2	
3	Mulu'Lega (little)	374723	802887	2304	0.3	

Source : Durame town water supply service office

Figure 3: The Ambericho mountain where spring sources exist

4.4. Collector and transmission Mains

The transmission lines of Durame water supply can be categorized into two ages. The old one which conveys water from the Ambericho springs until it reach to high school 50m3 concert reservoirs with transmission line of 3110m length and diameter of ND 50 mm GS pipe.

This system provides service to the Southern and older parts of the town. However, later three concert reservoirs at the middle of the town were constructed to supply the expansion of the town in the northern direction.

Generally, the old systems convey and distribute by gravity for a total transmission line of 8720m.

The second water source system is the one which is relatively younger and supplies to the net work after pumping from borehole to concert reservoir located at higher position (KMG-reservoir). Generally it comprises one borehole, one booster station, a transformer and generator set, 150m3 concert reservoir and ND 100mm mostly GS pipe with 3430 m length pressure main from the borehole to the reservoir.

4.5. Treatment plant

The water is not treated chemically and is distributed directly. At intervals the reservoir is cleaned and filled with water to which chlorine tablets are added.

4.6. Reservoir

There are five reservoirs in Durame town located at high school, Gogota care and KMG .The total volume of the reservoirs is 281m3. There is one temporary booster reservoir located on the Gocho borehole pressure line.

Figure 4:Gogota care reservoir KMG Reservoir

4.7. Distribution net work

The existing scheme has about 19.77 Km length distribution network having nominal diameter greater than or equal to 25mm (see table). The old net work was partially grid but the recent expansion is modified to branching type with reduced diameter as it goes to the consumers. According to the location of the service reservoir the distribution are named and classified as follows.

The high school reservoir which is located at the back of high school feed the surrounding and lower reach of the town with diameter of 40-50mm.

The Gogota reservoirs are fed by one GS ND 80mm gravity main and the outgoing pipe from these reservoirs supplies the current central parts of the city including shops and government office.

The third net work system is the one which feeds from KMG reservoir. The borehole at Gocho is directly fed to a 150m3 reservoir. The out let pipe is100mm and then branched in to lesser diameter as it feeds the south and west parts of the reservoir areas. The type length and diameter of the distribution system is tabulated in table 3.

Transmission lines					
No	Description	Material type	Size	Quantity	Remarks
1	Ambericho spring (that reaches KMG- reservoir	GS	ND80mm	4660m	
		GS	ND60mm	3110m	
		GS	ND50mm	950m	
2	From Goch hole to KMG -Reservoir	GS	ND100mm	2630m	
		uPVC	ND100mm	800m	
Reservior					
1	High school reservoir	Masonery	50m3	1	
2	Gogota reservoirs	Concret	27m3	3	
3	KMG- reservoir	Concret	150m3	1	
Booster station					
1	Gocho BH booster	cylinderical steel	30m3	1	
Distribution net works					
1	Distribution lines	GS	ND100mm	1199m	
2	Distribtion lines	GS	ND80mm	2850m	
3	Distribution lines	GS	ND60mm	308m	
4	Distribution lines	GS	ND50mm	6515m	
5	Distribution lines	GS	ND40mm	1570m	
6	Distribution lines	GS	ND32mm	0m	
7	Distribution lines	GS	ND25mm	7326m	

Table 3– Existing water supply system components

uPVC-Unplasticized Poly-Vinyl chloride

Source :Durame town water supply service office

4.8. Water production and consumption patterns

The town population figure obtained from the municipality is 42,000 with total connected customers of 1199, including 18 public taps each considered as a client. The distribution of water is on the basis of ration which reaches to customers once in a week or maximum twice in a week during wet season. The total current production from one borehole and spring is about579 m3/d. The last three years production and consumption pattern are as shown in table 14 below.

Table 4: The three years water production & consumption in Durame WSSO

Year E.C.	**2000**	**2001**	**2002**
Production in m3	210,970	210,970	210,570
Consumption in m3	55243	75401	84332

Source DWSSO

CHAPTER FIVE

5. Major Identified problem of the existing system

5.1. Characteristics of the respondent

The average household size in the town for the surveyed house hold is 6 with maximum family size in the array being 13 and minimum 1 per house hold.
Out of the total surveyed households, Male respondents are 61% while Female respondents are 39%.

The age categories of the surveyed house hold are dominated by active age group who fall in the range of 15-35 years. This age group constitutes 69% of the total surveyed household.
Majority of the people in the town are driving their livelihood by undertaking small and medium scale trade. These include small scale trading, micro enterprises, retail trading, cereal marketing, flourmills, pastries, cloth making and live stock product marketing etc. There are no large scale industries and commercial centers; this might be related with a considerable number of the respondent 31(34.4%) income falls on the range of 1001-2000. The next higher percent in income groups are those who earn above 2000 birr which is 28(31.1%) and the rest with percentage of 34.4 earn 1000 Birr and less.

Table 5: Income of respondent

income categories in Birr	Frequency	Percent
<600	12	13.3
601-1000	19	21.1
1001-2000	31	34.4
>2000	28	31.1
Total	90	100.0

Source: Household Survey

The average expenditure for water for the surveyed House hold is 47 birr with maximum expenditure of 160 birr and minimum 10 birr. As compared to UN standard (House hold should never pay for water more than 5% of their income) 14 % of the respondent pay for water more than 5% of their income.

5.2. Environmental factor

5.2.1. Topography

In general the topography of the study area is characterized by the highest elevated Ambericho Mountain of 3028 meters above mean sea level and its undulating topography in the high land and plain topography in lowlands.

Out of the surveyed House hold 39 of them said the topographic difference between and among users create distribution problem; kebele 03 is found at lower and relatively flat elevation than 04. As a result, water form KMG reservoir reach 03 kebele with high pressure. Kebele 04 with low pressure and low amount. The effect of topography also showed on their daily average water usage that is 54 liters per house hold in 04 and 80 liters per house hold in 03. Following this a significant difference was also observed on their monthly average expenditure for water, kebele 03 spent 51birr per house hold, while kebele 04 spent 43 birr per house hold. During field visit the researcher confirmed the topography of Durame has been a challenge for many years to equally distribute water to the customers.

Recent study by AG consultant in collaboration with RWRDB recommended that making the distribution of water by zoning will solve the problem significantly.

5.2.2. Quantity of water

According to Ethiopian water Resource Management policy, any water enterprise should provide potable water with acceptable quality and adequate quantity. Regarding the quantity of water almost all participant agreed on shortage of water in the town. An average of about 19% of population has house connections. Consequently, the majority of household use community water system or public stand pipes.

Those who are using piped water also complain that the system has water only once or twice in a week. On average the town experience insufficient water supply for 235 days per years, while countries on south east Asia and Pacific experience only 3.5 days of disruption per year(ADB 2008:5). In recent time, utilities are preoccupied more on the activities of billing and revenue collection with less coverage of services particularly in new expansion areas.

Production consumption analysis by researcher and DWSSO confirmed that daily production with the assumption of no interruption in the system was 579m3/day. Due to friction loss, leakage and breakage from the system, only 273 m3/day of water is consumed. The per capita consumption pattern on the average is 14 l/capita/ day which is far below the standard. As The demand projection, by 2020, the first phase of design horizon, production of 41l/s and additional 39l/s at the end of the design Horizon (by 2030) required to distribute water to all beneficiaries in adequate quantity(refer Appendix C).

5.2.3 Quality of water

Regarding quality problem the bore hole at Gocho is suspected to be polluted from waste of municipality.Durame town has no proper drainage system on top of that Gocho bore hole is situated at lower elevation as compared to the town setting. During rainy season wastes from the town are collected at Gocho bore hole. Concerning working hour of the pump, Due to shortage of water the pump at Gocho works more than designed, so that, sometimes problem of

mixing water with mud is observed. The effect is manifested on the aesthetic values of water.

The other potential source of pollutant for the town water is the steel wet well at booster station which is claimed to be to contaminate the system due to rusting. The KII w/o Meselech Taddese from DWSSO said, due to vertically installed pump inside steel wet well, cleaning the wet well regularly has been difficult for long time.

Figure 5:The steel wet well at booster station

Regarding quality of town water, the house holds evaluate as follows, 44(48.9%) said good, 39(43.3%) said poor and the other 7(7.8%) said medium.

Out of the 40 house hold who reported the presence of contaminant in the vicinity of source,15 of them said flood from runoff,2of them said waste from industries and household ,20 of them said due to over pumping and the rest 3 reported all could be potential contaminant source for pollution.

Water quality test undertaken by regional health bureau revealed that most of the mineral and ions in the water are in compliance with WHO standard. However, nitrate concentration at Gocho bore hole is beyond the WHO standard (maximum allowable concentration is 45mg/l, found in water 55.12mg/l). The high value of nitrate (NO3) in Gocho bore hole indicates there

is an effect of pollution at that particular locality generated from municipal wastes. The transport of these contaminate (leached nitrate) to ground water is slow if there is thick unsaturated zone. These may not be the case for the area affected by rift faults which may then act as conduit for infiltration /percolation of pollutants.

Excessive concentrations of nitrate in drinking water may cause methemoglobinemia in small children. According to Hem (1985) in AG consultant (2000)Concentration of nitrate in excess of 10 mg/l from the standard will cause this disease.

Some percentages of the population also collect water from unprotected source such as dug well and unprotected spring. As per the observation of the researcher these wells are not constructed properly, no head work at the top of the well, no concrete ring inside the well and no manhole cover constructed. Consequently, dirt, debris, runoff, etc. infiltrate to the well and contaminate the water. In addition people and animals fall in easily and loose their life. No quality test was undertaken whether to use it for drinking purpose or not. In general dwellers that are using these sources are liable to water born and related disease.

Figure 6: Hand dug well with no proper construction at lalo kebele

The health office also has well documented evidence on the most common infectious disease associated with poor quality water and sanitation service and the age group vulnerable to such disease. In the last 2 years water born and water related diseases are most affecting children under 5 with intestinal parasites and diarrheas.

As per the assessment of house hold in relation to water born disease, out of 41 respondent whose family are affected by water born disease 33 of them are reported to have their children miss school 15 days on average, 6 reported their children dropped out schools and the rest 2 couldn't start school. It is also reported that house hold spent 189 birr on average for medical treatment purpose.

5.2.4. Upstream water Right

Out of water sources which supply Durame town,getelega spring is the one which is found at the top of Mount Ambericho where it is inaccessible for transportation. In addition the yield from this spring is too small to feed both the town and the dwellers at mount Ambericho. Due to this reason for dwellers at Mount Ambericho where the source emerges are given only one water point. But to adequately feed this population it requires at least four water points. As a result, people at Mount Ambericho are forced to use water by breaking the line from which it conveyed to the town. Consequently, most of the produced water has been wasted through leakage and breakage along the main. To avoid wastage of this precious resource and undertake regular supervision, proper route for transportation and respecting upstream water right in allocating the existing water will expect from the enterprise.

5.3. Socio economic factor (problem)

Under socio economic factors that affect the existing water supply system: current tariff structure, ability and willingness of the community to pay for

improved water, rise in life standards, revenue meets or exceeds expense, and attitude towards scarce resource are the major aspects to be considered.

5.3.1. Current tariff structure

Current water tariff structure studied by the water supply service and implemented since June 1999E.C is adequate to recover operation and maintenance costs and parts of investment costs.
The following table shows ranges of consumption and block in which tariff is approved.

Table 6: Range of consumption & tariff approved by block

Block	**Range of consumption**	**Approved(birr)**
Public fountain	-	6.50
Block 1	0- 5m3/month	3
Block 2	6-10m3	3.25
Block 3	11-30m3	3.5
Block 4	>30m3	4

Source: DWSSO

But vendors are reselling water as high as ETB 5 per 20 l jerican. Such price distortion is resulted from supply constraint and in adequate number of public taps in the town. It is also found that there are utility staffs at each water point that allow a considerable amount of informal revenue (from price paid by vendors for water at the source) to enter their pocket.

Thus, investment for additional public taps could relief the existing constraints and at the same time the existing operation tariff could be adjusted to full cost recovery level.

5.3.2. Willingness to pay for improved water supply

In order to investigate community willingness to pay for improved water supply service, judgment on the existing water tariff service is assessed. The current tariff rate for water service according to surveyed House hold is by large not affordable 46(51.7%) and judged as expensive; however, some 37(41.6%) say affordable and judged as fair; the rest 6(6.7%) say it is cheap and complain it is not adequate to cover different expense. Summary of respondent's opinion on the current tariff is shown in table 9 below

Table 7: Surveyed HH responses on the opinion of current tariff

water tariff	Respondent	Percent
Expensive	46	51.1%
Fair	37	41.1%
Cheap	7	7.8%
Total	90	100.0%

Source –House hold survey

Willingness to pay for improved water supply service has been assessed for the surveyed area. Among the surveyed House hold 73(81.1%) expressed their willingness to pay for improved water supply. However, House hold that constitutes 17(18.9%) mentioned they are not willing to pay for safe and adequate water supply service.

House hold positively responded to pay for improved water supply service were also requested to quote the amount of money to pay for 20 l jerican.73 House hold quoted the amount they are willing to pay as shown in table 13 below.

Table 8: summary of HHs on how much to pay for improved water supply

Amount in (ETB)	Respondent	Percent
<0.5	30	33.3%
0.5 -1birr	34	37.8%
1birr-1.5birr	8	8.9%
>1.5 birr	1	1.1%
no response	17	18.9%
Total	90	100.0%

Source: house hold survey

Those households that are not willing to pay for safe and adequate water were asked their reason; 13 of them reasoned out that they have low income and the rest 4 said they have alternative source.

5.3.3 Revenue meets or exceeds expense

Revenue collected in 2000,2001,2002 (E.C.) from sales of water ,water meter rent, service charges and others are summarized below in Table 11.

Table 9: Revenue from different source

Source of revenue	**2000**	**2001**	**2002**
Sales of water	179700.08	189531.5	215887.5
Water meter rent			
Customer Deposit	13600	31738.25	19420
Public fountain sales	29283.9	15275	48633.6
Sales of material	15336.43	1268.52	11336.3
Line connection			
Service charge	38166.88	49224.3	60390.52
Excavation and refilling			
Other income	14489.16	6111.5	8028.01
Total	290576.45	293,149.07	353,695.93

Source: Durame water supply service office

Expenses

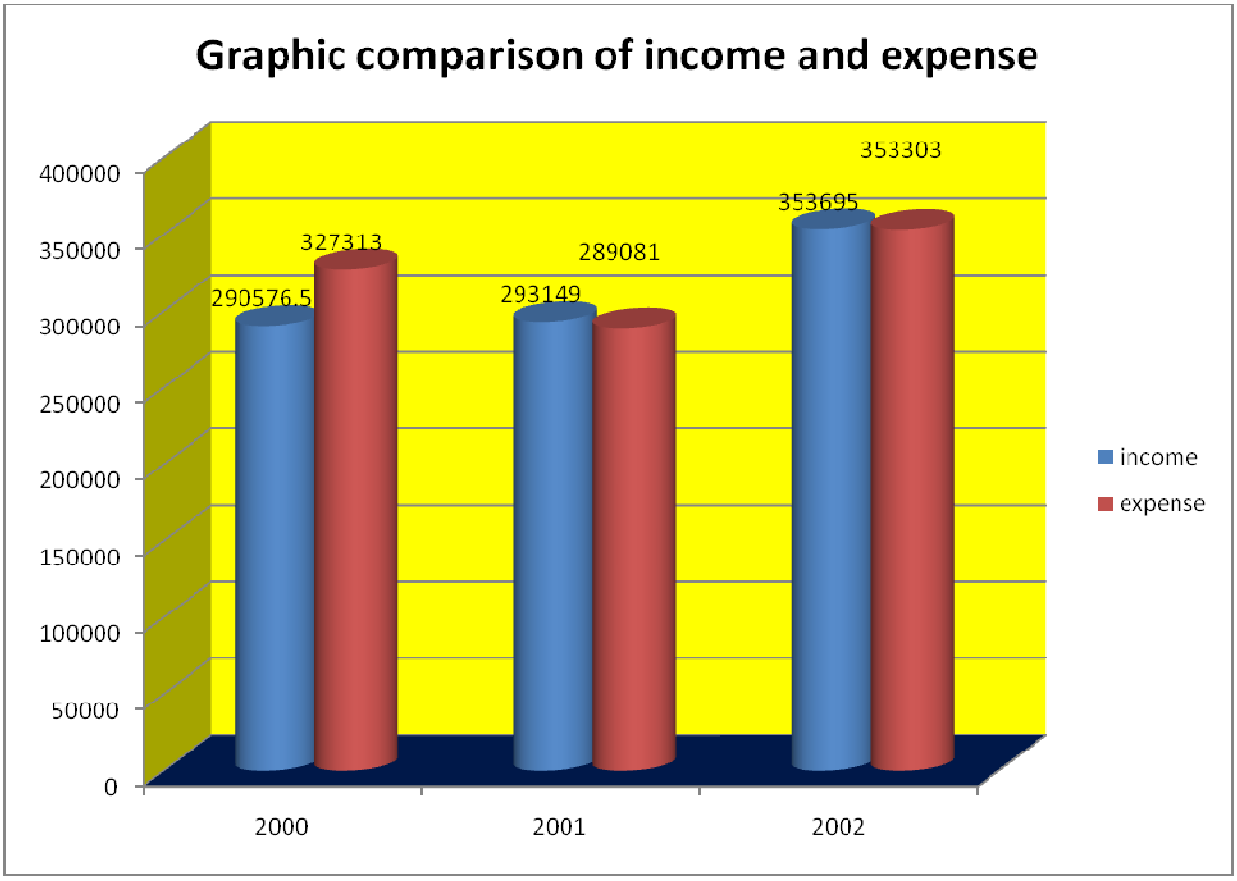
With regard to expense, the highest portion of the expense constitutes for salary and related costs, electricity cost and travel and perdium cost. For the year 2002E.C. annual expense for salary and related expenses, electricity, travel and perdium have constituted 56%, 24%,and 4.5% respectively. Expense for consecutive years are shown in table below

Table 10: The three years consecutive expense in town water supply in E.C.

Year	**2000**	**2001**	**2002**
Salary and related expense	166829.96	148957.75	198626.32
Travel and perdiem	13242.5	9901	15943
Contractual service	2436.89	2074.26	3190.65
Electricity	24810	27623.94	86129.72
Repair and maintenance	5085	7300	4413
Others material and supplies	5419	6077.3	12417.5
Purchase of stock items(pipe ,fitting	14130	37259.25	12783.9
Fuel and lubricants	78681	45276.34	1797
Other expense	166678	4611.48	18000
Totals	327312.95	289,081.32	353302.69

Source: Durame town water supply service office

Figure 7: Graphic comparison of income and expense



The three years trend in the figure above show that the enterprise was neither profitable nor loser. However, SNNPR proclamation No.40/2002 says that town water supply should at least deposit 40% of their revenue for future expansion. The case of the study area revealed that there is no deposit at least for maintenance and operation purpose let alone deposit for future expansion.

The key informant from DWSSO W/r Meselech Taddesse said the revenue from excavation and maintenance work were mismanage due to weak supervision and follow up of lower class worker such as plumber and assistance technician. Consequently, these groups of workers have developed rent seeking behavior.

Other significant problems in the services are that some customers do not pay their bills on time. Based from the House hold assessment the reason behind not to pay regularly is dissatisfaction with the service and deficiency of knowledge on the punishment laid by the government.

Figure 8: Key informant from DWSSO W/o Meselch Tadesse

The Key informant interviewee from DWSSO(W/o Mulu Adenew) added there is no enforcement mechanism in the parts of the Government for those users who are not willing to pay regularly.

The trend of neither profitable nor loser in the system shows that the enterprise is not viable economically. Unless this trend is reversed the sustainability of the service is threatening.

Key informant interviewee from DWSSO (Takele Lefamo head of the enterprise) suggested that there is no movement at all to secure funds for future capital recovery plan and to arrange training for worker from different organization; the board simply meets in three month interval to hear the report of the enterprise.

5.3.4. Rise in life standards, attitude towards scarce resource and population pressure

Population growth and rapid urbanization will create a severe scarcity of water as well as tremendous impact on the natural environment. In order to meet the future water demand, either expansion of the existing water supply system or developing new water supply sources are important.

The present water source, the spring has been constructed for not more than 10,000 population and now it is running out of design period (>21 years). The borehole which is relatively new has been giving service since 1997(E.C.).What is known here is both the bore hole as well as the spring are serving not more than half of the present population.

Currently, the town has a population of 42, 000, this figure was taken from town municipality. The rapid increase in this figure might be due to migration, natural growth and student who are coming from different region as per the allocation of the government (in TVET and Industrial College).

The key informant from zonal water resource office said next to the capital city of kembata Tembaro zone, Durame town has been undertaken different development activities such as telephone line installation, electric line expansion, road construction etc. Because of these migrant from nearby weredas were attracted by these development activities and resulted in population pressure.

Out of the surveyed household 63(70%) use water from taps, the rest 27(30%) use water from secondary source in addition to tap water.

In earlier time house tap users were small in number. Recently Substantial number of household use water from protected source (tap water) and use communal shower for bathing.

35(38.9%) house hold possess cloth washing faucet, bath room and hand washing faucet and have installed this fixtures some years after their house construction. This shows that considerable number of household have changed their life style to a level better than before.

Out of the surveyed house hold 49(54.4%) reported that their income have been increased during recent years. Out of 49 respondents whose income showed increment, 45 (91.5%) of them said their water demand also increased accordingly.

Table11: income increment in relation to water demand

Does the water demand increase accordingly	Respondent	Percent
Yes	45	50.0%
No	4	4.4%
N/A	41	45.6%
Total	90	100.0%

Source : House hold survey

Regarding public behavior towards the scarce resources, most 85(94.4%) agreed in protecting water from leakage. Out of 85 household that are agreed in protecting leakage 41 of them said water is an important resource and should not be wasted unnecessary and the rest reason out as water is expensive for them and they cannot afford for leakage or wastages.

In contrary 5(5.6%) believed water is easily available natural resource so that they do not want to bother about wastages and leakage.

Unless the existing water supply system is expanded both in quality and quantity, the sum of the above factors will aggravate the existing water supply shortage.

5.4. Technical Factors

5.4.1. Demand analysis

Demand analysis should consider into account; the population to be served, planning horizon, standard of living and activities, the cost of water supplied and the availability of waste water service etc. However the present and past water demand analysis of Durame town has not considered such parameters.
The KII from zonal water resource office Head, Ato Lolemo Sulamo said the existing and the earlier methods for demand analysis was not scientific; in effect there is always a mismatch between town water production and consumption.

Once the town water distribution system was constructed there were no major expansion works that were executed. But the focus group discussion with DWSSO revealed that even though there were no major expansion works undertaken, minor expansion works at the request of the beneficiary was in effect by WSSO. In reality, decision to expand the existing system should be made by calculating the existing water production and comparing with consumption. If the existing production is greater than and in sufficient quantity to supply the demand, decision would be made to expand the existing system. Otherwise simply elongation of the pipe at the request of the customer is a futile exercise which ultimately leads most of the pipe to run dry. This is what the researcher observed during survey time at lalo kebele and industrial college where there is no water in the pipe at all time.

Figure 9: Pipe line at industrial college with no water at all

5.4.2. Distribution system design

The oldest water source in Durame town is the spring at Ambericho and it is estimated to produce 3.8l/s. Although this source is rated at 3.8l/s, it was reported time and again in the past that about 1l/s or slightly more water enters to the reservoirs in the town.

To resolve this issue different investigation techniques were applied during this survey. First transmission line was checked from source to reservoirs and found out that no leakage was detected. Next the amount of water that enters the 50m3 high school reservoir was measured using container of known volume and found out that water enters to high school reservoir at the rate of 3.7l/s(water meter not installed).Water enters this reservoir only few hours during the day time and is allowed to by pass this reservoir so that it will be gravitated to 150 m3 KMG reservoir almost all the day. This reservoir is situated at higher elevation than high school reservior and was initially built as service reservoir for Gocho borehole pressure main. Measuring the volume of water entering KMG reservoir was not possible as the inlet pipe to service reservoir was situated at inconvenient place as well as it has no bulk water meter at the inlet or outlet sections.

It was noticed at the source of the spring that water in excess of 1.6l/s backflows at the collection chamber through the overflow pipe almost all the day. It was later found out that there was over flow at the collection chamber when water by pass the 50 m3 high school reservoir to be conveyed to the KMG reservoir.

The above field investigation and elevation difference analysis revealed that the total head including friction loss might not be sufficient to gravitate the water from spring source to the main (150m3 KMG) reservoir.

Previously investigator from zonal water resource office conclude that the spring was diminishing through time and depleted at the source probably due to environmental change around the spring, leakage along the transmission line and significant leakage at the spring capping structures.

Now it is certain that water backflows at the collection chamber when conveyed to the main reservoir due to the insufficient total head between the two end points (the source and the main reservoir).The above condition halted nearly about half of the full production capacity of the spring for the past several years.

Document analysis in office and house hold survey result showed that 20-25 household use water from pipe size less than 25mm. In reality for such a large number of beneficiaries this size of pipe is not adequate to convey the required amount of water.

Another distribution net work problems which are observed during field visit were expansion work from under sized pipe and decision for expansion without analyzing production capacity of the system. According to the KII from zonal water office the reason might be due to shortage of material and professional who are in charge of designing the existing system for further expansion.

5.4.3. Condition of water Storage.

In Durame town there are five reservoirs located at Durame high school, Gogota Care and KMG. The high school reservoir feed, the oldest and lower reach of the town. As it has been observed during the survey some crake on the top, bottom and side of the reservoir is observed and need some high level maintenance. There is no bulk water meter at the outlet to the reservoir, there fore, not possible to quantify the exact production and consumption pattern to manage system loss efficiently

The Gogota Care reservoirs and the surrounding area in which these are expected to feed were located at relatively the same elevation; in effect distributing water from these reservoirs by using gravity has not been effective so far.

In replacement to these KMG reservoir was constructed to cover the demand for the newly expansion area and the Gogota surrounding. At this point there is a bulk water meter but it is not functioning. The relative position of the reservoir as compared to the town setting is good and large area can be covered from this reservoir. But according to the key informant interviewee from zonal water resource office the area at leliso(05 kebele) and the surrounding can't get water from both reservoirs. Therefore, creating third zone at an elevation of 2175m and adjacent to Kalehiwot church by constructing new reservoir will solve the storage and distribution problem.

Figure10:Focus Group Discussion DWSSO

5.4.4. Electro Mechanical Equipment

Presently the town has only one bore hole with two pump station. The result of the assessment at BH revealed that there is no functional water meter at the well head. In addition the static and dynamic water level data is not available. Regarding pump controlling mechanism there are no mechanical or electrical components installed for control of the system. The controlling mechanism employed is through an estimate of time it usually takes to fill the reservoir. Unless it is replaced by systematic controlling mechanism the longevity of the system is under question mark.

According to the informant in the zonal water resource office, Generator at BH is technologically simple for which spare parts are available and supplied by regional water bureau recently. However electric system failure is reported repeatedly. The causes might be due to the guard at pump station works as he works as both guard and operator with no adequate skill and training.

The second station is found in between BH and KMG reservoir. At this station a submersible pump is vertically installed in a 30m3 steel wet well and transfers water to the main reservoir. Here also water meter is not installed at the discharge piping of the pump.

Regarding booster station, frequent failure at electric parts of the motor and pump are observed. The reason behind the failure according to the KII from DWSSO is low technical capability,working hour (19 hours/day) greater than design and sporadic supervision from parts of the enterprise.
Concerning problem on the distribution net work, focus group discussion in DWSSO revealed that pipe bursting and fitting failure (union nipples, elbow, gate valves) are commonly exhibited .The cause for failure is suspected to relate with the old age of the system and poor quality material.

5.4.5. Water loss management

In reality water loss management needs maintenance procedure, practice, follow up, adequate management structure, good material and good work man ship. With absence of the above requirement, reducing loss to the level acceptable might be difficult.

In Durame town water enterprise, there is no flow measurement or assessment mechanism. Bulk flow meter were not installed at any point in the net work, no organized section to inspect the net work by walking and check for evidence of any leakage and other problems. The office only waits for leakage report from customers. The current practices are mending only visible leaks and carried out as part of general duties of net work maintenance staffs.

Household survey and KII from Zonal water office showed once leak is detected and reported, it takes 5 days on average. In effect the amount of water lost through leaks or breakage is increasing significantly.

Figure11: Key informant from DWSSO Ato Takele Lefamo (Manager of the enterprise)

Preventative maintenance measure such as regular supervision of net work, good workmanship, quality material and organized section are vital for success of loss management in the system

5.4.6. Pressure efficiency

Pressure inefficiency can arise from low water in the system, topographic difference, bending in fitting and pipes, connecting disorder pipes and sub distribution system mismanagement.

The assessment of pressure inefficiency in the House hold revealed that, 45(50%) respondent said that the speed of flowing at each tap when fully opened was low, very low and no water at all.

KII from zonal water confirmed the evidence from House hold and added that some low level technician and plumber in office mismanage the distribution by letting water to some parts of the town; as the result, some other parts of the town were not getting water even on the basis of shifts.

Concerning disorder of pipes, as the diameter of the pipe and pressure inside the pipe are related inversely, connecting pipe from smaller size with larger will result in dropping significant amount of pressure. Such cases are observed at industrial college and investment village where some part of the pipe laid above ground.

Participants from community representatives express the reason behind the intermittent or low pressure in the system that it is due to officials insisting on extending the distribution of pipe work beyond its hydraulic capability.

On the other hand, shortening of pipe containing faucet and clothing the sub distribution system will not solve pressure inefficiency permanently. Therefore, to avoid pressure inefficiency from the system permanently, it requires sophisticated design and high skilled professional.

In general, technical factors affect the water production amount and exaggerate the difference between water production and consumption.
Source: Durame town water supply service office

5.5. Institutional factors

5.5.1. System policy

Sustainable operation and management of the water supply schemes can only be achieved if appropriate organizational structure and management systems are put in place. Thus, appropriate organizational structure has to be developed and implemented parallel to the system improvements.
In developing organizational structure various factors should be considered. Among the factors that influence organizational structure, policy and proclamation are the most important and should be considered in developing new structure.

Owing to this SNNPR state proclamation provided the establishments of urban water supply service as independent/autonomous public entities administered by generating their own income in the Region. Proclamation No.40/2002 issued on 20th April 2002 for the expansion of organizational system to provide reliable and sustainable service on the basis of full cost recovery plan. The consequence is that the water service will perform all function autonomously with limited supervision and support from Government.

Regulation No.2/2002/ issued on 2nd December of,2003 for the establishments of the "SNNPR urban drinking water service enterprises " in 15 town and later in February, 2004 the Regional Government has issued proclamation No. 7/2004, to amend some articles of the previous proclamation No. 40/2002. As results, the following functions are considered as the major activities of any urban water supply institution.

- Planning of the water supply development
- Conducting water supply study and design
- Construction of the facilities
- Administration of the water service
- Providing water supply service
- Conducting maintenance of the facilities
- Collecting water service fees
- Conduct procurement of goods and service and formulate tariff

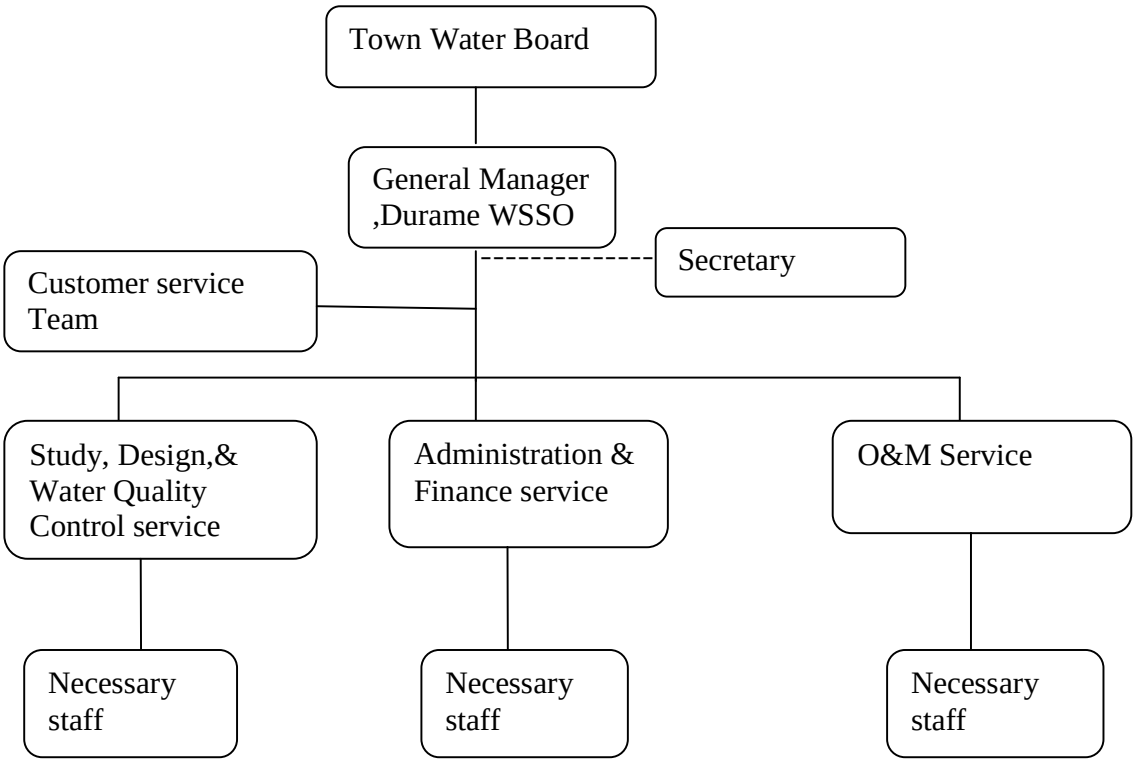
5.5.2. Human and material capacity

Organizational structure provides a useful frame to organize the work flow in an organization. However, to ensure the work objectives achieved, supportive processes like human resource development system need to be put in place.

The existing institutional frame work of the management and administrative structure of the town drinking water supply service enterprise are organized into three layers

- ✓ The board
- ✓ The enterprise General manger and his team and
- ✓ Employees of the Enterprise

Figure12: Existing organizational structure of Durame town



Regarding the management system of the office, there are no updated administrative procedures, guide lines and working manuals for uses by both the management and the employees of the water enterprises.

The DWSSO has set its vision, mission and goal statements, however, it hasn't yet developed and implemented service delivery improvement program. Due to

this reason, the activities carried out by enterprises staffs have very little relationship to the mission and objective set and not aligned with the interest of the customers.

Looking at the internal operation of DWSSO, clear delegation of duties and responsibilities among and between employees is lacking, and also relationship between staff members, the management and the town water board have not been clearly defined. Job description, duties and responsibility of all personnel including the General Manager are not fully developed and documented.

Personnel issues are carried out using partially by the regional civil service regulation channeled through the regional water resource bureau. However , practically, the water enterprise is not fully exercising the civil service regulation.Durame WSSO doesn't have its own unique organizational structure nor does it have its own salary scale which is structured according to its financial capability, the labor market, the standard of living and other factors that affect its operations. And also the salary scale follows civil servant salary grid and doesn't conform to the standard labor regulations and requirements. According to Arthur (2003:7) civil servant salaries do not encourage staff to help customers; its rules are complex, out dated and not appropriate for transparency.

5.5.2.1. Existing staffing situation

Table 12:Durame WSSO Existing Staff by Team Composition

No	Team	Man power				Vacant post
		As per the Organ structure	%	Existing man power	%	
1	General manger's office	2	4.08	1	4.76	1
2	O&M Service	12	24.49	6	28.57	6
3	Customer Service	2	4.08			2
4	Administration & Finance	30	61.22	14	66.67	16
5	Design, Study & Water Quality Control	3	6.12			3
Total		49	100	21	100	28

Source: DWSSO

The staffing situation can be summarized as follows;

- 17 employees are permanently employed& 4 are contract
- The maximum educational qualification is Diploma level and the minimum 4th Grade
- The minimum and the maximum experience years are 2 years and 17
- Staffing situation are based on the civil service requirement
- There are about 28 vacant positions to be filled either from internal or external sources.

Based on job position, more than 70% of the work force are grouped under support staff while less than 30% constitute the technical staff. From organizational and management perspective, manpower composition of the enterprise is not healthy to function effectively and efficiently; the enterprise has to reverse this gear, the technical and administrative staff ratio should be moved towards more operational activities for effective performance.

Currently, the operation and maintenance team leader position is filled by a delegate who is in fact working as a plumbing foreman. Some operators are covered by the guards that may create discomfort when the position is filled through recruitment

Table 13: Evaluation of the technical capacity of the WSSO

Evaluation	**No of respondent**	**Percent**
very good	2	2.2%
Good	8	8.9%
Satisfactory	16	17.8%
Poor	46	51.1%
very poor	18	20.0%
Total	90	100.0%

Source: House hold survey

Regarding technical capacity of the enterprises HH evaluated 58(64.4%) as poor and very poor, 22(24.4%) as fair, 8(8.9%) as good and the rust 2(2.2%) as very good. Here most of the respondent evaluated the technical capacity below very good and FGD with DWSSO also showed their gap in technical capacity.

In general, the enterprise is lacking expert such as hydraulic engineer, designer, planner, surveyor, and data manager. With the absence of the above experts accomplishing the mission of the office effectively and efficiently might be difficult.

Regarding material capacity, there is a shortage of office equipment and working tools. Concerning equipment, the office only has one desk top computer, one photocopy machine and one printer.

The water supply source, Ambercho spring, is found at 8Km distance & inaccessible for transportation. However, the office only has one old motor, serving both as a service for manager and supervising the whole system.

Currently, the office gives service on a rent house with no store. As a result, materials are seen in the yard scattering here and there with no guard.

As reflected from the Household survey, the material capacity of the office was evaluated as follows: 19(21.1%) very poor, 40(44.4%) poor, 16 (17.8%) fair 14(15.6%) good and 1(1.1%) very good. Here substantial number of respondent evaluated the material capacity below fair and the expert in zonal water resource office also agreed with the house hold survey result.

5.5.3. Stake holder coordination

Stake holders for town water are Regional water resource bureau, town administration, community, municipalty, Zonal water resource office and the town water board.

Regarding the combination of the board, the members are as per the requirements of the manual and women users are also represented in the board. Focus group discussion in DWSSO indicated that the board hasn't yet power, duties and responsibilities given to them. As a result, the members come to meeting regularly to hear the report from the enterprise. This shows the board has a serious constraint regarding planning, contract administration, supervision and evaluation of the activities.

The compliance of the work of the enterprise with national water resource management policy and water law is followed up by Regional water resource bureau. The assumption was that the Regional water resource bureau support the enterprise in consulting and technically on regular basis. But it is reported that the enterprise couldn't get technical and consulting service from regional water resource bureau regularly.

Regarding the relationship between the enterprise and zonal water office, after the enterprise was established as independent/autonomous entity, there were

no formal relationship between them. But on the basis of demand, the zonal water office gives technical support. From the observation of the researcher the enterprise lacks professionals like engineer, surveyor, Planner and Geologist. On the other hand, these experts are found in zonal water office. Therefore, the relationship between them should be formal at least to solve human resource problem temporally.

The house hold survey showed that there were a loose relationship between the enterprise and the community. According to the survey, out of 90 respondent 61of them said no communication for investment contribution and water related issue while the rest 29 said they communicate the office through the representatives of the users and contribute for water investment.

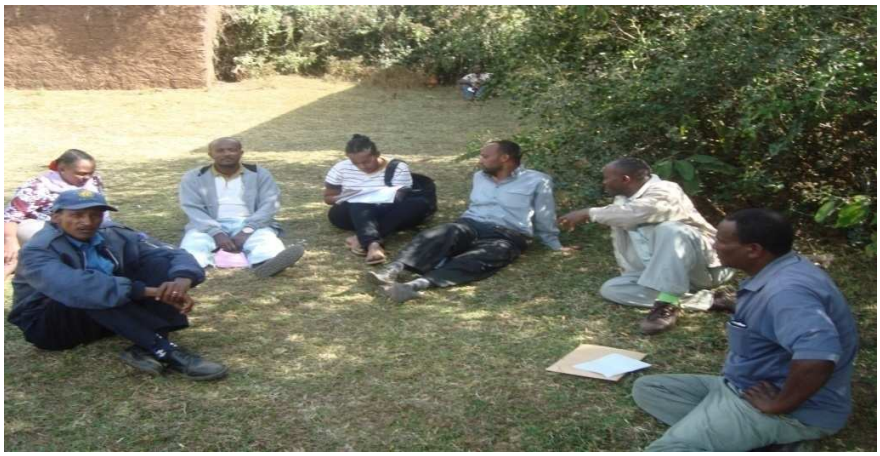


Figure13:Focus Group Discussion with representatives of the users

To validate the household survey result focus group discussion with board members was assessed and revealed the following, since independency of the enterprise, communication between either users or their representatives have been weakened and had brought no contribution for water investment. Concerning stakeholder coordination great mobilization work is expected from the enterprise.

5.3.4. Financial Management

DWSSO has financial system different from financial system of government. The office use receipts prepared by itself and report the finical status to the board.

The three years financial summary shows that the enterprise was neither profitable nor loser.

The key informant in DWSSO pointed out that computerized billing system and double entry accounting system were not installed and the enterprise has no plan to implement such system in the future.

Due to lack of sufficient knowledge of accounting, key financial activities such as calculation of depreciation, asset valuation and preparation of balance sheet are not performed.

Regarding financial support the municipality has responsibility to support the office at least on the basis of demand. What a pity here is the municipality doesn't refund the pipe cost incurred to office due to destruction and construction in the case of town infrastructure.

On the other hand, the participant of focus group discussion in DWSSO complain to the board of the town water as it was unable to prepare capacity building training to the finance staff and accounting clerks, in effect the financial section is inadequate and not sufficient as required.

CHAPTER SIX

6. Future Water Demand Projection

6.1. Design horizon

Prediction of future domestic water demand is very important before designing and planning a water supply system of any city. An efficient distribution system should serve an economical design period. The period should neither be too long so that the full financial burden is thrown on the present generation, nor should it be too short so as to avoid the uneconomical design. In practice, a period varying from 20 to 30 years is considered to be sufficient for design purposes (Duggal,1989; Durga, 2004) and a 20-year design period was used in this study

Regarding the assumed coverage as the initial capital cost for the constraction of water component is high it is advisable to implement the system by stage. In effect it is not possible to assume 100% coverage at the initial period. Considering the Millennium development Goal as a bench mark, by 2012 and on wards all the population in town should get 100 % coverage. This study assumed 91 % coverage for the initial years of forecasting .

To project the population, as a base year population figure obtained from the municipality and the growth rate from SNNPRS Volume II Analytical Report Dated December 1998 have been used. Accordingly, for the projection of population, the following exponential growth model is used:

$$Pt=Poe^{rt}$$

Where: pt=is the projected population at a time t

Po=is the initial population at time 0

r = is annual growth rate

t= number of years

Table14:SNNPR growth rates

Year	Growth rates	
	Urban	**Rural**
1995-2000	5.30%	3.10%
2001-2005	4.80%	2.80%
2006-2010	4.60%	2.50%
2011-2015	4.30%	2.30%
2016-2020	4.10%	2.10%
2021-2025	3.90%	1.80%
2026-2030	3.70%	1.50%

Table 15: projected population

Year	**2010**	**2015**	**2020**	**2025**	**2030**
Growth rate	4.6	4.3	4.1	3.9	3.7
Population	42,000	52,074	63,286	75,390	88,030

Note: the 2010 municipality figures are used as base (42,000)

6.2 Domestic demand

Domestic demand is the amount of water needed for drinking, food preparation, washing, cleaning, bathing and other miscellaneous domestic activities.

Based on the available data obtained from DWSSO, four major mode of services were identified for domestic water consumption. These are: house connection (HC), yard connection private (YCP), yard connection shared (YCS) and public taps (PT).

Long period data on consumption of water by blocks and mode of connection for either monthly or annual basis is not complied by the office.

Therefore, the 2002E.C. consumption data by mode of service is used as initial coverage estimation. This gives the current mode of service as 6.1%, 69.5%. 14.6% and 1.2% respectively for house connection, yard/private, yard/shared and public tap users.

The per capita water demand for various demand categories varies depending on the size of the town and level of development, the type of water supply schemes and the socio economic condition of the town.

According to the design criteria prepared in January, 2006 by MoWR, Table 19 shows the per capita domestic water demand adopted for urban water supply system for design horizon.

Table16: Break down of per capita water demand by purpose

Purpose	**Mode of Service**			
	HTC	YTP	YTS	PT
Total (l/c/d)	70	40	30	25

Source: MoWR 2006 design Criteria

It is difficult to estimate how exactly the per capita water demand will grow in between the design horizons. Therefore, the value given in table 19 has been used for the first year of design horizon (2010) and assumed to remain constant till 2020.

Between 2020-2030 design horizons, the assumption has been made that there will be a linear growth in per capita demand.

6.3. Non domestic demand

Non domestic water demand can be broadly classified into the following categories: institutional, commercial, industrial and animal water demands.

6.4. Institutional, commercial, and public demand

This refers to the water demand of facilities such as school, hospital, hotel, small commercial enterprise, and public demand where appropriate.
Bills from DWSSO show that the commercial, institutional, and public demand is ranging from 23-30% of domestic demand (DD).Since sometimes commercial area is also used as dual purpose including residence, the bills may over estimate entity for commerce and institute ; therefore, it will be fair to estimate and consider 10% of DD for commercial, institutional and public demands.

6.5 Un accounted- for (or non – revenue) water

Unaccounted – for water(UFW) is expected as a percentage of total water produced for the system.UFW arises from system leakage, illegal connection, inaccuracy in metering, overflowing of reservoirs and legitimate unmetered use such as fire fighting flushing, etc.

Since there is no metering in the system, it is not possible to assess the actual UFW of Durame town. Bills of the three consecutive years and operation time give 30 -50%UFW. In this figure there are a lot of uncertainties. Such as back flow from spring, frequent electric interruption, system failure, etc.To balance these two opposing notions, it will be reasonable to estimate UFW 15-20% DD in planning horizon.

6.6. Peak factor

The water consumption varies from day to day. The maximum day water demand is considered to meet water consumption change with season's and days of the week. The ratio of maximum daily consumption to the mean daily consumption is the maximum day factor. The proposed day factor usually varies between 1.0& 1.3 as per design criteria. Hence A maximum day factor of 1.2 is taken in this design.

After considering change in population, change in mode of service, per capita demand, non domestic water demand and adjustment factor, the detail of future water demand analysis of Durame Town is shown in Appendix C

6.7. Proposed source

Due to time,skilled expert, equipment and financial constraints it is not possible to assess the potential source for future recommendation. Therefore, source identification undertaken by AG consultant in collaboration with Regional water resource bureau is recommended for future expansion. Accordingly Bezena Benara-Wonko tectonic valley is nominated as a potential long term ground water source. The well field is located at 5km south of Durame town and the conservative estimate is 7l/s.Geological, Hydrogeological and other investigation have indicated that there is a potential to provide safe water for design horizon. This catchment includes part of the town and the existing water supply source Gocho borehole.

The main recharge to the aquifers is from channel loss along perennial and seasonal stream which drain the mountainous area, and from subsurface ground water flow through fractures and faults.

The catchment area of the valley include Teza Agara well field and up to the Bezena Benara which is recently drilled well that makes 95 Km^2.By considering

crude annual recharge of 58mm(about 5% of the precipitation which is 1152mm), can be arrived at an assumed potential infiltration to ground water in the valley aquifer of about 173l/s. This appears to be safe estimation since the dominant portion of the area is situated at mountainous area, escapement and low vegetation cover that facilitate high rate of runoff.
100% abstraction of the estimated recharge can be high. It is good practice to consider safety factor for estimated recharge. Thus only 70% of the estimated recharge is considered for long term sustainable use because the estimated recharge might not be at full as it can get access to be conveyed to deeper zones below rechargeable level. Therefore, the total amount of water that is available in the Bezena Benara –Wonko tectonic valley for abstraction is estimated to be 121l/s.

The total net demand for planning horizon up to 2020 and 2030 is 41l/s and total of 90l/s respectively. For the first stage 6 boreholes and additional 7 bore hole at the end of design period should be drilled to the south of the town.

CHAPTER SEVEN

Conclusion and Recommendation

Conclusion

At the time of the initial assessment and field observation, different officials and concerned bodies were consulted to visualize the status and shortage of water in the town. Based on walk over survey, measured data, and information from different stakeholders, it is observed that the town has critical water shortage and system problem in the distribution and ancillary works. Generally, the problem has hindered individual endeavors, micro-enterprises, hotels, institution and investements, etc which are without or meager water supply. In general the major problem in Durame town water supply can be summarized as follows:

- Critical water source and supply deficit due to population growth and expansion of new areas as the town becomes capital of the zone.
- The Ambercho spring has large backward flow at the collection chamber due to its connection to a higher altitude KMG reservoir. Actual on site measured value of 1.63 l/s was observed as a back flow at Ambercho collection box and giving only 2.15l/s flow through the system. When the line is totally connected to high school reservoir, the whole flow amounting 3.7l/s was checked. This implies that it is not advisable to extend to the KMG reservoir which induces loss of 141m3/d
- There are water supply shortage zones and unconnected areas even for this meager source.
- Gocho bore hole has nitrate concentration above WHO standards and expected to cause methemoglobinemia in infants
- The steel wet well used as booster station is claimed to be contaminating the system due to rusting.

- Network expansion needs due to population growth and expansion of new areas. Even those who have access to water, the current water consumption is less than the demand required.
- Expansion of undersized distribution mains and sub mains due to shortage of pipes and fittings. There is a trend of connection expanding (without designs) for large area from 12mm and 20mm diameter pipes serving large community.
- There is aged pipe as old as thirty, and needs replacement
- Experience from different corners of town shows most traditional dug wells are not provided with well head(above ground protection) and manhole cover to facilitate sanitary protection
- There are reported water related diseases occurred due to deficiency of water and unprotected source
- No clearly mapped network of the city for upgrading , leakage detection and regular supervision
- Loose coordination and unclear delegation among stake holder exhibited
- Durame town water enterprise has manpower, tools, computers, vehicles etc problem. During the time of assessment it is observed that the operator at borehole works twenty four hours both as technician and guard without overtime payment. Similarly in the office employees commonly handled two or more jobs and positions. In general, the following major administrative and management shortcoming are identified:-
    - ✓ Shortage of trained and equipped manpower
    - ✓ Lack of capacity specially, equipment and vehicles;
    - ✓ Lack of proper and specific manuals procedures tailored to the operation/activities of the water enterprise and are governed by a Civil Service Regulations which is not good for an enterprise operating on commercial basis;

- ✓ Though the enterprise has a budget code for education &training the staffs have not been given trainings related to their specific assignments to enhance their operation skills;
- ✓ Job description and specification is lacking;
- ✓ Though the water enterprise is established as a public enterprise; it is not operating on commercial basis
- ✓ Lack of reward and remuneration system to properly reward and motivate its employees;
- ✓ Lack of organized records and Management Information systems.

Recommendation

- As the initial capital for water investment is so high making the design horizon by phase will solve the financial constraint of the future expansion plan significantly
- As the researcher was not sure of the presence of water at proposed site (Bezena Benara- Wonko), additional investigation before drilling is recommended.
- To avoid overflowing at capping structure of Ambercho spring, connection to KMG reservoir should be halted and reconnected to high school reservoirs.
- For immediate improvement of source at Gocho bore hole, mixing this source with the other planned source (borehole) will dilute concentration of NO3 and make it acceptable for drinking.
- To avoid concentration of nitrate at Gocho bore hole and future well field appropriate management of the well field required. Management system include delineation of primary and secondary well field and proper drainage system .

- To avoid frequent flooding at Gocho borehole proper drainage and flood control structure should be implemented immediately
- In the promotion of hand dug well construction: well head, manhole cover and concert ring should be given attention and incorporated in the design. In addition the annular space between the dug well and concert ring above the static water level should be grouted with coarse sand, fine sand and puddle clay layers up to the ground surface.
- Expansion work from undersized pipe should be redesigned and replaced with adequate pipe size.
- Before the commencement of any activities concerning expansion, the following consideration should be taken in to account:
  - As compared to consumption, production should be greater and adequate to service the demand
  - Pressure efficiency should be checked; if the pressure efficiency in the system was low booster station should be installed as per the specification recommended by design engineer.
- The steel tank at booster station should be replaced with the new fiber glass tank which is relatively not affected by rust.
- Due to nature of topography, distributing water from the same point has been difficult for many years; to avoid this, making distribution by zoning will solve the problem

  The first zone KMG at an elevation of 2170m----- existing

  The second zone High school at an elevation of 2118m---- existing

  The third zone Kalehiwot at an elevation of 2175 m--proposed
- To decrease substantial amount of loss in system warn out and deteriorated pipe at older and lower reach of the town should be replaced with the new one.
- For upgrading, leakage detection and regular supervision clearly mapped network of the city is required.

- To avoid wastage of Getelega spring at mount Ambericho, proper route for transportation, regular supervision and respecting the upstream water right by enterprise is recommended from this study.
- Sustainable operation and management of the water supply schemes can only be achieved if appropriate organizational structure and management system are put in place. Thus, appropriate organizational structure has to be developed and implemented parallel to the system improvements.

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Appendix A

Operational Definition of Terms

Enterprises: any institution or organization established by proclamation to provide safe and adequate water to beneficiaries

Water supply service: providing service for commercial, industrial and institutional use

Water supply shortage: is used to describe a shortage where levels of water supply do not meet certain defined minimum requirements

Kebele: the smallest administrative unit under city or town administration

Rise in life standards: the change in the status of living due to economic set up.

Electromechanical equipments: Material in the water supply system with both electrical and mechanical characteristics like generators, pumps, etc

Pressure efficiency: the adequacy of pressure in the entire distribution network

Jerican: A container which is used to transport and store water

Region: Represents the second tiers of governments in the administrative structure of the Federal Democratic Republic of Ethiopia

Ato: Equivalent with mister (Mr.)

W/o: equivalent with Married woman

Birr: Refers to Ethiopian currency unit

Appendix B

Questionnaires for household survey

The purpose of this survey is to generate relevant information on the assessment of problem for Durame town water supply. The research is conducted for M.A. degree in development studies at Addis Ababa University. The information you provide is only used for academic purpose. Therefore you are kindly requested to give complete and reliable responses to all the questions.

Questionnaire no. : ---------- Name of interviewer: ----------Date of interview----

Personal information of respondent

1. Name of kebele----------2.Sex a) Male b) Female
2. Age a) Under 14 years b) 15-35 years c)36-64 years d)>65
3. Educational attainment a) None b) Read & Write c) Elementary school d)Secondary school d) College e) Graduated g) higher education h) others
4. House hold size

a) Infant less than one year old ---persons

b) Children 1-18 years old ---persons

c) Adults more than 18 years old----person

d) Total----persons

5. House holding a) government b)privet c)others specify

Socio-Economic Aspect

6. Monthly income (birr/month) a) <600 b) 601-1000 c) 1001-2000 d) >2000
7. Please indicate the monthly average household expenditure for water,----------in Birr
8. How long have you been living in this area?----------years
9. What type of source do you use in your home?
   a) House hold tap b) Privet dug well c) Privet water seller d) Rain water
10. If your answer to Q No 10 is house tap does the water from your tap satisfy your household demand? a) yes b)no
11. If no, what measures do you take
    a) Store water b) Buy from privet taps c) Use unprotected source d) Mention if other
12. For how long do you find water in your tap?---------hours in a day ,------days in week
13. How many liters do you consume daily on average?-------liters
14. Do you have flower/ vegetable garden a) yes b) no
15. Do you water your garden using tap water? a) yes b) no
16. If yes ,In which season a) during wet season b) during dry season c) in all season
17. Have your income showed increase for the last five years? a) yes b)no
18. Has your water demand increased accordingly? a) yes b)no
19. Do you have the following fixtures?
    a) Hand wash faucets b) Cloth washing faucets c) Flush toilets d) Bath rooms e) Other (please select one or more)
20. When did you install them?

a) During the house construction b) Some years after house construction c) Mention if other

21. How many times do you take bath a) daily b)once in a week c)twice in a week d)mention if others

22. How many times do you wash clothes weekly a)once b)twice c)mention if others

23. Is forgetting to close the tap a case for water wastage in your home a) yes b) no

24. Do you think protecting leakage from pipe is important a) yes b)no

25. If yes, why?

a) Water is an important resource and should not be wasted un necessarily

b) Water is expensive for me and I cannot afford to pay for wastage

c) It takes a lot of effort to get (fetching, carrying, etc) d) Others specify

26. If, no why? (please select one or more)

a) Water is an easily available natural resource b)Water does not cost much money c) Other reason specify

27. What do you say about the water tariff in Durame a) expensive b)fair c)cheap

28. How frequently do you pay for water you used?

a) Every month b) Quarterly a year c) Twice a year d) Other specify

29. Can you pay for safe and adequate water a) yes b)no

30. Are you willing to pay for safe and adequate water a)yes b)no

31. How much will you pay for safe and adequate water in

---------25 liters jerican

---------20 liters jerican

32. If you are not willing to pay how you can reason out it ?

a) Low income of the house hold b) Presence of alternative source c) Mention if you have any other reason

Technical Aspect

33. What size pipe do you use in your home a)1/2 inch b)3/4inch c)1inch d) if other specify

34. Do you know the size of the pipe from which your house hold tap extended and connected

a) No b) yes

35. If your answer to Q no 35 is yes, what size it is?

a) 3 inch b) 2 inch c)1 inch d) ½ inch e) if other specify

36. Do you know how many house hold get water from this main pipe coming to your home?-----

37. How is the water pressure (speed of flowing, when fully opened) from the town water supply at your tap

a) High b) Sometimes high /sometimes low c) low d) Very low d) Every time no water

38. Have you experienced the presence of water in your neighbor's tap while it is not in your own a) yes b) no

39. If yes why do you think?

40. What measure do you take In the case given in number 40?

a) Asking the neighbor to shut his faucet b) Shorting your pipe containing the faucet c) Shutting the sub distribution network d) Mention if other

41. What technical failures are usual in the water system?

a) Fitting failures in the house /yard connection b) Fitting failures in the distribution network c) Pump failure d) Generator failures

e) Pressure in efficiency f) Mention if others

42. What are the major causes of technical problem

a) Old age of the fitting b) Old age of the pump c) Poor management of the water service d) Low water amount in the system e) Infrastructure development like roads and Tele-communication f) Mention if others

43. How do you respond to a nearby system failures

a) Calling for water supply service office immediately b) Waiting for the water supply service supervision c)Taking personal measure for maintenance

d) Mention if others?

44. How do maintaining system failures take on average? fitting---------- days, pumps and generators ----------days, pipes ------days

45. Are the spare parts of the water system available?

Fitting, a) yes b) no. Pipes a) yes b) no. Pump and generator a) yes b)no

Institutional Aspect

46. Do you get adequate service from the water supply service office?

In extending the existing pipe lines a) yes b) no

In maintain the existing pipe lines a) yes b)no

In availing bills and collecting payment a)yes b)no

47. How do you evaluate the service delivery by the water supply service

a) Very good b) good c) satisfactory d) poor d) very poor

48. How do you communicate with the water supply service? For the water investment contributions

a) Through kebele administration b)Through the municipality c)Through the representatives of the users d) No contribution of water investment

In the case of technical failures

a) Contact the technician in the office b) Call the office c) Waiting for the supervision of the technician d) Mention if others

49. Whom do you think is responsible to avail water supply service for the town?

a) The municipality b) The water service office c) Regional water development bureau

d) The residents e)Aid organizations

50. How do you evaluate the capacity of the technician in the water office?

a) Very good b) good c) fair d)poor d) very poor

51. How do you evaluate the material capacity of the service?

a) Very good b) good c) fair d) poor d) very poor

Environmental Aspect

52. Is the quantity of water produced by the town water office sufficient? a)yes b)no

53. How do you feel with the quality of water you are drinking?

54. Is there a contaminate source that can affect the quality of water at the source

a)yes b) no

55. If yes, what are these source

a) Flood from run off b) Wastes from industries, hotels and home c) Due to over pumping d) If others please specify

56. If quantity and quality is not as intended what is your recommendation for future improvement

57. Do you think there is water loss in the town

58. Is there water distribution difference based on your area topography

Socio- economic impact

59. If water from your tap is not adequate or if it is intermittent where do you get water for your domestic consumption

a) Sharing from neighbor b) Buying from vendors c)From unprotected spring d)from dug wells e) From streams f)From public fountain g) Mention if others

Where do you take shower?

a) In the stream b) In the communal shower rooms c) at home buying water from vendors d) mention if others

60. Have you ever caught by skin infection due to using unprotected water source for shower?

a) Yes b) no

61. If you buy water, what is the common interval a)daily b) in two days time c)in three days time d)weekly e)in two weeks time f) monthly g)mention if others

62. How much do you pay for ---------liters while buying

Source for buying	Price per ---------liters
Public fountain	
Private	
Vendors	
Others	

63.How long does it take to collect

Source to collect	Time in minute	
	Walking to and from the source	Waiting at the source
Public fountain		
Stream		
Spring		
Tap water (out of yard)		

64.Does the time it takes to fetch water make children to miss school? a) yes b)no

65.How many days per year?-------days

66.Do you store water for water shortage problem? If yes for how many days do you store it

a) For a day b) For two days c) For 3-6 days d) For weeks f) Mention if others

67.What containers do you use to store water? a)pot b)barrel c) jerican d)bucket e)mention if others

68.Has water borne disease affected your family member in the last one year ?a)yes b)no

69.What was the effect of water born diseases on your children school condition?

a) Could not start school b) Dropped out from school c)Missed school days

b) Mention if others

70.What was your expense related with water borne diseases?---------- birr in a year

71.On average how many working days did you lose due to water borne diseases?--------days in a year

KII Checklist (for expert from water supply service and zonal water office)

For experts from the water supply service office

1. What is the yield of the source?----------(m^3 /day)
2. What amount of the yield is in the distribution system?
3. When was the whole water system constructed
4. Were there expansion works? When?
5. What where the causes for expansion?
6. Does the yield from spring and borehole vary? a)yes b)no
7. Does the variation have a relation with rain fall change patterns?
8. Does the yield variation account for the water supply shortage in the town?
9. Are there suspected contaminant sources
10. How many pump stations are there
11. What amount are they pumping
12. What are their average pumping hours
13. Are they functional? Age? Technology?
14. What is the length of the transmission main
15. How many reservoirs are there in the system? Volume? Functionality? Relative elevation to the town setting?
16. Do you have water meter at the out let to each source and reservoirs? Are they functional
17. How many distribution zones are in the system?
18. How is the pressure efficiency in each distribution zone
19. How many connection and public fountains are in the system

20. How many customer do you have by service type

House tap users--------Yard tap users-------- Public tap users--------

Neighbor tap users----------

21. How many customer do you have by customer type

Domestic/privet--------- Government/institution--------- Commercial----------

Industrial----------Public fountains----------

22. How are decisions made for extending connections?

a) As per the request of the users b)By considering hydraulic calculation

b) Mention if others

23. with illegal water connection? If yes how frequent it is?

24. Do you think that all customers pay for all water they are consumed? If no, why is that do you think

25. How do you estimate the residential water demand

26. How long does the existing system served?----------years

27. Is it in the designed period a) yes b)no

28. What is the average percentage of loss in the system----------%

29. Does the water service office have a map of the distribution net work a)yes b)no

30. What are the major operation and maintenance problems?

a) Budget shortage b)Availability of spare parts c)Shortage of professionals d)Repeated failure of electromechanical equipments e)Low support from the regional bureau f) Low support from the water board

31. Do planning, design and construction has an impact on water supply system?

If yes, in what way?

32. Currently do you think that Durame town is under water scarcity/ stress? If yes what do you suggest as a main reason? And what solution do you expect?

33. Do you have a plan to expand the existing water infrastructure

34. Is there structural link among regional water resource bureau, zonal water resource office and town water supply service office a)yes b)no if yes ,what is their clear mandate and responsibility concerning the water office

35. What measures does the water service take for power inconsistencies a)stand by generator b)manual generator c)no measure

36. Have you conducted water auditing in the town water supply system annually?

37. What do you say about profitability of the water service?

38. Is there a problem in managing the finance of the water service?

39. How do you manage technical and financial data in the water office

40. How do you evaluate man power and material situation of your office

41. What is the price range for m^3 of water

    For house hold users------

    For public tap users-------

KII Checklist for experts from zonal water office

1. What technical collaboration do you have with the water service office?
2. What do you say about common practices in water demand estimates and projection of urban water supply system
3. Does the slop of the transmission main affect water flow?
4. How about the setting of some parts of the town in relation with water flow and reservoir?
5. What can you comment on the distribution network of the water system
6. What can you say about decisions made for extending connections by the water service office?
7. Do you observe institutional capacity (human and material) problem in the water service office yes/no
8. What are the major operation and maintenance problems of the water system

FGD Checklist for representative of the users, water service office and town water board

For representative of the users

1. Do you actively participate in the meeting of the water board
2. What types of issues goes to the board for decision making
3. Is there a significance population increase in the town?
4. If yes, what do you think are the causes of population increase?
5. What are the life style changes of the public that entail increased water consumption?
6. What is the reason behind pressure in efficiency in the system

7. How do you evaluate the resident feeling to pay for water?
8. How frequent are water losses in the distribution network?
9. How speedily does the water service office respond to these losses?
10. How do you see the human and material capacity of the water service?
11. How do you see the coordination of different stakeholders (regional water bureau, municipality, town administration, and residents)
12. What secondary water source are used during water shortage in the town
13. How prevalent is the water born disease when using secondary source
14. What are the major causes of water supply shortage problem in the town
15. What socio economic impact do you see due to the water supply shortage problem
16. What measure do you suggest to alleviate the water supply shortage problem

FGD Checklist for water service office

1. Are there reports of quality problems of the water supply
2. What are the contaminants?
3. What is the rate of increase in privet connection request?
4. Do you experience reluctant users to pay for water?
5. How frequent are fitting, pump and generator failures?
6. How clear are the water system failures for the technicians?
7. Are there illegal connection?
8. Do you experience pressure losses in the distribution network
9. What do you say about the composition of the water board?
10. What do you say about the institutional framework of the water service?
11. Can the water service invest on large expansion projects of the water supply?

12. How do you see the attention given by stakeholder to the water supply?
13. How do you evaluate human and material capacity of the water service?
14. What do you think are the major causes of the water supply shortage problem
15. What are the socio economic impacts?
16. What recommendation do you have for alleviation of the problem?

FGD Checklist for Members of the water board

1. What is the problem you experience related with composition of the board members?
2. Are there contaminate sources in the vicinity of the water sources?
3. Do you think there is institutional capacity problem in the water supply service office?
4. Did the water service, town administration or municipality invest on town water expansion?
5. How does the board facilitate in capacitating (human and material) the water service
6. Is the water service profitable?
7. If not what is the reason behind?
8. Is there coordination among stakeholders of the water supply
9. What are the major causes of water supply shortage problem in the town?
10. What socio economic impact do you see due to the water supply shortage?
11. What solution do you recommend for the water supply shortage?

Appendix C: Future Water demand Forecasted for Durame town

Description	Source	**Unit**	**Year**				
			2010	**2015**	**2020**	**2025**	**2030**
1.Population							
Growth rate	SNNPRS report	%	4.6	4.3	4.1	3.9	3.7
Population of town	$P=Poe^{rt}$		42000	52074	63286	75390	88029
Coverage of town	Assumed	%	91	98	100	100	100
Coverage by service type							
HTU(house tap user)	From DWSSO	%	6	10.5	13	16	20
YTU(yard tap user)	-	%	69.5	51.5	48	45	40
NTU(Neighbor tap user)	-	%	14.6	21	26	27	30
PTU(public Tap User)	-	%	1.2	15	13	12	10
Pop served by							
HT	Pop*coverage		2520	5468	8227	12062	17606
YT	-		29190	26818	30377	33925	35212
NT	-		6132	10936	16454	20355	26409
PT	-		504	7811	8227	9047	8803
Total pop served	Sum(HT+TY+NT+PT		**38346**	**51033**	**63286**	**75390**	**88029**
Demand							
Domestic water demand (DWD)							
P/c/d							
HTU	Assumed-from-standards	l/c/d	40	50	50	60	70
YTU		l/c/d	30	30	30	35	40
NTU		l/c/d	20	25	25	28	30
PTU		l/c/d	15	20	20	23	25
2.Consumption daily							
HTU	Pop served*l/c/d	m3/d	101	273	411	724	1232
YTU	-	m3/d	876	804	911	1187	1408
NTU	-	m3/d	123	273	411	569	792
PTU	-	m3/d	7.5	156	165	208	220

Total domestic demand	Sum (HTU+YTU….	**m3/d**	**1107**	**1508**	**1899**	**2689**	**3653**
Non domestic demand							
Institutional,commerical,&public	10%DWD	m3/d	111	15.6	16.5	20.8	22
Industrial	3%DWD	m3/d	33	45	57	81	110
Loss	15%DWD	m3/d	166	256	322	511	731
3.Total Demand		m3/d	1417	1960	2468	3550	4859
Max day factor(MDF)	Design criteria		1.2	1.2	1.2	1.2	1.2
Max day demand	TD*MFD	M3/d	1700	2352	2962	4260	5831
Raw water production	Existing	m3/d	579	579	579	579	579
Deficit		**m3/d**	**1121**	**1773**	**2383**	**3681**	**5252**
4.Proposed production		m3/d	**1124**	**1773**	**2383**	**3681**	**5252**

Declaration

I, the undersigned; declare that the thesis is my original work. Has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged

Declared by

_____

_____

Candidate

Confirmed by

_____

_____

Advisor