

Executive summary

Without having such practical exercise in the course we might have got difficulty to fully understand the subject matter. This paper is a document for the semester project we did for water supply system for the Town of Debrezeit which is located in Benishangul region in Ethiopia.

In this project we describe the source to be used, the distribution pipe network location and parameters such as diameter, head and flow. Also the cost for the implementation of the project and the design for pump and service reservoirs, which help in maintaining a constant supply at the time of excess demands is included in this document.

The data for the population number and water demand requirements depends on the house to house count carried out by each Kebele in the town.

The contents of the paper have been divided in to seven chapters and the main topics covered include methodology of design, design criteria, water demand projection, system design and water pump. Different tables and figures are attached in the paper to illustrate the discussed ideas and to summarize the calculations done.

Acknowledgment

Through all this project, We Couldn't do it without the help of others so, first We would like to thank our water supply Instructor Zerihun Alemayehu for giving us his time and attention on our frequent questions, for being helpful to us throughout this project and during the lecture time of this course, And also for giving us this project which empowers us to know a lot of things and new concepts. Next we are grateful to all our classmates and senior students for their help.

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Introduction

Water is a precious resource and vital for life. Without it we would die within days. Access to a safe and affordable supply of drinking water is universally recognized as a basic human need for the present generation and a pre-condition for the development and care of the next. Water is also a fundamental economic resource on which people's livelihoods depend. In addition to domestic water use, households use water for productive activities such as farming and livestock rearing in rural areas, or horticulture and home-based microenterprises in urban settlements. Water shortage, poor quality water, or unreliable supply has profound effects on people's well-being. Providing safe water alone is not enough, however, as water can quickly become unsafe, and the faecal-oral transmission of diseases can occur in other ways. If people do not have adequate and appropriate sanitation facilities or the chance to develop good hygiene practices, diseases can be spread through the contamination of water or through other pathways in the home

environment. At any one time around half of all people in developing countries are suffering from one or more of the six main diseases associated with inadequate water supply and sanitation: diarrhea, ascariasis, dracunculiasis, hookworm, schistosomiasis, and trachoma. Improving the health of the poor is a frequently cited goal of water and sanitation projects. The relationship is difficult to establish in practice at the project level, but over the longer term it can be demonstrated that there are significant health-associated benefits from improvements in water supply and sanitation provision, particularly when these are associated with changes in hygiene behavior. From the experience, millions of the world's poorest people die from preventable diseases caused by inadequate water supply and sanitation services. Hundreds of millions more suffer from regular bouts of diarrhea or parasitic worm infections that ruin their lives. Women and children are the main victims. Burdened by the need to carry water containers long distances every day, they must also endure the indignity, shame, and sickness that result from a lack of hygienic sanitation.



The impact of deficient water and sanitation services falls primarily on the poor. Unreached by public services, people in rural and peri-urban areas of developing countries make their own inadequate arrangements or pay excessively high prices to water vendors for meager water supplies. Their poverty is aggravated and their productivity impaired, while their sickness puts severe strains on health services and hospitals.

Apart from the overwhelming social arguments, there are also powerful economic and environmental reasons for improving water supply services for the poor. Human waste is a major polluter of rivers and groundwater resources. As water demand rises inexorably with social and economic

progress, scarcity of water becomes a major consideration in development planning. **Industrialization and food**

Security may both be threatened, unless water resources are protected and conserved.

For all these reasons, improved Water supply services have been seen as a high priority need by the development community for more than 20 years. So why is the suffering and the squalor virtually unabated in so many countries? There are many reasons, and the problem is a complex one because solutions depend on a mix of political, social, technical, and institutional approaches, most of them involving changing established practices. An indication of the type of considerations that need to be taken into account.

There is no standard blueprint for a sustainable and effective Water supply and sanitary project. Each situation needs a coordinated approach by all of the stakeholders to ensure that the installation reflects the true demands of all sections of society. Discovering these demands can involve a lot of Preparation, time and effort, which has not always been provided in the past.

Background

The estimated water supply coverage for Ethiopia is 46.4% for rural and 82 % for urban and the country's water supply coverage reaches 52.5%.

This project is worked on Benishangul region water, mine, and energy resource development Bureau to develop water supply system for Debrezeit town of the region. Debrezeit town is the capital of Wonbera district of Benishangul Gumuz regional state in Ethiopia. It is located at western Ethiopia about 641km from Addis Ababa. The town has total area of 217 hectares and the grid coordinate of the town is 35039'52"E longitude, 10037'45"N latitude and 2520masl altitude. It is situated

on a plateau surrounded by deep gorges formed by Aleltu, Tiso Boka, Gorshi and Neger rivers.

Debrezeit area is characterized by sub humid climate. The area gets rainfall in the months starting from May to October; and attains maximum in August. The maximum daily temperature of the area is 30.5^oc and the minimum is 11.4^oc occurring during the months of April and December respectively.

According to the information obtained from district administrators, the population of Debrezeit towns including those not covered in the sample is estimated to be around 4000. When we look at the composition of household heads of Debrezeit town 66% are female and the remaining 44% are male.

Out of the 73 respondents of Debrezeit town 97% are married, 1% is unmarried and the remaining 1% falls to others. Almost 100% of respondents of Debrezeit town are Christians. Under normal circumstances households with high income are expected to be able and willing to pay more for a given quantity of water than households with lower incomes. In fact, the percentage of income spent for water may be high for households with lower income than households with relatively high income group. From this perspective we can judge that majority of the residents at Debrezeit Respondents were asked about their priority on basic community facilities. As a result 97% of Debrezeit respondents choose clean water supply as their first priority. Next to clean water supply food and health facilities have got major concern by respondents. Among the alternatives given transport facility is taken to be the least concern for the town.

Respondents were asked about which type of water related problems they encounter. The major problem in the town is frequent interruption of the water supply. 46% of Debrezeit respondents stated that frequent interruption is a problem. Quality problem and longer queues were also significant problems described by the respondents.

The collected data indicates town dwellers use water for Drinking, Cooking, Washing, Bathing& shower, house cleaning and sanitary purposes. Respondents were asked the average daily amount of water they consume for various purposes.

85% of Debrezeit respondents on average use more than 50 Litter water per day. Another significant portions use between 20 to 50 Litter water per day. There is no respondent that consumes less than 10 Litters of water per day anywhere which is true especially for large family size households. More over it is a known fact as these towns grow the demand for water resources is likely to grow necessitating an improved water supply for the town.

Based on 2007 census the population of Debrezeit town is 5476. The results of the survey will be used as an input for the design and socio-environmental management plan of the town's water supply network. Data is collected on important parameters like demographic, social, cultural, and economic conditions of the two town dwellers. This part has covered the different socio economic status of the respondent, such as the monthly family income, educational qualification of all the members of the family, occupation, number of family members, marital status and age. In terms of occupation the largest proportion of debrezeit dwellers is found to be private business followed by government employees. This may ensure that many households are capable of bearing a fair tariff to recover the cost of investment for the water supply project.

Respondents were asked about the availability and type of toilet facility they use. The intention here is to know whether households have toilet facility at their disposal and the nature of that toilet. A subsequent question was also raised about where they defecate in the absence of toilets. 93% of Debrezeit respondents respectively assured the availability of toilet facility. With regard to the type of facility 100% of respondents of Debrezeit use pit latrine. Interviewed households were also asked whether they use shower or not. The nature of the shower was specified as piped or using baldi in a place defined for that particular purpose. The result was that 94% of Debrezeit respondents confirmed that they have no shower facility at their home. In general, the living standard of the population is very low. Major source of water is river.

This project covers the design of water supply for Debrezeit town based on the assumption that there is no existing water supply system. And since, there is no information regarding the establishment of any industries in the near future in the

town, it is assumed that a significant change is not expected to happen with respect to emerging of large industries in the area. The system comprises of the following major elements

- Source(river)
- Raw water collection structure(intake structure)
- Treatment plant
- Distribution systems(pipes, pumps, reservoirs, different appurtenances)

Objective

The main objective of this Project is to provide a sufficient water supply system for the town. Which includes:-

- ⇒ Providing Safe and wholesome water.
- ⇒ Having adequate quantity.
- ⇒ Readily available to encourage personal and household hygiene.

Methodology

The methodology's we followed when we do this project are as follows:-

1) We select the design period.

2) We project the population.

3) Then Design of pipes follows;

- Transmission main: these mains are designed to transmit the **peak discharge** plus **additional demand** for institution to the distribution mains.
- Distribution mains: design to transmit the maximum of **peak hour demand** or the coincident draft.
- Design of Service pipes: to design the service pipes use the greater of either the $Q_{\text{day max}} + Q_{\text{for institution}}$ or $Q_{\text{hr max}} + Q_F + Q_{\text{for institution}}$

4) Pipe Layout

The distribution pipes are generally laid below the street pavement, and as such, their layouts will generally follow the layout of the road. We have chosen loop type of pipe network.

5) Area Delineation

We have delineated the whole area served by the pipes using Auto-cad as shown.

6) Importing pipe network in to water-cad as a background and tracing pipe layout

7) Determining node discharge and elevation

Node elevation is obtained by interpolating the contour elevation if the point is located at intermediate point.

Node discharge= (no of population)*(peak hour demand) + (additional no of estimated institutional population)*(demand)

= (hour demand)*(no of population)

8) Locating position of reservoir and determining reservoir capacity

9) Checking the allowable velocity which ranges from $0.6-3 \frac{m}{s}$, and allowable pressure which ranges from 245-415kpa by iterating pipe diameter and reservoir elevation.

10) Finally by using Water-Cad head loss will be obtained

4, Design Criteria

4.1 Design period

The design period is planned to be 30 years for the expansion of the town water supply. A two phase implementation is recommended for the project, however, the design is done considering a one phase implementation and the different design parameters are calculated at the end of the design year. The design period runs from the year 2010 to the year 2040.

4.2 Source

The source of water for the expansion of the water supply system is the river which is located in the map of the city attached below.

4.3 Transmission mains

$$\Rightarrow Q_{\text{day-max}} = 21.7767 \text{ l/s or } 1881.52 \text{ m}^3/\text{day}$$

4.4 Distribution mains

Are designed for the greater of the two

$$\Rightarrow Q_{\text{hr-max}} = 34.0852 \text{ l/s}$$

$$\Rightarrow Q_{\text{day-max}} + Q_F = 21.7767 \text{ l/s} + 0 ; \text{ since } Q_F \text{ is very small}$$

$$= 21.7767 \text{ l/s}$$

4.5 Service pipes are design greater of the two

$$\Rightarrow Q_{\text{hr-max}} = 34.0852 \text{ l/s}$$

$$\Rightarrow Q_{\text{day-max}} + Q_F = 21.7767 \text{ l/s} + 0 ; \text{ since } Q_F \text{ is very small}$$

$$=21.7767 \text{ l/s}$$

4.6 Storage facilities

Distribution reservoir provides service storage to meet fluctuating demands often imposed on distribution systems, to accommodate firefighting and emergency requirements, and to equalize operating pressures.

4.7 Design population

The design population is taken to be 25017 which is projected from house to house count done by each Kebele in the town in 1998E.c (2006)

Table 4.1, projected population of Debrezeit

	2006 Base population	2008 Present population	2010	2015	2020	2040
Populati on	6,613	7,194	7,826	9,613	11752	25017

The detail calculation for the population projection is given in part 5.2

4.8 Water requirements

The water requirements for the town are estimated from the analysis results of the questionnaire given to members of each village.

4.9 System design

➤ Selection of design period

Since population is forecasted for 30 years and it's quite reasonable for rural area which has low probability to expand at high rate, so we take 10 years as a design period.

➤ Population projection

The growth rate of Debrezeit is given on the data

Year	2008	2010	2015	2020	2025	2030	2035	2040
AGR (%)	4.3	4.3	4.2	4.1	4.0	3.9	3.8	3.7
population	7194	7826	9613	11752	14298	17312	20861	25017

For projecting the population of Debreziet town for the design period, the Geometric increase method formula was adopted. i.e.:

$$PN = P_p (1+R)^N$$

Where,

$PN =$ is design population at the end of N years

$P_p =$ is present population at initial year

$R =$ Is Population Growth Rate

Thus at our opening year which is 2040, the forecasted population is 25017.

- Design of Transmission main
- Design of Distribution mains
- Design of Service pipes
 - **For domestic water demand**

Per capita demand by mode of service were determined for HUT (house tap users), YTU (yard tap users) and PUT (public tap users) are **73 l/c/d**, **55 l/c/d** and **26 l/c/d** respectively. Then after adjusting this per capita demand by climate factor **0.9** and socio-economic factor **1**, the value for per capital demand for HTU, YTU and PTU will be **65.7 l/c/d**, **49.5 l/c/d** and **23.4 l/c/d** respectively. Then total domestic water demand will be the sum of adjusted HUT, YUT and PUT that is **138.6 l/c/d**.

- For calculate peak hour demand or $Q_{day\ max}$, we use the step below
 - ⇒ Adjusted per Capital Demand (ACD) is taken from the above calculation for domestic water demand which is **138.6 l/c/d**
 - ⇒ Public water demand is 25% of the ACD = **0.25*138.6 l/c/d=34.65/c/d**

[illegible]

HTU(l/c/d)	40	40	44	49	54	60	66	73
YTU(l/c/d)	30	30	33	37	41	45	50	55
PTU(l/c/d)	20	20	21	22	23	24	25	26
HTU(m ³ /d)	0	3.1304	21.148 6	46.067 84	0	0	0	401.773
YTU(m ³ /d)	0	11.739	31.722 9	86.964 8	0	0	0	674.208 2
PTU(m ³ /d)	143.8 8	147.12 88	171.59 21	186.15 17	0	0	0	188.628 2
Total Domestic demand(m ³ /d)	143.8 8	161.99 82	224.46 36	319.18 43	0	0	0	1264.60 9
Socio economic factor	1	1	1	1	1	1	1	1
climatic factor	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Adjusted Domestic water demand(m ³ /d)	129.4 92	145.79 84	202.01 72	287.26 59	0	0	0	1138.14 8

⇒ Peak hour demand or Q_{day max} is calculated multiplying Maximum day demand by 1.8 which is

$$=231.43 \text{ l/c/d} \times 1.8$$

$$=416.57 \text{ l/c/d}$$

To design the service pipes use the greater of either the Q_{day max} or Q_{hr max} +Q_F

🚒 The annual volume required for firefighting purpose is expected to be small so we neglected the value of Q_F=0. So **Q_{day max}** will be our design flow.

In addition to the demand calculated assuming equal population density throughout the town, the additional demands resulting from different institutions are calculated for the corresponding nodes by multiplying the per capita demand for each institution by the number of employees plus per capita demand times the number of people served in the institution.

Here, the area of the institution is considered to be very small relative to the area being served by the nodes hence it is not subtracted from the delineated area. This is considered as safe assumption since the demand estimated would be a little bit higher than that would be calculated by subtracting those areas.

Below are the details of institutional demand estimations;

Here it is assumed that

- ✚ pupils join school(Nursery) at age 4
- ✚ They stay in nursery for a year
- ✚ They learn for two years in KGs

Total percentage of age group <15 out of the total population = **44%**

Total design population =**25017**

- **4%**(total population) = pupils in nursery = **1001**
- **8%**(total population) = pupils in Kindergarten = **2001**
- **32%**(total population) = pupils in Elementary school = **8005**

Taking age of high school students to be in the range of 15 - 64 and assuming **15%** of this age group is high school student,

15 % (56) = 8.4%; where 56 is the percentage of the age group 15 -64 out of total population

- No. of high school students = **8.4%**(total population) = **2101**

B) Health office

- ✓ The health office is estimated to have maximum of 5 beds.

C) Government offices

As the census indicates government employees account **26%** of the total population

$$\mathbf{26\% (total\ population) = 6504}$$

Then this number is distributed to the government offices and institutions that are found in the town according to the following percentage to find the number of staff.

- ❖ Health office $7\%(6504) = 455$
- ❖ Municipality $31\%(6504) = 2016$
- ❖ EEPCO $10\%(6504) = 650$
- ❖ Tele(old) $10\%(6504) = 650$
- ❖ Tele(New) $10\%(6504) = 650$
- ❖ Water supply office $10\%(6504) = 650$
- ❖ High school $8\%(6504) = 520$
- ❖ Elementary school $8\%(6504) = 520$
- ❖ Kindergarten $4\%(6504) = 260$
- ❖ Nursery $2\%(6504) = 130$

D) Stadium

Adult population = **56%** (total population)

- ❖ All male adults $\mathbf{26\%}(25017) = 6504$
- ❖ 10% of female adults = $\mathbf{10\%(30\%)} = 3\%(25017) = 751$
- ❖ Total population for the stadium = $6504 + 751 = \mathbf{7255}$

The water demand for the stadium is expected to come from drinking and toilet flushing requirements;

- For drinking = 1l/c/d
- For flushing toilet = 1l/c/d
- Total = 2l/d

- $l/c/d \text{ for the stadium} = 2l/c/d * 1 * 0.9 = 1.8l/c/d$ where 1 & 0.9 account for the social status and climatic correction factors respectively.

The above $l/p/d$ demand is taken from the requirement for public tap users (PTU) and the requirement for drinking was reduced since they wouldn't stay there for the whole day.

- ⇒ To get the demand of specific area = peak hour demand * no of population which are existed in a particular that is calculating by assuming populations are uniformly distributed throughout the town.
- ⇒ If there is school like elementary, nursery and other in the area, the demand of water will be

$= \text{no of population} * \text{peak hour demand} + \text{additional no of estimated institutional population} * \text{demand (which is listed on table 4.4)}$

➤ Determination of node discharge and elevation

Using Auto-Cad we have determined the elevation and area of each node.

Calculation of node discharge is shown above and the table below shows tabular node discharge and elevation

Node discharge elevation

DETERMINATION OF RESERVOIR STORAGE

CAPACITY

Total reservoir capacity = equalizing demand + Emergency demand
+ Fire demand

The 24hr reservoir capacity is as shown below.

- Balancing demand = 9802.89m^3
- Emergency demand (25% of balancing demand) =
 $0.25 \times 9802.89\text{m}^3$
 $= 2450.73\text{m}^3$
- Fire demand (10% of balancing plus emergency) =
 $0.1 \times (9802.89 + 2450.73)$
 $=$

1225.36m^3

✚ The total reservoir capacity for the 24hr

$$= 9802.89\text{m}^3 + 2450.73\text{m}^3 +$$

1225.36m^3

$$= 13478.97\text{m}^3$$

NOTE: But we assumed to provide two reservoirs, so that each reservoir has the following capacity and dimension.

$$= 13478.97\text{m}^3 / 2$$

$$= 6739.49\text{m}^3$$

➤ From the table

Capacity (m3)	Depth, m
< 500	2.5 - 3.5
500 - 2000	3.0 - 5.0
2000 - 5000	4.5 - 6.0

> 5000	5.0 – 8.0
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- We select the depth of the reservoir is **8m**
- So that X - sectional area= $6739.49 \text{ m}^3/8\text{m}$

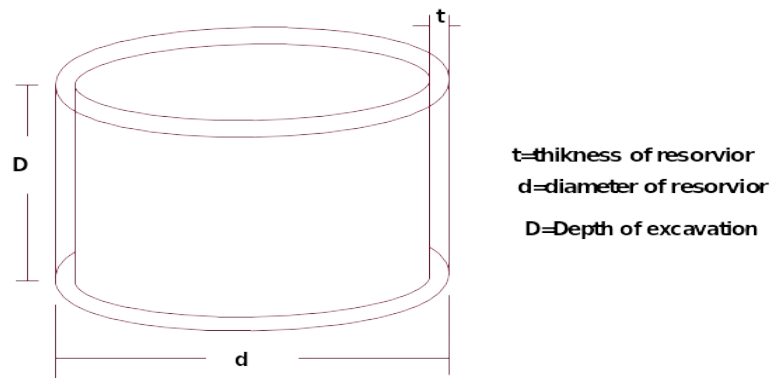
$$= 842.44\text{m}^2$$

- If we **take circular tank**, the diameter of the tank will be :

$$A = \pi * D^2 / 4$$

$$D = (A * 4 / \pi)^{0.5}$$

$$= 32.75\text{m}$$



5. Water Demand projection

5.1 Design horizon

The design horizon of the expansion of Debreziet town water supply is taken to be 30 years (from year 2010.i.e. expected implementation of the project). Accordingly, the population and water supply demand for Debreziet town is estimated for the year 2040.

5.2 Population projection

Population: According to the 2003 Central Statistical Authority (CSA) data, the population of Debreziet town was 3,640. Projecting this data, the population of Debreziet in 2006 is estimated to be 4,138. On the other hand, the data obtained from the house to house count carried out by each Kebele Administration of Debreziet Town shows that the population of Debreziet town in 2006 (1998EC) is 6,613. Comparing to the CSA based projection; the difference is, i.e. $6,613 - 4,138 = 2,475$. As per the justification given from the Town Municipality, similar to the other town of the region, the difference is because of high migration of the rural community to the town.

Therefore this report adopted the population size obtained from the house to house count data of the Kebele Administration as base population and the population size for present and future years is projected accordingly by using the annual growth rate recommended by CSA for Benishangul Gumuz Regional State.

Growth rate: According to 1998 analytical report, the urban population growth rate for Benishangul Gumuz region was classified in the medium variant growth rate as shown in table below:

Growth rate adopted for population projection

Year	2008	2010	2015	2020	2025	2030	2035	2040
AGR(%)	4.3	4.3	4.2	4.1	4.0	3.9	3.8	3.7
populati on	7194	7826	9613	11752	14298	17312	20861	25017

Sample calculation $P_{2015} = P_{2010} * (1 + AGR)^5$

$$= 7826(1 + 4.2\%)^5$$

$$P_{2015} = 9613$$

5.3 water Requirement

Design of water system components requires estimation of expected water demand applicable to the sizing of pumping equipment, transmission and distribution lines, and storage facilities. Estimating water demands (i.e., average day, maximum day, and peak hourly demands) involves consideration of a number of factors such as: climatic influences, socioeconomic influences, historic water uses, mode of services, condition of the distribution system (leakage rates, corrosion problems, etc.) and the like.

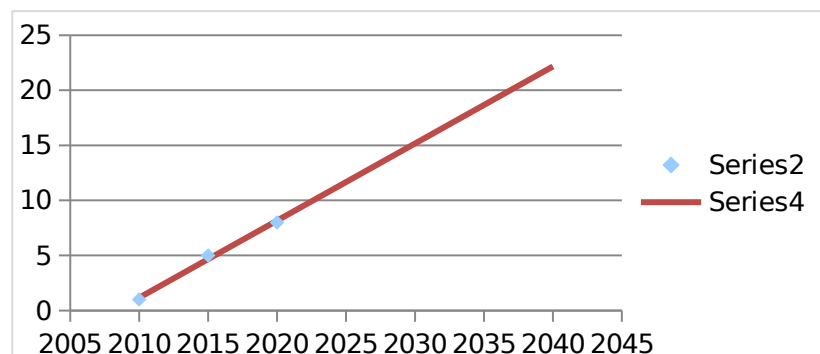
Domestic Water demand:-Domestic water demand includes the water required in private buildings for drinking, food preparation/cooking, bathing, washing clothes and dishes, flushing toilets and other miscellaneous domestic purposes. The amount of water used for domestic purposes varies depending on the lifestyle, living standard, climate, mode of service and affordability.

Demand categories and Mode of Service:-Domestic water demand service can be categorized according to the mode of service to be provided and per capita water required satisfying the demand served by the level of service. The categorization of demand as a standard is not made so far and different projects use their own categorization depending on the size and water collection methods for those particular towns and general experience of the experts.

There are three types of mode of services, which all commonly practiced, these are; Public tap users (PTU), Yard taps users (YTU) and House tap users (HTU). Accordingly the proportion by mode of service is summarized in the following table.

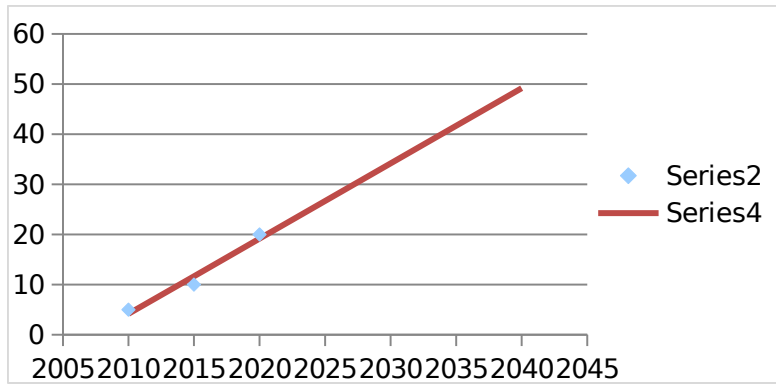
The PROJECTED HOUSE TAP USERS FOR THE YEAR 2040

YEAR	HTU	HTU projected
2010	1	1.166667
2015	5	4.666667
2020	8	8.166667
2040		22.166667



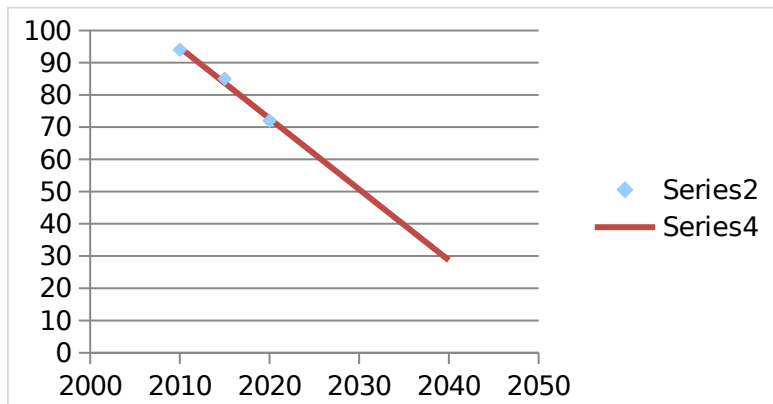
PROJECTED YARD TAP USERS FOR 2040

YEAR	YTU	PROJECTING
2010	5	4.167
2015	10	11.667
2020	20	19.167
2040		49.167



PROJECTED PUBLIC TAP USERS FOR 2040

YEAR	PTU	PROJECT ED PTU
2010	94	94.677
2015	85	83.677
2020	72	72.677
2040		28.677



PERCENTAGE OF Population by mode of service

mode of service	2010	2015	2020	2040
HTU(%)	1.0	5.0	8.0	22
YTU(%)	5.0	10.0	20.0	49
PTU(%)	94.0	85.0	72.0	29

Percapita water demand requirement by mode of service.

The projected domestic water demand based on mode of service.

Use demand growth rate	YTU	YTU	PTU
	2%	2%	1%

Mode of service	2010	2015	2020	2025	2030	2035	2040
HTU(l/c/d)	40	44	49	54	60	66	73
YTU(l/c/d)	30	33	37	41	45	50	55
PTU(l/c/d)	20	21	22	23	24	25	26

Sample calculation

$$\text{➤ } P_{2015,HTU} = P_{2010}(1 + HTU_{2010})^5$$

$$= 40(1 + 2\%)^5$$

$$= 44$$

$$\text{➤ } P_{2015,YTU} = P_{2010}(1 + YTU_{2010})^5$$

$$= 30(1 + 2\%)^5$$

$$= 33$$

$$\text{➤ } P_{2020,PTU} = P_{2015}(1 + PTU_{2015})^5$$

$$= 21(1 + 1\%)^5$$

$$= 22$$

▮ **Socio Economic Factor**

The socioeconomic adjustment factor is determined based on the degree of the development of a particular town under study as the socioeconomic conditions play great role on the amount of water consumption. The following grouping & adjustment factor corresponding to each group is given in Table below

Table 5.6:- Socio Economic Factors

Group	Description	Factor
A	Towns enjoying high living standards and with high potential for development	1.10
B	Towns having a very high potential for development, but lower living standards at present	1.05
C	Towns under normal Ethiopian conditions	1.00
D	Advanced rural towns	0.90

Domestic Demand Adjustment Factors

The average domestic water demand shall be adjusted based on the socio-economic study revelations and prevailing climatic conditions.

▮ **Climatic Factors**

The water consumption is less in area where the average temperature is low and high where temperature is very high. Accordingly, Debreziet town fall under average altitude of **2520** masl. And temperature ranges from 11.4°C to 30.50°C. Hence the climatic factor of 0.9 is considered.

Table 5.7:- Climatic Effects Factors

Mean Annual Temp. (°C)	Description	Altitude	Factor
<10	Cool	>3,300	0.8

10-15	Cool temperate	2,300-3,300	0.9
15-20	Temperate	1,500-2,300	1.0
20-25	Warm temperate	500-1,500	1.3
25 and above	Hot	<500	1.5

Summary of Domestic Water Demand

The projected average per capita domestic water demand, including climate and socioeconomic adjustment factor, for particular year is obtained by multiplying the per capita demand in each demand category for the year under and summing the results for all the demand categories as shown in Table below.

Table 5.8:- Summary of Domestic Water Demand projected for 2040

Description	Year
	2040
Population Growth Rate	3.7
Projected/Forecasted Population	25072
Per Capita Demand by Mode of Services	
HTU (l/c/d)	73
YTU (l/c/d)	55
PTU (l/c/d)	26
Socio- Economic Factor	1.0
Climatic Factor	0.9
Adjusted Domestic Water Demand (l/c/d)	138.6

Non Domestic Water demand

Public/Institutional and Commercial Water Demand

The water required for schools, hospitals, public offices, commerce, institutions, public parks, small scale industries and other public purposes is classified as public/institutional and commercial water demand. The public/institutional and commercial water demand is usually expressed as the percentage of the domestic water demand. There are no enough previous recorded data that separate domestic from public and commercial water consumption in order to analyze and forecast the future public and commercial water demand of the town. In practice, where typical public and commercial water demand data are not in existence 20 to 40 % of the domestic water demand is recommended. Accordingly, **25%** of domestic water demand has been assumed for Debreziet town.

Livestock Water Demand

Livestock water demand may be required if there are no water sources to the proximity of the town. From the existing information and observation made around the town, there are Big and Small Aleltu River and some unprotected springs close to the town and they are currently used for livestock watering. Hence provision for livestock Water Demand is not considered.

a) Industrial Water Demand

Presently there are no industries in Debreziet town. Besides, there is no information regarding the establishment of any industries in the near future in the town. But with in the design horizon considered, a significant change is not expected to happen with respect to emerging of large industries in the area. In fact small scale processing units may arise. The water demand of such units is considered as public/institutional and commercial water demand and provisions for this is already considered as it indicated under part (a) above. Therefore, Industrial Water Demand is not considered here. In case if large scale industries implemented, it has to have its own water supply source since it is difficult to forecast the amount of water required for a particular industry in question and it may also significantly increase the investment cost and water tariff.

b) Water Requirement for Fire Fighting

The annual volume required for firefighting purpose is expected to be small. However, during periods of need, the demand may be exceedingly large and in many cases govern the design of distribution, storage and pumping requirements. In this case the

fire fighting water requirements is considered to be met by stopping supply to consumers and directing it for this purpose. This demand is taken care of by increasing the volume of storage tanks by **10 %**.

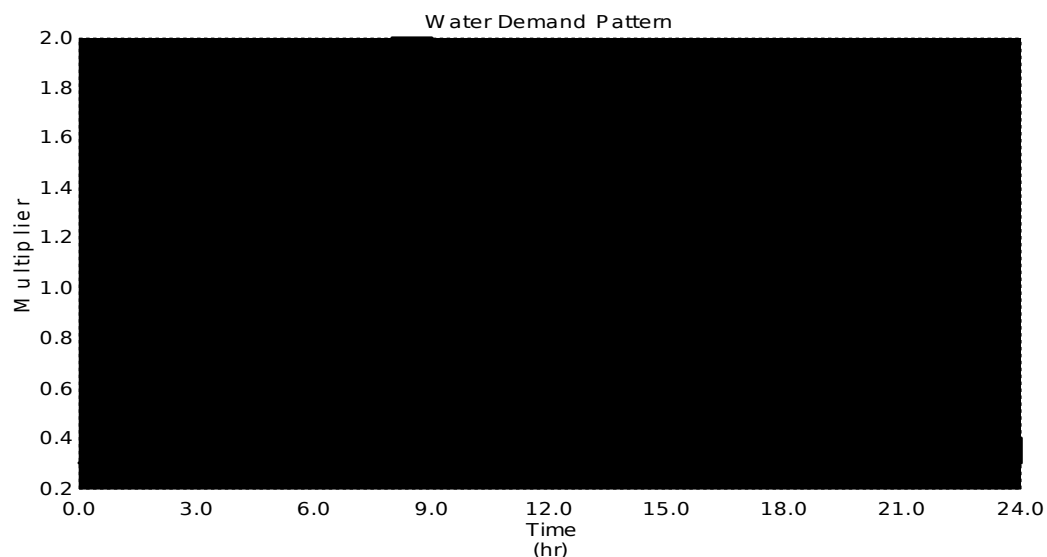
c) Unaccounted-For Water (UFW)

Unaccounted-for water includes water losses in the water supply system, illegal connections, overflow from reservoir and improper metering. It is also sometimes called “**non-revenue-water**” which also includes water for which bills have not been paid. The amount is usually expressed in percentage of the sum of the domestic water demand, public and commercial water demand and the industrial water demand covered from the water supply system. It is assumed that **15%** of total average day water demand.

5.4 Variation of water use

a) Average Day Demand

The average day water demand is the sum of average domestic, public and commercial, industrial and water losses which are used to estimate the maximum day and the peak hour demand. The water demand in a day varies with time according to the consumers' life style which is expected to improve with time. Hence, the adopted hourly flow factors, fractions of average daily demand, for the two phases are presented in Fig below.



Time(hr.)	Factor	Average demand	Hourly Demand
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1	0.3	1636.09	490.827
2	0.3	1636.09	490.827
3	0.3	1636.09	490.827
4	0.3	1636.09	490.827
5	0.3	1636.09	490.827
6	0.7	1636.09	1145.263
7	1.1	1636.09	1799.699
8	2	1636.09	3272.18
9	1.7	1636.09	2781.353
10	1.5	1636.09	2454.135
11	1.4	1636.09	2290.526
12	1.4	1636.09	2290.526
13	1.4	1636.09	2290.526
14	1.3	1636.09	2126.917
15	1.2	1636.09	1963.308
16	1.7	1636.09	2781.353
17	1.6	1636.09	2617.744
18	1.5	1636.09	2454.135
19	1.3	1636.09	2126.917
20	1	1636.09	1636.09
21	0.7	1636.09	1145.263
22	0.5	1636.09	818.045
23	0.4	1636.09	654.436
24	0.3	1636.09	490.827
		sum =	39593.378

b) Maximum day demand

The maximum day water demand is considered to meet water consumption changes with seasons and days of the week and for this particular case a factor of **1.15** is adopted.

c) Peak Hour Demand

This occurs when particularly all the water taps are opened at a particular rush hour. Such event happens during morning hours when most people use water for bathing, cooking and could also occur towards the end of the day due to peoples' need for water for the same purpose after working hours. For this particular case a factor of **1.8** is adopted.

d) Total Demand

Item	Description	Unit	Year
			2020
1	Population to be Served	No	25702

2	Adjusted Per Capita Demand (ACD)	l/c/d	138.6
3	Public Water Demand (25% of ACD)	l/c/d	34.65
4	Industrial Water Demand (0% of ACD)	l/c/d	0.00
5	Total per capital Demand (TPCD)	l/c/d	173.25
6	UFW (15% of TPCD)	l/c/d	25.99
7	Day Water Demand	l/c/d	199.24
8	Max Day Factor	-	1.15
9	Max Day Demand	l/c/d	229.13
10	Peak Hour Factor	-	1.80
11	Peak Hour Demand	l/c/d	412.43

6. System Design

6.1 Rising and gravity mains

6.2 hydraulic analysis of distribution line (pipe)

After determining the peak hour's discharge which is maximum at peak hour's velocity within the pipe will be high. So by iterating pipe diameter the velocity must be within allowable range, that is 0.6-3 m/s.

During night water demand is very low which results in high pressure at the junction so by iterating reservoir elevation the pressure must be within allowable range that is 245-415kpa.

6.3) reservoir

Reservoir are storage reservoir which store the treated water for supplying water during emergencies and also to help in absorbing the hourly fluctuation in water demand. The main functions are

- Equalizing supply and demand
- Increasing operating convenience
- Leveling out pumping requirement
- Providing water during source or pump failure
- Maintaining pressure level within acceptable rang

Reservoirs are classified in to:

1. Surface reservoir
2. Elevated reservoir

We have chosen one elevated type reservoir in which water is pumped in to this elevated tank from the filter unit and then supplied to the consumers. We have calculated total reservoir capacity as 3397.26m^3

6.4) pipe appurtenance

- Shutoff valves:-used to stop the flow of water through a pipe line. Depending on the district within the city and size of water mains, valves and spacing in the distribution area rang from 150-370m.
- Check valve:-is a semi automatic device that permits water flow in only one direction.
- Attitude valves:- are used to automatically control the floe in to and out of an elevated storage tank or stand pipe to maintain design water elevation.
- Air release and vacuum valve:-are used to discharge trapped air.
- Vacuum valve:-allow air to enter the pipe which is needed to protect pipe lines from collapsing as they are empitified.
- Pressure releasing valves:-due to topography the flow might be very high these valves are used to reduce pressure at this location
- Pressure sustaining pumps:-used to prevent a drop in upstream hydraulic grade line

- Back flow preventers:-water in a distribution system must be protected against contamination from the back flow through customer service line and other system outlets. We have used air gap separate which prevent back flow in to the supply pipe

Hydrant:- provide access to underground water mains for the purpose of extinguishing fire washing down streets and flashing out water mains. They are installed along streets behind curb line a sufficient distance, usually 0.6m, to avoid damage from overhanging vehicles.

7) Water pump and power supply

Pump is a mechanical machine. It is used for lifting water or any fluid to a higher elevation at higher pressures. The operation of lifting water or any fluid is called pumping.

We have provided high lift pump after the treatments plant and it is designed based on maximum value of $3Q_{\text{day-avg}}$ or $4/3Q_{\text{day-max}}$.

$Q_{\text{day-avg}}$ = average water demand + additional demand from institute

Reference

- ⇒ **M.Hammer:-Water and Waste water Technology**
- ⇒ **Element of water supply Engineering by Tesfaye Nigussie**
- ⇒ **Water supply by Garg**
- ⇒ **our hand out**

