A Study of Water Supply Infrastructure in Tezpur Urban Agglomeration Area, Assam, India

A thesis submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy

Sri Jatijiban Bora
Ph. D. Registration No. 001 of 2008

School of Management Sciences,
Department of Business Administration,
Tezpur University.

June, 2009

This thesis has been dedicated to my beloved father Late Jatindra Nath Bora and father-in-law Late Chandra Kanta Kalita.

ABSTRACT

1.0 INTRODUCTION:

Urbanization has become a global phenomenon. It is generally perceived as a *determinant and consequence of economic development. As per UN Report of 2008,* although 29.8% of the world's population in 1950 resided in urban areas, it is expected that half of the world's population will live in urban areas by the end of 2008.

In India, 27.8% of the total population lived in urban areas as per 2001 census; of the 1.02 billion population, 285 million lived in urban areas which comprised of 5,161 towns. Urban centres in India present a grim picture with regard to basic infrastructure.

About 21% of the urban population lives in squatter settlements where access to basic services is extremely poor. 89% of the urban population is reported to have access to safe drinking water but there are severe deficiencies with regard to equitable distribution of water. Nearly 46% of urban households have water borne toilets but only 31.3% of urban households are connected to the public sewerage system. Garbage collection efficiency ranges 50% to 90% of the solid waste generated in cities having population 1 Lakh to 50 Lakhs. City roads have become inadequate for traffic requirements leading to congestion. (Tenth Five Year Plan Report, GOI, 2002)

Water is the most essential ingredient for virtually any human activity. Water forms the lifeline of the society. Less than 1% of the world's surface or underground water is accessible for human use. The Planning Commission of India has estimated additional investment needs for Water Supply and Sanitation for the period 1997 to 2001, to be about US$ 12321 Million and the Rakesh Mohan Committee's India

Infrastructure Report estimates, in respect of water supply, a requirement of US$ 17418 Million to address the backlog upto 1995, an additional investment of US$ 2153 Million during 1996-97 and an additional investment of US$ 1934 Million during the period 2001-06.

Cities are governed by local bodies. The fundamental problem of municipal finance is the mismatch between the available resources and the municipal expenditure needs. In India, general financing position of the urban water supply and sewerage system is very poor. Only a few providers in large urban areas generate sufficient revenue to make any contribution to investment. There is an attempt to cross subsidizes from commercial and industrial consumers to domestic consumers. 76% of the towns surveyed did not raise sufficient revenue from water supply to cover revenue expenditure on the service. (Tenth Five Year Plan Report, GOI, 2002)

Budget allocations for Urban Water Supply and Sanitation in India from the first Five Year Plan (1951-56) to Tenth Five Year Plan (2002-2007) have been found to be around 1.50% of the total Plan outlay.

To counter the inadequate urban infrastructure, various Public Private Partnership (PPP) options have emerged such as Build-Own-Operate (BOO), Build-Operate-Transfer (BOT), Build-Own-Operate-Transfer (BOOT) etc. Though local authorities have started trying PPP approach, but all PPP projects are not success stories because of lack of feasibility studies, risk management, and financial modeling studies.

1.1 LITERATURE REVIEW:

The water projects in less developed countries were poorly operated and maintained and project benefits and development impacts fell short of plan. Donor and host country biases in the project identification, design, and construction stages led to inappropriate projects, unsustainable technologies, and shoddy construction (Howe & Dixon, 1993). The evolving public private partnerships should not foreclose opportunities for small domestic companies/enterprises to provide water supply where

gaps were left by public sector utilities (James, 1998). The households in Kathmandu Valley spent on an average about 1% of their current income as coping cost for water which was twice as much as their monthly water bill yet their WTP for improved water services were significantly low (Pattanayak, Yang, Whittington, Kumar, 2005).

The BOT (Built-Operate- Transfer) type partnership for the greater Beirut Area in the water supply sector was proposed as an effective coping strategy to alleviate the present water scarcity in the capital Beirut and its suburbs (Yamout & Jamali, 2007). The enhancements of institutional capacity at the community level and water education are essential for the sustainability of Drinking Water Supply (DWS) in rural villages throughout Nepal (Bhandari & Grant, 2007). The water user committee can be made trustworthy by enhancing facilitation skills, clarifying the responsibilities, imposing transparency in decision making and augmenting credibility (Lopez-Gunn, 2006)

The WTP survey for safe drinking water is required as water tariff from the consumer's point of view helps in finding an implementable water management policy beneficial to all involved. Some of the finding of WTP survey done by other researchers include (i) rural customers in Nigeria do not want to pay in advance or commit themselves to a fixed monthly payment due to their mistrust of public providers (Whittington, 1990b) (ii) WTP for improved water services increases with income and wealth, family size, education and dissatisfaction with traditional sources (Bohm, 1993) (iii) Consumers' willingness to pay for clean water supply in Kolkata, India, exceeded the production and maintenance cost. (Guha, 2008) (iv) The household income had a positive and statistically significant impact on WTP for both quantity and quality of supplied water. (Farolfi, Mabugu & Ntshingila, 2007)

There is a need for innovative planning in urban infrastructure and it may be the fourth "P" i.e. People in the partnership process (PPPP). The study of "Willingness to Pay" and "Willingness to Participate" of the consumers is required in bringing "People" in the partnership process alongwith "Public" and "Private". (Suresh, 1998b)

1.2 RESEARCH GAP:

A number of studies have been carried out on sustainability of drinking water schemes for urban as well as rural areas in the international level. Miller & Lewis (1987); Whittington, Okorafor, Okore & Mcphail (1990b); Bohm, Essenburg & Fox (1993); Altaf, Whittington, Jamal & Smith (1993); Howe & Smith (1993); Howe & Dixon (1993); Piper & Martin (1997); Ngowi (1997); James (1998); Hoehn & Krieger (2000); Neumayer (2001); Njiru & Sansom. (2001); Bahri (2001); Tati (2005); Pattanayak, Yang, Whittington & Kumar (2005); Oca & Bateman (2006); Pattanayak, Berg, Yang & Houtven (2006); Lopez-Gunn & Cortina (2006); Yamout & Jamali (2007); Montginoul (2007); Bhandari & Grant (2007); Farolfi, Mabugu & Ntshingila (2007); Kinfe & Berhanu (2007); Hassanein & Khalifa (2007) are some of the researchers who have contributed to this field of study.

Again in India, a few studies have been done in this field and some of these were carried out by Mehta (1993); Suresh (1998a); Suresh (1998b); Singh et al. (1993); Pathak (1996); Patra and Pradhan (2005); World Bank (2006); Guha (2008). These studies were mainly confined to WTP for improved water supply.

Such a study has not been done in North East India. Most of the Indian studies focused on WTP in terms of monthly tariff. The literature review suggests that no study appears to have focused on WTP in project finance and involvement of users in the operation of a water supply scheme. In North East region of India, states like Assam, Meghalaya and Nagaland seem to have experienced a decline in access to piped water (WB Report, 2006). The percentage of households having access to piped water in the case study area is 6.66 % which is far below the national average of 74 %. This has been revealed from secondary data.

This demonstrates the importance of the study. The current study also tries to find out consumers willingness to pay for an improved water supply scheme in Tezpur Urban Agglomeration. Consumer perception about existing water supply as well as desired

water supply is analyzed. The study also tries to identify avenues of consumer involvement in such a scheme.

1.3 JUSTIFICATION OF THE STUDY:

To the best of the researcher's knowledge no attempt has been made to assess the functioning of the water supply service of Tezpur Urban Agglomeration (TUA). This study proposes to identify the gap between the desired water supply service in TUA and the existing one.

Literature review has highlighted that

(a) consumer should pay for water supply service.
(b) focus should be on revenue generation through domestic connection.
(c) such services should be appropriately priced.

Keeping this in mind, the study proposes to make an assessment of how much the consumers are willing to pay a for water supply service. It would also like to assess their willingness to finance a water supply scheme and finally the level of involvement that can be expected from the consumers in terms of operation and maintenance of the scheme.

These above parameters then can be kept in mind while designing future water supply schemes in TUA area.

1.4 OBJECTIVES OF THE STUDY:

The objectives for the proposed study are -

1. To assess the demand for water supply in TUA area.

2. To identify the gap between existing and desired service.

3. To assess the "Willingness to pay" attitude of the household in the study area both in terms of monthly tariff and towards project cost.

4. To suggest an appropriate mechanism for ensuring the success of future water supply projects in TUA area.

1.5 SCOPE OF THE STUDY:

The study is confined to the water supply system of Tezpur Urban Agglomeration (Census of India, 2001). The study focuses on Tezpur Town and seven neighbouring villages viz. Hazarapar, Dekargaon, Parbatiagaon, Da-Parbatiagaon, Deurigaon, Majgaon, Bamunchuburi, and Barikachuburi.

1.6 LIMITATION OF THE STUDY:

The study has some limitations. The study area was selected purely on the basis of convenience, although attempt was made to include respondents from each section i.e. rural/ urban, with home connection/ without home connection and individual/ institutional.

Though the most widely used model in Contingent Valuation studies is based on logistic regression, in the study the WTP was calculated by using an adapted version of the Card Approach (mentioned in Chapter - **II**). Different payment ranges were offered and respondents had to select any one. Based on these responses the weighted average was calculated to obtain the amount that respondents were willing to pay on an average.

Only preliminary financial analysis has been done for a water supply project in TUA since "Willingness to Pay" was the major focus of the study. Social cost benefit analysis was not done in this study.

In case of institutional respondents, some institutions were found to be operational in rented building constructed for residential use. The water line connected to that building was that of residential connection although the function of the building was institutional. Such cases had to be dropped.

Rejection of 300 questionnaires, mainly due to incomplete and contradictory responses may have affected the stratawise sampling size. This may affect the ultimate result of the study.

The questionnaire was prepared in English. Some respondents found it difficult to understand the questions and the questions alongwith the technical terms had to be explained to the respondents in their mother tongue.

1.7 METHODOLOGY USED:

To fulfill the objectives of the research a research plan was designed. Data was collected from secondary sources to get a picture of the existing water supply scenario. Primary data was collected to find out the gap between the existing and desired water supply service, to assess WTP, and preferred mode of involvement of the consumers in a water supply scheme.

1.7.1 Sample Survey:

A sample survey was carried out in Tezpur Urban Agglomeration. A draft questionnaire was designed after studying WTP survey of similar nature and a Pilot Survey was carried out during June 2004 among 27 respondents. The pilot survey highlighted some points to be added to know the existing as well as desired level of water supply services. Modifications were made and the questionnaire was finalized.

A total number of 700 questionnaires were distributed out of which 300 questionnaires could not be included because of the respondent's unwillingness to answer all the questions and/or contradictory answers Finally 400 questionnaires were found to be complete in all aspect and considered for analysis.

1.7.1.1 Sampling Units: The units in the population are the "household" in case of individual consumer and the "institution" in case of Institutional consumers. The interviews were taken during July to October 2005. Stratified sampling method was employed for individual samples and convenience method was used for institutional samples.

1.7.1.2 Sample Size: The sample sizes for most of the WTP surveys for improved water supply schemes were found as 202 (Guha, 2008); 205 (Bhandari et al. 2007); 240 (Roy, 2003); 10,000 (World Bank, 2006).

Farolfi et al. 2007 conducted WTP survey for their research for improved water supply in Swaziland, the sample size was 374 from a population of 2,33,843 households and were equally weighted for the two strata, rural and urban.

Again Kinfe et al. (2007) carried out a similar survey for their research in Addis Ababa with 240 samples from a total 1,26,108 household. They divided the study area in three strata and samples were equally weighted for each stratum.

For the present study the sample size is confined to 379 households from a population of 20,681 households and 21 institutions were also covered.

1.7.1.3 Questionnaire: All the questions of the questionnaires were closed ended except two. There are three questions using 5 point Likert scale, 1 question using 7 point Likert scale and 11 questions with multiple choice answers. 8 questions were also designed to know the personal details of the respondents with multiple choice answers except the last two wherein respondent's name and address were recorded.

1.7.1.4 Variables Measured: Water supply service quality has many dimensions as continuity, water quality, pressure, and degree of responsiveness of service provider to customer complaints [WHO guidelines, 1993]. Drinking water quality has a microbiological and physiological dimensions as Iron content, Fluoride content, Arsenic content, Lead content, Pesticide, Total coliforms, Faecal coliforms, Calcium content, Chloride content etc. [WHO guidelines for drinking water quality volume 1 & 3, 1993 in CPHEEO Manual on Water Supply and Treatment, 1999]. To study the

existing level of water supply service 20 statements were measured across three questions. Again to study the desired level of water supply service 16 statements were measured. Statistics of these variables were calculated.

1.7.2 Data Analysis:

The data collected was analyzed using Statistical Package for the Social Sciences i.e. SPSS 11.0 version. The analytical instrument used for exploring relationship and significant differences included the statistical test such as independent sample T test of equality of means, and chi-square test.

Mean scores were used to prioritize the variables of a proposed water supply scheme in the case study area.

WTP for improved water supply in the study area was found out by weighted average.

1.8 MAJOR FINDINGS:

1.8.1 Demand for water supply:

- Only 31.5% respondents in the study area had access to home connection and 4.5% were dependent only on that.
- Though majority of respondents (94.75%) had their own arrangement for water yet 89.3% of them want to have home connection from the proposed water supply scheme.
- On an average, the water demand in the study area was 840.88 litres per household per day and 2210.10 litres per institution per day. The existing supply is about 350 litres per household/institutions per day.
- 62.5% of the respondents suffered from water borne diseases and they spent on an average Rs. 94.53 per month for the treatment of the diseases.

From the above it can be safely assumed that there is a demand for water supply service.

1.8.2 Gap between existing & desired water supply:

- Majority of the respondents with home connections perceived the existing water supply as inadequate in quantity as well as pressure, contained excessive iron content and mud, irregular timing and dependent on power supply.
- Even in case of respondents who had their own water supply system, majority felt that the water they used contained excessive iron content and foreign particles and dried up during winter.
- Majority of respondents using stand pipes felt that the waiting time was long (90.5%) and the location of stand pipes was not at proximity (94.9%).
- For a new water supply, majority of respondents felt that (i) it should be a 24 hours continuous supply, (ii) operation and maintenance should be done by community level registered society or private organization, (iii) supplied water should be safe and aesthetically attractive, (iv) connection charge and monthly tariff to be fixed by consumers, (v) grievance handling should be prompt.

The following gap can be seen:

- The existing water supply was inadequate in terms of quantity and the supply timings were irregular. Users desired to have a 24-hours continuous supply.
- Users of the existing water supply scheme as well as respondents having their own water supply arrangements found that the water to be high in iron content. They desired to have safe and aesthetically attractive water.
- From secondary data it was found that the existing monthly tariff for urban and rural users was Rs. 150.00 and Rs. 50.00 respectively. Yet the users desired that monthly tariff must be fixed in consultation with the consumers.
- Users of the existing water supply schemes felt that grievance handling was not prompt. They desired to have prompt grievance handling. The present O & M does not appear to be satisfactory as is evidence from the fact that there is not prompt response to complaints.

- Users of the existing water supply schemes felt that privatization would lead to better operation & maintenance of the schemes. They also desired that Community level registered society or Private Organization should be involved in operation & maintenance of the proposed water supply scheme in the study area.

1.8.3 Willingness to Pay:

- Majority of the respondents (54.8%) did not want to invest in the new water supply scheme. Though 45.2% respondents wanted to invest in the scheme, these investments were dependent on their income. Majority of them (85.9%) wanted return of their investments in the form of both deduction from monthly tariff and shares of the profit earned (46.4%).
- 46.5% of the respondents wanted to pay monthly water tariff as per meter reading.
- Majority of the respondents (60.7%) felt that the connection fee should be less than Rs. 1000/- and on an average it worked out to Rs. 925.67 for individual samples and Rs. 1644.34 for institutional samples.

  Again majority of respondents wanted to pay monthly tariff in the range of Rs 100/- to Rs. 200/- and on an average it worked out to Rs. 146.47 for individual consumers and Rs. 289.71 for institutional consumers.

1.8.4 Mechanism:

- Majority of the respondents (65.9%) wanted to participate in operation and maintenance of the new water supply scheme and 34.03% of them wanted to participate both in minimizing water losses and theft as well as ensuring timely deposit of water tariff.
- Majority of respondents appeared not to prefer the involvement of Urban/ Rural local body like Municipalities/ Gaon Panchayats in implementation process and Community level registered society/Private Organization in the conceptualization process for a water supply process.

1.9 OTHER FINDINGS:

- Respondents localitywise and consumer categorywise had different line of thinking regarding the existing water supply service.
- The choice to avail a new water supply service was found to be independent of locality, income, consumer category and ownership of building.
- Respondents' willingness to pay monthly water tariff was dependent on present water supply provision, number of family members and income.

1.10 CONCLUSION:

The existing water supply schemes in TUA were constructed with government grants and have been running without recovering the operating cost. As a result water supply has been intermittent, and unsafe for drinking (Source: Tezpur Municipal Board & PHED, Tezpur, 2005). The fact that 62.5% of the respondents suffered from water borne diseases and 4.5% had depended only on home connections highlighted the need for treated and safe water supply system.

The WTP of the consumers for a new water supply scheme in TUA (which is dependent on present water supply provision, number of family members and income) will help in proper pricing of future water supply services.

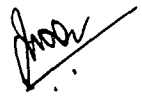
The respondents appeared to be willing to participate in some of the operational process of the water supply schemes and this is a very healthy sign.

As 54.8% of the respondents do not want to invest in the project cost of future water supply schemes in TUA, other financing options like grants from Government of India must be sought for the capital cost of the scheme.

Declaration by the scholar

I, Sri Jatijiban Bora, Research Scholar in the Department of Business Administration, School of Management Sciences, Tezpur University, Assam hereby declare that this research work titled "A Study of Water Supply Infrastructure in Tezpur Urban Agglomeration Area, Assam, India" is a bonafide work carried out by me under the supervision of Dr. Chandana Goswami, Professor and Head of Department of Business Administration, School of Management Sciences, Tezpur University.

This work has not been submitted elsewhere for any other purpose.



(Jatijiban Bora)

Registration No. 001 of 2008.

TEZPUR UNIVERSITY

This is to certify that the thesis entitled "**A Study of Water Supply Infrastructure in Tezpur Urban Agglomeration Area, Assam, India**" submitted to the School Of Management Sciences, Tezpur University, in partial fulfillment for the award of Doctor of Philosophy in Management Sciences is a record of research work carried out by **Mr. Jatijiban Bora** under my supervision and guidance.

All help received by him from various sources have been duly acknowledged.

No part of this thesis has been submitted elsewhere for any other degree.

Signature of Supervisor: Chandana Goswami

(Dr. Chandana Goswami)

Designation : Professor.

School : Management Sciences.

Department : Business Administration.

ACKNOWLEDGEMENT

First of all, I am deeply grateful to my Supervisor Dr. Chandana Goswami, Professor and Head of Department of Business Administration, School of Management Sciences, Tezpur University for her constant guidance, regarding all aspects of my study, without which I could not reach this point.

Thanks are due to Professor Mrinmoy K Sarma, and all other members of Doctoral Research Committee, all faculty members, office bearers of School of Management Sciences, Tezpur University for their support and help as and when required.

I gratefully recall the contribution of Late Dulal Bhuyan, Deputy Director, Town & Country Planning, Government of Assam, and Late Prof. Madhab C Bora, School of Management Sciences, Tezpur University in the initial stage of this study. Here, I pray to the Almighty for their departed souls.

I would like to thank Urban Development Department, Government of Assam for issuing No Objection Certificate to carry out this study.

The information provided by the engineers and accountants of Tezpur Municipal Board, Tezpur as well as Public Heath Engineering Department, Tezpur Division - 1 regarding the present scenario of water supply service in my study area is gratefully acknowledged.

I would like to thank my mother Mrs. Lily Bora, my wife 'Mala', my son 'Jittam' and other family members for their support and encouragement during the entire period of study.

I am grateful to all the officers and staff of the offices where I am working at present, for their help on different occasions. Special mention of Suman, Amulya, Naba, Chironjeev, Nipon, Ankur, Hemen, Nayan, Isidar, Azad, Karna, Phani & Bulen (all my subordinate officers/staffs) who accompanied me, with their vehicle, to the university as and when required as well as rendered help as per their capacity.

Last but not the least, special thanks to Krishna and Suman who accompanied me during my sample survey.

Thanks.

(Jatijiban Bora)

TABLE OF CONTENTS

LIST OF TABLES
LIST OF FIGURES AND MAPS
LIST OF ABBREVIATIONS

CHAPTER – I	**INTRODUCTION**	**1-11**
1.1	WATER SUPPLY AS INFRASTRUCTURE	2
1.2	AVAILABILITY OF DRINKING WATER	3
1.3	URBAN INFRASTRUCTURE AND ITS FINANCING	4
1.4	URBAN FINANCE IMPROVEMENT - A CHALLENGE	5
1.5	URBAN WATER SUPPLY IN INDIA - A REVIEW	6
1.6	PROBLEM DEFINITION	7
1.7	STATEMENT OF THE PROBLEM	8
1.8	AN OVERVIEW OF THE THESIS	9
CHAPTER – II	**REVIEW OF LITERATURE**	**12-28**
2.1	INTERNATIONAL STUDIES	13
2.2	STUDIES IN INDIA	21
2.3	MEASURING WTP	23
2.4	CHARACTERISTICS OF 'DRINKING WATER'	25
2.5	SOME DEFINITIONS	28
CHAPTER – III	**RESEARCH METHODOLOGY**	**29-38**
3.1	RESEARCH GAP	29
3.2	JUSTIFICATION OF THE STUDY	30
3.3	OBJECTIVES	31
3.4	METHODOLOGY USED	31
3.4.1	SAMPLE SURVEY	32
3.4.2	SAMPLING UNITS	32
3.4.3	SAMPLE SIZE	32

	3.1.1	SAMPLING FRAME	33
	3.1.2	QUESTIONNAIRE	35
	3.1.3	VARIABLES MEASURED	35
	3.1.4	DATA ANALYSIS	35
3.2		LIMITATION OF THE STUDY	36
3.3		SCOPE OF THE STUDY	37
3.4		AN INTRODUCTION TO THE STUDY AREA	37
CHAPTER – IV		**DATA ANALYSIS**	**39-65**
4.1		DEMOGRAPHIC DETAILS	39
4.2		EXISTING WATER SUPPLY INFRASTRUCTURE	44
4.3		EXPECTATION FROM A NEW WATER SUPPLY SCHEME	53
CHAPTER – V		**FINDINGS AND CONCLUSIONS**	**66-78**
5.1		FINDINGS	66
	5.1.1	DEMAND FOR WATER SUPPLY IN THE STUDY AREA	66
	5.1.2	GAP BETWEEN EXISTING AND DESIRED WATER SUPPLY SERVICE	68
	5.1.3	WILLINGNESS TO PAY	71
	5.1.4	APPROPRIATE MECHANISM	72
	5.1.5	PROPOSED MECHANISM	73
5.2		COMMUNICATING TO STAKEHOLDERS	75
5.3		CONCLUSION	76
5.4		CONTRIBUTION OF THE STUDY	77
5.5		SCOPE FOR FUTURE STUDY	78
REFERENCES & BIBLIOGRAPHY			**79-98**
ANNEXURES			**99-128**

LIST OF TABLES

Table 2.3.1 Limitations of different WTP elicitation techniques.

Table 2.4.1 Recommended guidelines of WHO for physical, chemical parameters and bacteriological quality of drinking water.

Table 3.1 Localitywise & Consumer Categorywise Breakup of the Sample

Table 3.2 The Sampling Frame for Individual Consumers

Table 4.1.1 The Sample

Table 4.2.1 Existing Water Supply Scenario in the study area

Table 4.2.2 Receipt and expenditure of Tezpur Municipal Board for the last five financial years

Table 4.2.3 Perception on Existing municipal/PHE Water Supply

Table 4.2.4 Perception about own Water Supply

Table 4.2.5 Perception about Stand Pipes

Table 4.2.6 Mean Scores of Perception on Municipal/PHE Water Supply, Localitywise

Table 4.2.7 Mean Scores of Perception on own Water Supply, Localitywise

Table 4.2.8 Mean Scores of Perception on Stand Pipes, Localitywise

Table 4.2.9 Mean Scores of Perception on Municipal/PHE Water Supply, Consumer Categorywise

Table 4.2.10 Mean Scores of Perception on own Water Supply, Consumer Categorywise

Table 4.2.11 Water borne diseases

Table 4.2.12 Expenditure incurred on Water borne diseases

Table 4.3.1 Perceptions on New Water Supply of Scheme

Table 4.3.3 Availing of Water Supply Scheme

Table 4.3.4 Locality Vs Availing of Water Supply Scheme

Table 4.3.5 Income Vs Availing of Water Supply Scheme

Table 4.3.6 Consumer Category Vs Availing of Water Supply Scheme

Table 4.3.7 Ownership of the building Vs Availing of Water Supply Scheme

Table 4.3.8 Requirement of Water

Table 4.3.9 Investment in Water Supply Scheme
Table 4.3.10 Investment in Water Supply Scheme Vs Income
Table 4.3.11 Return from Investment
Table 4.3.10 Return from Investment Vs Income
Table 4.3.11 Form of Return from Investment
Table 4.3.12 Connection Charge
Table 4.3.13 Basis of Monthly Tariff
Table 4.3.14 Monthly Tariff
Table 4.3.15 Monthly tariff Vs Present Water Supply Provision
Table 4.3.16 Monthly tariff Vs Number of Family Members
Table 4.3.15 Monthly tariff Vs Income
Table 4.3.16 Willingness to Participate
Table 4.3.17 Participation in different O & M functions
Table 5.1.1 Perception on Water Adequacy (from Municipal/PHE connection as well as own arrangement)
Table 5.1.2 Perception on Water Adequacy (from stand pipes)
Table 5.1.3 Perception on Water Quality (from Municipal/PHE connection as well as own arrangement)
Table 5.1.4 Regularity of Water Supplied by Municipality/PHE
Table 5.1.5 O & M of Municipal/PHE water supply service as well as own arrangement

LIST OF FIGURES AND MAPS

Fig. 1.1 Layout of the thesis

Fig. 4.1.1 Ownership of Building

Fig. 4.1.2.1 Water Supply Arrangement -1

Fig. 4.1.2.2 Water Supply Arrangement -2

Fig. 4.1.3 Household size

Fig. 4.1.4 Occupation

Fig. 4.1.5 Monthly Income

Fig. 4.1.6 Educational Qualification of Home-managers

Fig. 4.1.7 Consumer categorywise respondents

Fig. 4.1.8 Localitywise respondents

Fig. 4.2.1 Water borne diseases

Fig. 4.2.2 Expenditure incurred on Water borne diseases

Fig. 4.3.1 Availing of Water Supply Scheme

Fig. 4.3.2 Requirement of Water

Fig. 4.3.3 Investment in Water Supply Scheme

Fig. 4.3.4 Return from Investment

Fig. 4.3.5 Form of Return from Investment

Fig. 4.3.6 Basis of Monthly Tariff

Fig. 4.3.7 Monthly Tariff

Fig. 4.3.8 Willingness to Participate

Fig 5.1 Proposed Mechanism

Map 3.1 Map showing the location of the study area

LIST OF ABBREVIATIONS

1. BOLT - Build-Operate-Lease-Transfer
2. BOOT - Build-Operate-Own-Transfer
3. BOT - Build-Operate-Transfer
4. CEMIS – Community based Environmental Management Information System
5. CPHEEO - Central Public Health and Environmental Engineering Organization.
6. CV – Contingent Valuation
7. DBFOT - Design-Build-Finance-Operate-Transfer
8. HUDCO - Housing & Urban Development Corporation Limited
9. LICI - Life Insurance Corporation of India
10. lpcd – litres per capita per day
11. MDG - Millennium Development Goal.
12. NERIWALM - North East Regional Institute of Water and Land Management
13. NSS - National Sample Survey
14. O&M - Operation & Management
15. ODB-UK - Overseas Development Bank of United Kingdom
16. PHED – Public Health Engineering Department
17. PPP - Public-Private-Partnership
18. ROT - Rehabilitate-Operate-Transfer
19. TUA – Tezpur Urban Agglomeration
20. ULB - Urban Local Body
21. UN - United Nations.
22. UNCHS – United Nation's Centre for Human Settlement
23. WB - World Bank
24. WHO – World Health Organization
25. WTA – Willingness to Accept
26. WTP – Willingness to Pay

CHAPTER - I

INTRODUCTION

CHAPTER - I

INTRODUCTION

Urbanization has become a global phenomenon. It is generally perceived as a determinant and consequence of economic development. It has been noticed that higher levels of urbanization in countries lead to high per capita incomes as well as high growth rate of the national economy. For example in India 17.3 % of urban population had contributed to 29 % of total income in 1951 which was raised to 60 % in 2001 with 27.8 % urban population.[1] Thus urbanization is a reality that people must face and turn to people's advantage as urban centers are the centers of economic and social development and powerhouse of prosperity and cultural progress.

Urban population growth is mainly due to rural urban migration in search of employment and better job prospects. Despite the relatively high incomes of urban population, the availability of basic infrastructure in major urban centers is poor. Urban basic infrastructure are supposed to be provided by the urban local bodies' i.e. municipal authorities and it is ironic that they are usually short of sufficient money to meet their responsibilities.

The India Infrastructure Report (Rakesh Mohan Committee) has estimated that the aggregate levels of total annual investment requirement for urban infrastructure inclusive of water supply and sanitation and other infrastructure, would be Rs. 28,297 crore over the period of 1996-2001, and it would be of the order of Rs. 27,773 crore for the 2001-2006 period. The Central Public Health and Environmental Engineering Organization (CPHEEO) has estimated that by the end of the year 2007, the total fund

[1] Suresh. (1998a).

required for water supply, sanitation and solid waste management would be Rs. 53,719.80 crores.[2] The UN Millennium Development Goal (MDG) 7 aims at reducing 50% of people without sustainable access to safe drinking water by 2015.[3]

In 1950, only 29.8 percent of world population lived in urban areas, but in 2008 it has been raised to 50%.[4] In India 27.8 percent of the total population live in urban areas as per 2001 census; i.e. of the 1.02 billion population, 285 million lives in urban areas which comprises of 5,161 towns. (Urbanization in India, 1901-2001 is given in Annexure I) Urban centers in India present a grim picture with regard to availability of basic infrastructure. About 21% of the urban population lives in squatter settlements, where access to basic services is extremely poor. 89% of the urban population is reported to have access to safe drinking water but there are severe deficiencies with regard to equitable distribution of water. Nearly 46% of urban households have water borne toilets but only 31.3% of urban households are connected to the public sewerage system. Garbage collection efficiency ranges between 50%-90% of the solid waste generated in cities having population between 1 lakh to 50 lakhs. City roads have become inadequate for traffic requirements leading to congestion. Quality of roads has deteriorated due to excessive loads.[5]

1.1 WATER SUPPLY AS INFRASTRUCTURE:

Water is the most essential ingredient for virtually any human activity. Water forms the lifeline of any society. Water supply and sanitation plays a critical role in ensuring the health of the residents of any country.

In ancient times, water was acknowledged and regarded as a valuable resource. Almost every ancient culture has regarded water as sacred and essential to life and all

[2] Tenth Five Year Plan. GOI. (2002). Chapter 11
[3] www.who.int/mgd/en/
[4] UN Reports. (2008).
[5] Tenth Five Year Plan. GOI. (2002). Chapter 11

civilizations came up on the bank of a water body. The shortage of water leads to reduction in food production, misbalancing the environment, hampering economic development etc. In the absence of adequate water supply and sanitation, the poor lose their wages because they tend to be sickly and not healthy enough to work. Impure water can lead to diseases like diarrhea, typhoid, cholera etc., while unsanitary conditions lead to trachoma, poliomyelitis, malaria etc. A person of low income group will not only have to forgo wages but also spend money for treatment and become poorer in the process. Thus the link between water and poverty needs to be addressed.

Population growth has put enormous pressure on the world's natural resources, particularly on water. The need of the hour is to tackle water problem through a combination of supply and demand management.

1.2 AVAILABILITY OF DRINKING WATER:

Water covers about three fourth of the earth's surface. The hydrological cycle of evaporation and precipitation circulates the earth's water between the oceans, land and the atmosphere. Out of the total water available on earth 97.5% is salt water and only 2.5% is fresh water. Again out of the freshwater, 74% is found in form of icecaps and glaciers, 25.7% is deep groundwater or locked in soils as moisture or permafrost and only 0.3% is in rivers or lakes. Again less than 1% of the world's surface or underground freshwater is accessible for human use. A substantial amount of fresh water (about 70%) is used to irrigate cultivable land. The remaining fresh water is used for many purposes – domestic, industrial and others viz. rearing cattle[6].

Expansion of construction activities of all kinds had led to destruction of wetlands, drying up or contamination of lakes and rivers. Increase in population has put enormous pressure on freshwater. Water tables are falling in every continent due to

[6] India Infrastructure Report. (2001). pp 236-277.

over exploitation of underground water resources and major rivers are drained dry before they reach the sea because of intensive irrigation and urban consumption. Further, pollution and depletion of water resources, wastage of treated water and lack of investment in the water sector are all contributing to the impeding global water crisis. Some of the temporary measures to reduce water crisis may be - elimination of wastage of water and reduction in the current usage of water by industrial and agricultural sectors, better infrastructure for water supply and changing water tariff structure etc.

Guwahati, the capital city of Assam and gateway of North - East India, has witnessed depletion of water table in several areas mainly near the newly constructed high-rise residential flats. Most residents purchase water from private vendors viz. 'Brahmajal' whose rate varies from Rs. 2.00 per litre at the production site to Rs. 3.00 per litre within 3 KM radius from the production site. The irony is that Guwahati is located on the bank of the mighty river Brahmaputra.[7]

1.3 URBAN INFRASTRUCTURE AND ITS FINANCING:

Infrastructure is generally defined as "service road, mass transportation, water and sewer systems, solid waste management, drainage and flood protection, electric installations and telecommunications - traditionally supported by public sector to enhance private sector production and to allow for household consumptions" [8]

Infrastructure is generally defined as the physical framework of facilities through which goods and services are provided to the public. It includes[9]

(i) Public utilities - power, telecommunications, pipe water supply, sanitation and sewerage, solid waste collection and disposal, and piped gas.

(ii) Public works - roads, and major dam and canal works for irrigation and drainage

[7]Dainik Asam. 22nd May.(2004). A report in an Assamese newspaper

[8] Fox. (1994).

[9] *World Bank. (1994). World Development Report: 1994*

(iii) Other transport sector - Urban and inter - urban railways, urban transport, ports & waterways and airports.

Urban infrastructure financing is one of the most complex and politically sensitive issues in countries around the world. Traditional budgets of Central, State and Local governments are the primary sources of funding infrastructure projects. These are generally insufficient. The likely availability of funds for the 10th plan period in India was Rs. 358.0 billion, but the estimated required funds was Rs. 537.0 billion; thus a deficit of funds was Rs. 179.0 billion[10]

Moreover, in most countries the Central governments not only control most of the revenues but are also reluctant to cede control over the use of these funds. Thus local authorities need to seek financial innovation.

1.4 URBAN FINANCE IMPROVEMENT - A CHALLENGE:

Cities are governed by local bodies. Without adequate financial resources and the proper governance structure to manage them, the cities are unable to meet the challenges of poverty, population, inadequate urban services, and infrastructure upgradation etc. all of which arise from a rapidly growing population. The fundamental problem of municipal finance is the mismatch between the available financial resources and the municipal expenditure needs. This gap widens as urban population increase brings with it an increasing demand for infrastructure and urban services.

The growth of municipal revenue does not match the increase in urban activity as most of the value added tax is collected by Central Governments, and municipalities receive back a little amount from that. The reasons for weak municipal finances are –

[10] World Bank. (2006). India, Water Supply and Sanitation, Bridging the Gap Between Infrastructure and Service

(i) local taxes lack buoyancy e.g. rise in property values may not be captured immediately with a tax increase because property is usually revalued after every few years rather than annually,

(ii) lack of autonomy to establish their tax base, tariff rate and enforcement procedures,

(iii) poor financial management,

(iv) lack of transparency and predictability in financial transfer from higher government.[11]

Most countries have set up specialized public finance institutions that lend to local authorities for infrastructure investment. But most of the local authorities are not independent enough to borrow long-term funds from capital markets for urban infrastructure development, as they do not have authority to impose tax and have to follow government rules and guidelines. (Infrastructure financing options adopted by other countries are provided in Annexure – **II)**

1.5 URBAN WATER SUPPLY IN INDIA - A REVIEW:

As per Census of India, 2001, 6.54% of the urban household had access to drinking water facilities within their premises, 25.2% within a distance of 0.5 kms and 9.2% beyond 0.5 kms. Again 68.7% of urban households depend on piped water while 2.2% depend on tank/ pond, river / canal, spring, tankers, bottled water etc. Again the availability of drinking water in concerned households varies from 165 lpcd for class-I cities to 54 litres for class-IV cities and that in slum areas is 27 liters.[12] As per NSS[13] 54th Round, 2000, 15% of household did not get sufficient drinking water from their principal source, between April and June, May being the worst month. 18% percent reported using some supplementary source of drinking water and 96% reported storing their drinking water.

[11] Lohse. (2003). et al.
[12] Shelter, volume 5, No.1, page 71; A HUDCO-HSMI publication
[13] NSS = National Sample Survey

Financing of urban water supply schemes in India is through (i) Budgetary provisions of Central, State and Local Government (ii) grants and loans from multilateral-bilateral agencies like World Bank, Overseas Development Bank of UK (ODB-UK) (iii) Institutional lending from financial institution like HUDCO, LICI etc. (Government of India Water supply, Institutional structure, Policies and Programmes are provided at Annexure -**III**)

In India, the general financing position of the urban water supply and sewerage sectors is very poor. (Current financing practices in urban infrastructure delivery in India are placed in Annexure -**IV**) Only a few providers in large urban areas generate sufficient revenue to make any contribution to investment. (Municipal Bond as urban infrastructure financing option is provided at Annexure – **V**) There is an attempt to cross subsidize from commercial and industrial consumers to domestic consumers. 76% of the towns surveyed did not raise sufficient revenue from water supply to cover the revenue expenditure on the service[14].

1.6 PROBLEM DEFINITION:

Water supply project is generally implemented by the State Public Health Engineering Department. Now-a-days these schemes in urban areas are being executed by Urban Water Supply Board or Authority. Though it is essentially a municipal function to be discharged by Urban Local Body (ULB), these bodies are unable to take any significant initiative because of their weak financial base. Though the ULBs are ultimate owners of the water supply scheme, they have little say in control or operation and maintenance of the project.

The main problem in financing of urban water supply is that the ULBs have to depend upon the State Government's willingness and capacity to provide guarantee for institutional finance as well as agree to its share of the project cost. Delay in providing

[14] Tenth Five Year Plan. GOI. (2002). page 638

share by the State Government leads to a situation of incomplete work, delay in completion of the projects and cost over run.

The issue of resources for urban water supply finance is also critically linked to the macro financial system. It is seen that the budgetary allocations for infrastructure are likely to decline further with the structural adjustment policies now under process. The above discussion points out that mobilizing municipal resources has been a major problem for years and is likely to remain so.

1.7 STATEMENT OF THE PROBLEM:

Municipalities are normally short of money to provide all amenities to its citizens. Traditionally, they depend upon budgetary provisions of governments, loans and grants from financial institutions and its internal accruals. But these are totally inadequate to meet the large capital expenditure requirements for water supply projects. These projects being capital intensive, municipalities cannot solely rely upon the above mentioned financing options. They need multilateral financing or consortium/ syndication or Central and State Govt. guarantee with financial support. Private sector participation in the form of additional financial support can solve the problem to some extent. Consumers' "Willingness to Pay" for cost of project and monthly tariff will go a long way in solving financial problems associated with a water supply project.

To counter the inadequate urban infrastructure, various Public Private Partnership (PPP) options have emerged such as Build-Operate-Transfer (BOT), Build-Operate-Own-Transfer (BOOT), Build-Operate-Lease-Transfer (BOLT), Rehabilitate-Operate-Transfer (ROT), Design-Build-Finance-Operate-Transfer (DBFOT). But the crucial issue is to ensure access to basic services to all, including the low income group and economically weaker section. Though the local authorities have adopted PPP approach, all PPP projects have not been success stories because of lack of preparatory work as feasibility studies, risk management, and financial modeling

studies. The gap between desired and existing level of water supply service needs to be identified before offering a new service.

There is a need for innovative planning for urban infrastructure and it may be 4th P - People in the partnership process. The study of 'Willingness to Participate' of the consumers is required in bringing 'People' in the partnership process with Public & Private.[15] (At Annexure – **VI** Public-Private-People's Partnership: Prospects and constraints is provided) The present study tries to find out how people's participation can be incorporated in a water supply scheme in an urban area.

1.8 AN OVERVIEW OF THE THESIS:

The first chapter presents the urban infrastructure scenario with special reference to water supply in the world as well as in India. It also presents the issues related to urban infrastructure financing. The problem definition and the statement of the problem are also described in this chapter.

The second chapter provides a detailed literature survey along the lines of water supply service – its financing, operation and maintenance; willingness to pay for improved water supply service etc. The different WTP elicitation techniques with their limitations are also presented in this chapter. Although the bulk of literature survey findings are concentrated in this chapter, parts of literature survey findings are spread through chapter **I** & **III**.

The third chapter presents the objectives of the study. It also identifies the limitation of the study, scope of the study and gives an introduction of the study area. Detailed research methodology of the study is presented in this chapter too.

[15] Suresh. (1998b)

The layout of the thesis is as shown in figure below –

CHAPTER I: INTRODUCTION

- Background
- Problem Definition
- Statement of the Problem

CHAPTER II: REVIEW OF LITERATURE

- Review of WTP Elicitation Techniques
- Review of similar International and National studies

CHAPTER III: RESEARCH METHODOLOGY

- Justification and Objectives of the Study
- Research Methodology
- Introduction of the Study Area

CHAPTER IV: DATA ANALYSIS

- Existing Water Supply Scenario in TUA Area
- Desired Water Supply Service in TUA Area
- Willingness to Pay Study
- Willingness to Participate study

CHAPTER V: FINDINGS AND CONCLUSIONS

- Detailed Discussions
- Conclusions
- Proposed Mechanism for future Water Supply Service in TUA
- Scope for Future Study

REFERENCES & BIBLIOGRAPHY

ANNEXURES

Fig. 1.1 **Layout of the thesis**

The fourth chapter explains the existing water supply scenario in the study area with the help of primary and secondary data. This chapter also identifies the desired water supply service in the study area. People's willingness to pay for an improved water supply system and their willingness to participate in the proposed scheme is also presented here.

The fifth chapter is about the summary of the findings and main conclusions of the study. The chapter also presents the proposed mechanism for water supply service in TUA. This chapter identifies the scope for future study too.

CHAPTER - II

REVIEW OF LITERATURE

CHAPTER - II

REVIEW OF LITERATURE

The literature of water supply infrastructure is quite rich with examples of innovative solution to the problems of its financing as well as operation and management. Financing of water supply infrastructure has been witnessing a rapid change. Primarily government had provided water supply services through budgetary provisions and citizens generally considered these as social goods. The pricing for supplied water generally can not cover the operation and maintenance cost, and for operation and maintenance of a water supply scheme, the authority has to depend upon government budgetary provision. (Whittington et al. 1990b, Altaf et al. 1993)

Most consumers of water generally consider it as a nature's "free gift" and/ or a public utility to be provided by the government free of cost. To them the water supply system is to be fully relied upon to meet their continual requirements at all hours of day and must be within easy reach. However supply of water to consumers should normally be based on the principle of effective demand that should broadly correspond to the standard service which the users as a community are willing to maintain, operate and finance. At the same time special provisions should be made to meet the needs of the poor who have less capacity to pay.

The operation and maintenance (O&M) of a water supply scheme aims at the achievements like

(i) the quality of water supplied should be safe,

(ii) service to consumers should be satisfactory,

(iii) operations should be safe and self supporting and

(iv) financial management should be sound.

The entire work of O&M require a huge financial involvement in the form of a) fixed charges comprising debt servicing, staff remuneration and minimum maintenance charges and b) variable charges comprising power, chemicals and raw water bills which are proportional to the quantity of water produced.

In this chapter an attempt has been made to review some of the recent studies on water supply infrastructure financing and management. The Central Library of Tezpur University, library of North East Regional Institute of Water and Land Management (NERIWALM), the online library of the United Nations Centre for Human Settlement (www.unhabitate.org, www.unchs.org); World Bank (www.worldbank.org); Asian Development Bank (www.adb.org) and search engine scholar google.com have been extensively used.

2.1 INTERNATIONAL STUDIES:

Lewis & Miller (1987) in their research had found out that public water supply systems were characterized by high costs, insufficient supplies, and chronic deficits that were covered by central government transfers. On the other hand the private water supply programme in Abidjan had not met its coverage targets, but yet the system had remained financially solvent and fostered a rapid growth in capacity through the informal sector. The study revealed that where the public sector decided to control and operate the water supply and sanitation system, some partnership with the private sector was possible through contracting out specific tasks as billing, metering, maintenance of distribution system or tracking water losses. According to them, the supply of water would be an ideal activity for a public-private partnership.

Flack & Howe (1990) in their study had discussed that the WTP[1] per unit increase in reliability was significantly different than the WTA[2] for a unit decrease in reliability of urban water supply system. They surveyed 220 residential water users in Boulder, Colorado and the study concluded that (i) Water officials, elected decision makers, and water user hold quite different attitudes towards the risk of water shortage, (ii) Urban water officials prefer highly reliable systems that are not keeping with public attitudes towards water shortage, (iii) The economically justifiable level of reliability may be quite different from that by water officials and elected decision makers, (iv) Water officials usually overestimate the public's concern with water shortage and their WTP to avoid shortage. (v) Public WTP's for higher level of reliability differ significantly from their WTA compensation for similar decreased levels of reliability.

Whittington, Okorafor, Okore & Mcphail (1990b) discovered that the rural communities in Nsukha district of Anambru state, Nigeria did not want to pay for water in advance or commit themselves to a fixed monthly payment as they did not trust government with reliable public water supply. The existing arrangement for cost recovery i.e. fixed monthly fees for both public taps and unmetered private connections were inappropriate. The researchers suggested that the Kiosk system or Kiosk system with metered private connections for some household would be the most promising way to cost recovery.

Bohm, Essenburg & Fox (1993) studied the financial sustainability of rural water system in the Philippines and according to them WTP is greater for household connections than for public faucets and it increases with income and wealth, family size, education of respondents and existing water services of the household.

Altaf, Whittington, Jamal & Smith (1993) studied the rural water supply policy of Punjab, Pakistan. Their study revealed that the rural water policies had not kept pace with the rapid economic development in that region. Contingent valuation method

[1] WTP - Willingness to Pay
[2] WTA - Willingness to Accept

was used for benefit estimation and found that the WTP for reliable and improved service was too high to recover full cost. They suggested that rural water sector strategy to be changed from a centralized, supply oriented focus to a decentralized, demand oriented policy.

Howe & Smith (1993) carried out research to compute the attitudes of different stakeholders of urban water supply in three different cities of Northern Colorado-Aurora, Boulder and Longmont towards the risk of water supply shortage. The different stakeholders were users, water officials and elected officials. In their research, they used contingent valuation technique to measure benefit and cost of different reliability levels in terms of water user's willingness to pay for increase in reliability as well as willingness to accept compensation in the form of lower water bills for lower level of reliability. The study concluded that water managers' preferences were consistent with customer WTP (WTA) value associated with the risk of water shortages and system cost associated with reliability. Again the study revealed that majority of customers expressed interest in change when they were shown the justification by comparing the supply system costs with aggregate WTP for additional reliability.

Howe & Dixon (1993) had pointed out that water projects in less developed countries were poorly operated and maintained and project benefits and development impacts fell short of plan. Donor and host country biases in the project identification, design, and construction stages led to inappropriate projects, unsustainable technologies, and shoddy construction. According to them excessive centralization, lack of rewards for good operation and maintenance and widespread corruption in forms that seriously disturb allocative efficiency of host country, and donors' desire to build monuments and sell technology, provision of excessive capital to favoured sectors/institutions and unwillingness to require a reasonable quid pro quo from the host country were the reasons for low or negative pay off of water projects in less Developed countries in the Third World.

Piper & Martin (1997) in their research conducted a WTP survey for improved rural water supplies in western United Sates and found that monthly tariff for improved water ranged between $ 4.43 and $ 17.29 per household. They suggested that private and public officials with the help of this estimated WTP must determine how a limited fund should be spent for water supply improvements.

Shaoul J. (1997) in his study found out that for public concern over the adequacy of the water supply and the crumbling infrastructure, the capital maintenance could not be delayed indefinitely. If the regulator's primary duty was to ensure that the water business would continue to finance their activities, which included dividends, then the regulator must allow prices to rise.

Ngowi (1997) discovered that community managed facilities would work if the people in the community would participate in all the stages of a project - Planning, design, construction and eventually maintenance. The study showed that with proper planning the people in the community can be mobilized, sensitized and made to participate in the management of infrastructure facilities upon which they depend.

James (1998) had found out that the evolving public private partnerships should not foreclose opportunities for small domestic companies/enterprises to provide water supply where gaps were left by public sector utilities. He also pointed out that the smaller cities were unlikely to attract large amounts of private capital in the near term due to high demand for the services of the few international private firms. He suggested one alternative of public-private partnering expanding its parameters and exploring linkages between community services provider and municipal water supply system, whether publicly or privately owned and operated. The study also revealed that it would be successful if financing opportunities would be made available to small enterprises and community groups.

Hoehn & Krieger (2000) in their study had found out that non-market valuation methods were useful in planning and evaluating investments in water infrastructure in developing countries. They used contingent referendum methods to estimate

household willingness to pay for each of four types of service improvement stemming from water and waste water investment in Cairo, Egypt. Their study revealed that (i) Benefits exceeded costs for all projects, (ii) Cost recovery was not assured with a fixed tariff, (iii) WTP for some households, was less than per household cost, necessary for cost recovery. Again cost recovery was found sensitive to whether tariffs were set for individual services or charged for a combined package of services.

Neumayer (2001) in his research had discovered that developing countries had made greatest progress during the period 1980 and 1993-1996 in terms of population having access to safe drinking water and adequate sanitation. According to him, this convergence was a good message – (i) Convergence of environmental standard was in concordance with an increase in world social welfare. (ii) It reduced inequalities in access to important life resource. (iii) The fate of people suffering from the poorest environmental conditions had been improved considerably.

The study carried out by Njiru & Sansom (2001) had revealed that by structuring service delivery with appropriate pricing, utilities can offer improved services to existing customer at affordable cost as well as achieve financial sustainability. They suggested that water supply utilities should consider using the strategic marketing approach as it has potential to improve services to existing and potential customers while meeting utilities objectives such as improving utility's revenue base.

Bahri (2001) in his research discovered that with urbanization growth and increased competition for natural resources and water in particular there is a need for a holistic approach which integrates the different issues relating to sustainable urban and peri-urban development and defining the best strategies and option. To him water management is becoming a driving component in water resource management which requires the combination of micro and macro scale approaches, water saving technique and increased water use efficiency in every activity sector and minimizing production and discharge of waste and recycling and reuse as much as possible and disposing of the remainder in an environmentally sound manner.

Tati (2005) studied the public-private partnership (PPP) for water provision in urban Congo. The study showed that the PPP arrangement did not develop as planned despite some promising early results and private enterprises ran into financial problems. He also pointed out that the role of the political environment in compromising with the potential benefits of PPP.

Pattanayak, Yang, Whittington & Kumar (2005) had found out that though the households in Kathmandu Valley spent or an average about 1% of their current income as coping cost for water which was twice as much as their monthly water bill yet their WTP for improved water services were significantly low. The study revealed that coping costs are positively correlated with WTP.

Oca & Bateman (2006) assessed WTP for maintained and improved water supplies in Mexico City, the largest city in the developing world and the result showed that the authorities could collect resources to fund household preferred schemes as well as reduce current subsidies substantially. As their study confirmed that the higher income household enjoyed better level of the current provisions and the poorer household endured lower current standards of water supply, they incorporated those with income within the scope sensitivity test. The study confirmed the difference in priorities according to the initial condition, the ranking changes when the ability to pay is equalized across society. They arrived at those results using contingent valuation survey to investigate WTP for two levels of service quality- (i) maintenance of current provision level and (ii) improvement over current provision level.

Pattanayak, Berg, Yang & Houtven (2006) had conducted WTP survey among 1800 households in Negombo town and in capital strip from the town of Kalutara to Galle and found out that the demand for piped water service in Sri Lanka was low and goal of nearly universal piped water coverage could not be achieved true. The study recommended that some policy investments such as subsidization of connection fees could be used to increase demand for pipe water but that was unclear whether the benefits of the use of such policies would outweigh the costs.

Lopez-Gunn & Cortina (2006) suggested in their research that a shift is to be encouraged towards self regulation of ground water uses, particularly development of reflexive management system. According to them institutional change is also facilitated by other factors that strengthen collaborative actions with higher level authorities that assesses self-regulations by water uses which, in turn, rely on clear boundaries, legitimate recognition of appropriates, means to facilitate rules, trust in cross-scale linkages, clear division of responsibility, institutional culture and co-management model choices.

Yamout & Jamali (2007) in their research proposed BOT (Built-Operate- Transfer) type partnership for the greater Beirut Area in the water supply sector as an effective coping strategy to alleviate the present water scarcity in the capital Beirut and its suburbs. Their study revealed that if the private sector would adopt and enforce a raising block tariff structure and take steps on endemic deficiencies related to water leaks, customer management and billing and collection problems, it would result in operating efficiency of water supply services.

Montginoul (2007) had pointed out that the current water pricing in France influenced by past pricing structure, tried to recover supply cost only and indirectly encouraged users to consume water for outdoor uses. He suggested that if the new French Water Law proposal, May 2006, would compel the user to install meters, then it would incite water uses to save not only water from public water network but also all types of water.

Bhandari & Grant (2007) discovered that water users in market centers in Nepal strongly prefer water quantity; adequate flow pressure, convenient water point locations and on the other hand rural villages placed high priority on good operation and maintenance management, convenient water point locations and reliability of supply. According to them enhancement of institutional capacity at the community level and water education are essential for the sustainability of Drinking Water Supply (DWS) in rural villages throughout Nepal. They also found out that the degree of satisfaction of the consumers influenced WTP for maintenance and operation of DWS

Schemes i.e. satisfied and highly satisfied user of market centre and rural villages, DWS Scheme in Nepal evince a low WTP for improved water supply.

The research done by Farolfi, Mabugu & Ntshingila (2007) had discovered that household income had a positive and statistically significant impact on WTP for both quantity and quality of supplied water. Distance to the water source regardless of the location (urban and rural), household head's age, education and gender were found positively associated with WTP. They also found out that more a household consumes water, the less that household was willing to pay to have improved quantity but the same household was willing to pay for improved water quality. The study also revealed that the rural households showed a much higher WTP for improved water services than urban households in Swaziland. The study suggested that there was a possibility of introducing a demand-driven program to expand the rural tap water schemes in Swaziland.

Kinfe & Berhanu (2007) had found out that the income of the households, sex of respondents, education, households year of stay, household's not using tank as a storage, wealth (ownership of the building) of a household, occupation of the respondent, household satisfaction with the existing service, and the location of the study site had positive and significant effects on WTP and family size had negative and significant effect on WTP. They recommended that the inhabitants of Addis Ababa city were willing to pay for improve water supply service if that would be provided at an affordable cost price.

Rahaman, Everett & Nue (2007) had discovered that the Government of Ghana had been grant to force to grant concession to foreign multinationals whereby they would not be required to provide the mandatory capital investment in the water sector, though they would be guaranteed a margin on their operations. The success of anti-privatization advocated in slowing the introduction of water privatization would make the act of arranging things within this field even more costly for the Government of Ghana, if the privatization initiative would be eventually implemented.

The research done by Hassanein & Khalifa (2007) revealed that an increase in the tariffs charged for water services, various forms of privatization like public-private partnership were all possible solution that could improve financial position of the utilities in developing countries and Egypt, permitting them to offer high quality service.

2.2 STUDIES IN INDIA:

Mehta M. (1993) Suggested a strategic planning approach for water supply through delineating the full set of feasible options (both technically and for different institutional contexts – Public, private or community), identifying realistic public and private costs related to each option; identifying user preferences for access to and/or improvement in water service; matching supply and demand into a sustainable set of choices depending on capital investments necessary and feasible as well as pricing level necessary and feasible; developing financing and institutional arrangement for efficient implementation and operation of system including private and community participation and related monitoring arrangement.

Suresh V. (1998a) had pointed out that India is indeed poised for substantial involvement of private sector in the field of water supply and sanitation. The realization and recognition of the possibilities for unbundling of the water supply and sanitation operations has opened up a whole new world of opportunity. According to him a consensus is emerging on the need for establishment of utilities Regulatory Board/ Commission on the lines of Telecom Regulatory Authorities either at the city level or at the state level, which may look into the large issues of equity aspects of pricing / supply / distribution, production cost and leakage reduction ensuring quality of service as well as involvement of private sector with special reference to urban utilities.

Suresh V. (1998b) had pointed out that initiatives are underway to develop a legal, institutional, fiscal and financial structure for urban infrastructure delivery, which is

responsive to the needs of commercialization, and in the line with the new economic reality in India. He suggested that there should be attempts to involve all stakeholders in urban development in infrastructure development projects through Public-Private People-Partnerships (PPPP). He also mentioned that commitment from policy makers and political commitment would be essential to arrive at a comprehensive liberalized environment for urban development.

Singh et al. (1993) described the situation of water supply in rural Kerala (India), India as "low-level equilibrium trap" as water system provided a low level of service with few yard taps. The monthly tariff from household connections was low. With the help of WTP survey, the researches suggested that there might be possibility of lifting the system out of this trap by making few critical policy changes, encouraging private connections through high tariff and thus the system could be lifted up to a "high level equilibrium" in which there would be many connections, greatly increased monthly revenues and improved consumer welfare.

Pathak (1996) had discovered that revenues generated by municipal corporations and infrastructure agencies through taxes and user charges were not adequate to meet the O & M cost of various services in spite of their attempt to revise water rates. The study revealed that there was wide variation in the water pricing structure in Indian cities.

Patra and Pradhan (2005) in their research created a complete geo-spatial database for monitoring water and air quality for the whole state of Gujarat, India. With the data on air and water quality, the community can address both water quality issues and ambient air quality. Using the data in design and implementation of water supply project can result in (i) improved water quality (ii) reduction of pollutant loading in downstream receiving water and (iii) reduction in water treatment cost.

World Bank (2006) studied the coping costs, WTP and affordability for Delhi Water Supply and Sewerage services and found out that income, household size, education of respondents, coping cost currently being borne, quality of water consumed,

ownership of the building, adequacy of current supply, present provision of a bore well, current water pressure influenced households WTP for improved services. The study also discovered that all middle and high income households of Delhi and 44% of low income households can afford water tariff to cover cost of operation, interest, and depreciation and 68% of low income households can afford to pay water tariff to cover operating cost only.

Guha (2008) discovered that consumers' willingness to pay for clean water supply in Kolkata, India, exceeded the production and maintenances cost. The study revealed that the affordability for water supply and sanitation Kolkata is more than that fixed by Asian Development Bank (2001) i.e. 5% of household income.

2.3 MEASURING WTP:

With the help of Contingent Valuation (CV) method, people are asked directly to report their willingness to pay to obtain a specific good that is not exchanged in regular markets or it is difficult to observe market transactions under the desired conditions. The different WTP elicitation techniques are –

(i) Open ended questions to know respondents WTP. This technique results in many missing values as respondents may find difficulty in answering the payment questions.

(ii) Iterative bidding approach of querying respondents at some initial value and keeps rising (lowering) the value until the respondent declines (accepts). The final value is the respondents' WTP. That approach tends to result in starting point bias.

(iii) Asking respondents to choose the amount from cards showing the possible WTP values. The amount thus chosen by the respondents can be taken as the respondents' WTP. In this approach the respondents have to limit their announced WTP to the values listed on the cards.

(iv) In dichotomous approach, a dichotomous choice payment question asks the respondent if he/she would pay $X (the bid value) to obtain the good. There are only two possible responses to a dichotomous choice payment question: "yes" or "no". The WTP for the respondents can not be found out when their answers are "no" to the bid value.

(v) A follow-up question may be added to the dichotomous choice payment question to overcome the problem of negative responses. It may be lowering the original bid value. It is also possible to introduce a second follow-up question or an open-ended follow-up question like "What are the most you would pay for the good?"

(vi) In Polychotomous choice, multiple bounded CV survey, respondents are presented with a panel of bid values and asked to choose the amount which they feel that they would pay. The bid values may be arranged in a matrix with different degree of satisfaction. Though this approach may lead to better result but respondents find difficulty in understanding the question.[3]

UNCHS (Habitat) and its Community based Environmental Management Information System (CEMIS) project started a research initiative aimed at developing and testing a manual for assessing effective demand by communities for infrastructures like drainage, sanitation, water supply services in Jakarta and Indonesia. Herein the communities are trained to assess their own demand for services through community self surveys and community workshop. The community leader and volunteers are used here which reduces the need for external resources, and lead to community empowerment and determination. Mobilization of locally available information and resources is done here. After community mobilization a community level meeting is called by the community leader to discuss the problems and prioritize them. For example, in case of water supply, community would decide to determine effective demand for water. In the beginning, a workshop would be organized for community volunteers to familiarize them with the methodology and develop a plan for self survey, then the survey would be conducted by the volunteers. The data is collected, analyzed and presented in a community meeting. From this, the commitment of

[3] FAO CORPORATE DOCUMENT REPOSITORY. (2000).

individual households to contribute to the provision, operation and maintenance of water supply service can be arrived at.[4]

The different WTP elicitation techniques and their limitations are as follows:

Technique	Limitation
1) Open Ended Questions	Respondents find difficulty in answering.
2) Iterative Bidding Approach	Starting value biased.
3) Card Approach	Responses are limited to the values on the card.
4) Dichotomous Choice Approach	WTP can not be found out for negative answers.
5) Dichotomous Choice Approach with a follow-up Question	It may lower the original bid value.
6) Polychotomous Choice Approach, Multiple Bounded Survey	Respondents find it difficult to understand.
7) Technique adopted by UNCHS (Habitate) and CEMIS	Costly and time consuming.

Table 2.3.1 **Limitations of different WTP elicitation techniques.**

2.4 CHARACTERISTICS OF 'DRINKING WATER':

Throughout history man derived systems to purify water for drinking purpose. The purification of drinking water using liquefied Chlorine gas was developed in 1910 by US Army Major Darnall, Professor of Chemistry, Army Medical School. After that Col. Lyster, Army Medical Department used a solution of Calcium Hypochlorite in a linen bag to treat water. US ground forces had been using this technique for many decades. The basis for present day's system of municipal water purification is the method developed by Darnall.

[4] Dzikus A. (1996).

The necessity of purifying water was also known in ancient India. The book "Sushurt Sanhita" compiled in 2000 BC in Sanskrit mentioned the following –

- "It is good to keep drinking water in copper vessel. Expose it to sunlight and filter it through charcoal."
- "Contaminated / polluted water should be boiled first and then exposed to sunlight. Then a piece of hot copper should be dipped in it several times and finally filtered through coarse sand."

Drinking water quality has a microbiological and physiochemical dimension. There are thousand of parameters of water quality as per WHO guidelines for Drinking Water Quality Vol. 1 – 1993.

Sl. No.	Characteristics	Acceptable	Cause for Rejection
1.	Turbidity (Nephelometric Turbidity Unit)	1	10
2.	Colour (units on Platinum Cobalt scale)	5	25
3.	Taste and Odour	Unobjectionable	Objectionable
4.	pH (pH units)	7.0 to 8.5	<6.5 or >9.2
5.	Total dissolved solids (mg/l)	500	2000
6.	Total Hardness (as $CaCO_3$) (mg/l)	200	600
7.	Chlorides (as Cl) (mg/l)	200	1000
8.	Sulphates (as SO_4) (mg/l)	200	400
9.	Florides (as F) (mg/l)	1.0	1.5
10.	Nitrates (as NO_3) (mg/l)	45	45
11	Calcium (as Ca) (mg/l)	75	200
12.	Magnesium (as Mg) (mg/l)	≤ 30	150
13.	Iron (as Fe) (mg/l)	0.1	1.0
14.	Manganese (as Mn) (mg/l)	0.05	0.5
15.	Copper (as Cu) (mg/l)	0.05	1.5

16.	Aluminium (as Al) (mg/l)	0.03	0.2
17.	Alkalinity (mg/l)	200	600
18.	Residual Chlorine (mg/l)	0.2	>1.0
19.	Zinc (as Zn) (mg/l)	5.0	15.0
20.	Phenolic compounds (as Phenol) (mg/l)	0.001	0.002
21.	Anionic detergents (mg/l) (as MBAS)	0.2	1.0
22.	Mineral Oil (mg/l)	0.01	0.03
	TOXIC MATERIALS		
23.	Arsenic (as As) (mg/l)	0.01	0.05
24.	Cadmium (as Cd) (mg/l)	0.01	0.01
25.	Chromium (as hexavalent Cr) (mg/l)	0.05	0.05
26.	Cyanides (as CN) (mg/l)	0.05	0.05
27.	Lead (as Pb) (mg/l)	0.05	0.05
28.	Selenium (as Se) (mg/l)	0.01	0.01
29.	Mercury (total as Hg) (mg/l)	0.001	0.001
30.	Polynuclear aromatic hydrocarbons (PAH) (µg)	0.2	0.2
31.	Pesticides (total, mg/l)	Absent	-
	RADIO ACTIVITY		
32.	Gross Alpha activity (Bq/l)	0.1	0.1
33.	Gross Beta activity (Bq/l)	1.0	1.0
	BACTERIOLOGICAL QUALITY		
Sl. No.	Organism	Guideline value	
34.	(for all water intended for drinking) E. coli or thermotolerant coliform bacteria	Must not be detectable in any 100-ml sample	
35.	(for treated water entering the distribution system) E. coli or thermotolerant coliform bacteria Total coliform bacteria	 Must not be detectable in any 100-ml sample Must not be detectable in any 100-ml sample	

36.	(for treated water in the distribution system) E. coli or thermotolerant coliform bacteria Total coliform bacteria	 Must not be detectable in any 100-ml sample Must not be detectable in any 100-ml sample. In case of large supplies, where sufficient samples are examined, must not be present in 95% of samples taken throughout any 12 month period.

Table 2.4.1 **Recommended guidelines of WHO for physical, chemical parameters and bacteriological quality of drinking water.**

2.5 SOME DEFINITIONS:

As per the Census of India, 2001; the definitions of different urban areas are as

a) Statutory Town - all places with Municipality Corporation, Cantonment Board or Notified Town Area Committee etc. so declared by state law,

b) Census Town - Places which satisfies the criterion

i) A minimum population of 5000

ii) Atleast 75 % of male working population engaged in non agricultural pursuits

iii) A density of population of atleast 400 persons per Sq. Km.

c) Urban Agglomeration -

i) A city or Town with one or more contiguous outgrowths,

ii) Two or more adjoining towns with their outgrowths and

iii) A city or one or more adjoining towns with their outgrowth all of which form a continuous spread. The core town or atleast one of the constituent towns within the agglomeration should necessarily be statutory town and that the total population of all constituent should be a minimum of 20,000.

CHAPTER - III

RESEARCH METHODOLOGY

CHAPTER - III

RESEARCH METHODOLOGY

3.1 RESEARCH GAP:

A number of studies have been carried out on sustainability of drinking water schemes for urban as well as rural areas in the international level. Miller & Lewis (1987); Whittington, Okorafor, Okore & Mcphail (1990b); Bohm, Essenburg & Fox (1993); Altaf, Whittington, Jamal & Smith (1993); Howe & Smith (1993); Howe & Dixon (1993); Piper & Martin (1997); Ngowi (1997); James (1998); Hoehn & Krieger (2000); Neumayer (2001); Njiru & Sansom. (2001); Bahri (2001); Tati (2005); Pattanayak, Yang, Whittington & Kumar (2005); Oca & Bateman (2006); Pattanayak, Berg, Yang & Houtven (2006); Lopez-Gunn & Cortina (2006); Yamout & Jamali (2007); Montginoul (2007); Bhandari & Grant (2007); Farolfi, Mabugu & Ntshingila (2007); Kinfe & Berhanu (2007); Hassanein & Khalifa (2007) are some of the researchers who have contributed to this field of study.

Again in India, a few studies have been done in this field and some of these were carried out by Mehta M. (1993); Suresh V. (1998a); Suresh V. (1998b); Singh et al. (1993); Pathak P. (1996); Patra and Pradhan (2005); World Bank (2006); Guha S. (2008). These studies were mainly confined to WTP for improved water supply.

Such a study has not been done in North East India. Most of the Indian studies focused on WTP in terms of monthly tariff. The literature review suggests that no study appears to have focused on WTP in project finance and involvement of users in the operation of a water supply scheme. In North East region of India, states like Assam, Meghalaya and Nagaland seem to have experienced a decline in access to piped water[1]. The percentage of households having access to piped water in the study area is 6.66% which is far below the national average of 74 %[2]. This has been revealed from secondary data.

This demonstrates the importance of the study. The current study also tries to find out consumers willingness to pay for an improved water supply scheme in Tezpur Urban Agglomeration. Consumer perception about existing water supply as well as desired water supply is analyzed. The study also tries to identify avenues of consumer involvement in such a scheme.

3.2 JUSTIFICATION OF THE STUDY:

To the best of the researcher's knowledge no attempt has been made to assess the functioning of the water supply service of Tezpur Urban Agglomeration (TUA). This study proposes to identify the gap between the desired water supply service in TUA and the existing one.

Literature review has highlighted that

(a) consumer should pay for water supply service.
(b) focus should be on revenue generation through domestic connection.
(c) such services should be appropriately priced.

Keeping this in mind, the study proposes to make an assessment of how much the consumers are willing to pay a for water supply service. It would also like to assess

[1] World Bank. (2006).
[2] Census of India. (2001).

their willingness to finance a water supply scheme and finally the level of involvement that can be expected from the consumers in terms of operation and maintenance of the scheme.

These above parameters then can be kept in mind while designing future water supply schemes in TUA area.

3.3 OBJECTIVES:

Based on the problem definition in Chapter I and the literatures reviewed in Chapter II, the objectives for the study was set as follows:

1. To assess the demand for water supply in TUA area.

2. To identify the gap between existing and desired service.

3. To assess the "Willingness to pay" attitude of the household in the study area, both in terms of monthly tariff and towards project cost.

4. To suggest an appropriate mechanism for ensuring the success of future water supply projects in TUA area.

3.4 METHODOLOGY USED:

To fulfill the objectives of the research a research plan was designed. Data was collected from secondary sources to get a picture of the existing water supply scenario. Primary data was collected to find out the gap between the existing and desired water supply service, to assess WTP, and preferred mode of involvement of the consumers in a water supply scheme.

3.4.1 SAMPLE SURVEY:

A sample survey was carried out in Tezpur Urban Agglomeration. A draft questionnaire was designed after studying WTP survey of similar nature and a Pilot Survey was carried out during June 2004 among 27 respondents. The pilot survey highlighted some points to be added to elicit information about the existing as well as desired level of water supply services. Modifications were made and the questionnaire was finalized. A total number of 700 questionnaires were distributed out of which 300 questionnaires could not be included because of the respondent's unwillingness to answer all the questions and/or contradictory answers. Finally 400 questionnaires were found to be complete in all aspect and considered for analysis.

3.4.2 SAMPLING UNITS:

The units in the population are the "household" in case of individual consumer and the "institution" in case of Institutional consumers. The interviews were taken during July to October 2005. Stratified sampling method was employed for individual consumers and convenience method was used for institutional consumers.

3.4.3 SAMPLE SIZE:

The sample sizes for most of the WTP surveys for improved water supply schemes were found as 202 (Guha S. 2008), 205 (Bhandari et al., 2007), 240 (Roy J. 2003), 10,000 (World Bank, 2006).

Farolfi et al. (2007) conducted WTP survey for their research on improved water supply in Swaziland. The sample size was 374 from a population of 2,33,843 households and were equally weighted for the two strata, rural and urban.

Again Kinfe G et al. (2007) carried out a similar survey for their research in Addis Ababa with 240 samples from a total 1,26,108 household. They divided the study area in three strata and samples were equally weighted for each stratum.

For the present study the sample size is confined to 379 for a population of 20,681 households and 21 institutions were covered.

Locality / Consumer Category		Individual		Institutional		Total
		With Connection	Without Connection	With Connection	Without Connection	
Urban	Population (Household)	1002	14343			
	Samples	72 (7.68%)	166 (1.12%)	10	6	254
Rural	Population (Household)	376	4960			
	Samples	43 (12.50%)	98 (1.90%)	1	4	146
Total	Population (Household)	1378	19303			
	Samples	115 (9.14%)	264 (1.77%)	11	10	400

Table 3.1 **Localitywise & Consumer Categorywise Breakup of the Sample**

3.4.4 SAMPLING FRAME:

In the study area, some localities viz. Tezpur town, Majgaon, Barikachuburi, Deurigaon and Parbatia have water supply schemes and the other localities viz. Bamunchuburi, Dekargaon and Hazarapar Dekargaon do not have water supply schemes. From the concerned authorities dealing with water supply in those areas, the list of households with water supply connections were collected. Once the households with water supply connection were identified; the households without water supply connections were found out. Thus a sampling frame was defined for individual consumers.

For institutional consumers sampling frame could not be defined.

Area	No. of House-holds	No. of Households/ Institutions Having Water Supply Connection		No. of Households/ Institutions Without Water Supply Connection	
		N[3]	n[4]	N	n
URBAN 1.Tezpur Town	15345	1055 Total 1002 H/H 53 Inst.	82 Total 72 H/H 10 Inst.	14343	172 Total 166 H/H 6 Inst.
(i)Ward No.1	967	27	6	940	9
(ii)Ward No.2	1004	38	3	966	10
(iii)Ward No.3	2492	18	2	2474	10
(iv)Ward No.4	183	7	2	176	11
(v)Ward No.5	287	137	10	150	4
(vi)Ward No.6	1049	116	6	933	7
(vii)Ward No.7	529	69	3	460	9
(viii)Ward No.8	647	118	8	529	8
(ix)Ward No.9	469	166	6	303	9
(x)Ward No.10	345	49	6	296	9
(xi)Ward No.11	418	152	12	266	6
(xii)Ward No.12	951	33	5	918	10
(xiii)Ward No.13	948	70	5	878	10
(xiv)Ward No.14	870	49	7	821	7
(xv)Ward No.15	1009	6	6	1003	8
(xvi)Ward No.16	858	0	0	858	10
(xvii)Ward No.17	613	0	0	613	10
(xviii)Ward No.18	258	0	0	258	10
(xix)Ward No.19	1448	0	0	1448	10
RURAL	5336	377 Total 376 H/H 1 Inst.	44 Total 43 H/H 1 Inst.	4960	102 Total 98 H/H 4 Inst.
2.Mazgaon	1550	122	22	1428	20
3.Bamunchuburi	867	0	0	867	16
4.Barikachuburi	1328	210	12	1118	10
5.Deurigaon	334	25	10	309	12
6.Dekargaon	391	0	0	391	16
7.Hazarapar Dekargaon	217	0	0	217	11
8.Parbatia	649	20	4	629	13

Table 3.2 **The Sampling Frame for Individual Consumers**

[3] N = Population
[4] n = Sample

3.4.5 QUESTIONNAIRE:

All the questions of the questionnaire were closed ended except two. There were three questions using 5 point Likert scale, 1 question using 7 point Likert scale and 11 questions with multiple choice answers. 8 questions were also designed to know the personal details of the respondents with multiple choice answers except the last two wherein respondent's name and address were recorded. (A Questionnaire is provided in Annexure – **VII**)

3.4.6 *VARIABLES MEASURED:*

Water supply service quality has many dimensions as continuity, water quality, pressure, and degree of responsiveness of service provider to customer complaints [WHO guidelines, 1993]. Drinking water quality has microbiological and physiological dimensions as Iron content, Fluoride content, Arsenic content, Lead content, Pesticide, Total coliforms, Faecal coliforms, Calcium content, Chloride content etc. [WHO guidelines for drinking water quality volume 1 & 3, 1993 in CPHEEO Manual on Water Supply and Treatment, 1999]. To study the existing level of water supply service 20 statements were measured across three questions. Again to study the desired level of water supply service 16 statements were measured. Statistics of these responses were calculated from the frequency table.

3.4.7 DATA ANALYSIS:

The data collected was analyzed using Statistical Package for the Social Sciences i.e. SPSS 11.0 version. The analytical instrument used for exploring relationship and significant differences included the statistical test such as independent sample T test of equality of means, and chi-square test.

Mean scores were used to prioritize the variables of a proposed water supply scheme in the case study area.

3.5 LIMITATION OF THE STUDY:

The study has some limitations. The study area was selected purely on the basis of convenience, although attempt was made to include respondents from each section i.e. rural/ urban; with home connection/ without home connection and individual/ institutional.

Though the most widely used model in Contingent Valuation studies is based on logistic regression, in the study the WTP was calculated by using an adapted version of the Card Approach (mentioned in Chapter - **II**). Different payment ranges were offered and respondents had to select any one. Based on these responses the weighted average was calculated to obtain the amount that respondents were willing to pay on an average.

Only preliminary financial analysis has been done for a water supply project in TUA since "Willingness to Pay" was the major focus of the study. Social cost benefit analysis was not done in this study.

In case of institutional respondents, some institutions were found to be operational in rented building constructed for residential use. The water line connected to that building was that of residential connection although the function of the building was institutional. Such cases had to be dropped.

Rejection of 300 questionnaires, mainly due to incomplete and contradictory responses may have affected the stratawise sampling size. This may affect the ultimate result of the study.

The questionnaire was prepared in English. Some respondents found it difficult to understand the questions and the questions alongwith the technical terms had to be explained to the respondents in their mother tongue.

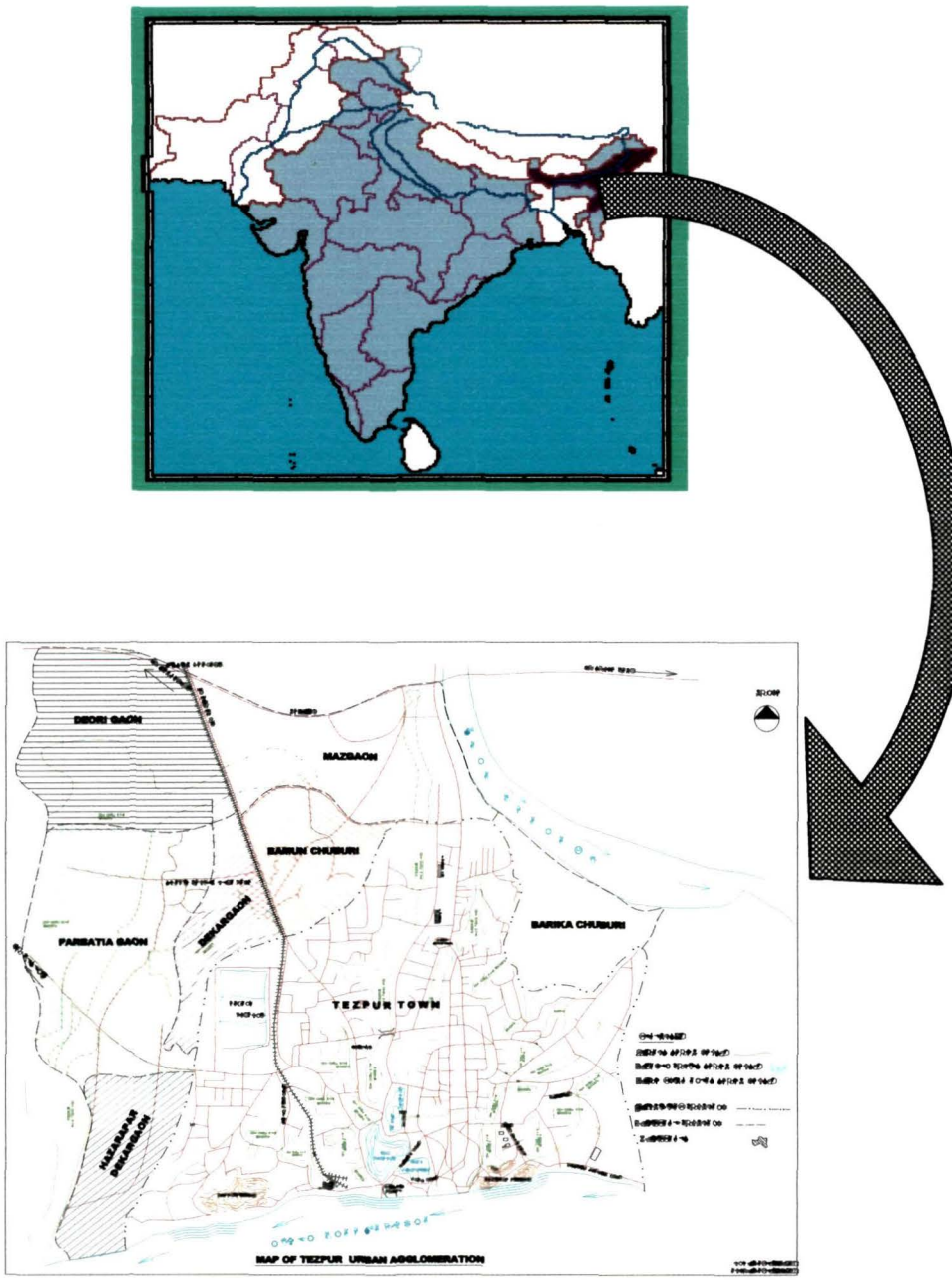
3.6 SCOPE OF THE STUDY:

The study is confined to the water supply system of Tezpur Urban Agglomeration (Census of India, 2001). The study focuses on Tezpur Town and seven neighbouring villages viz. Hazarapar Dekargaon, Parbatiagaon, Da-Parbatiagaon, Deurigaon, Majgaon, Bamunchuburi, and Barikachuburi.

3.7 AN INTRODUCTION TO THE STUDY AREA:

Tezpur town is the administrative head-quarter of Sonitpur district, Assam, India. Over the years, this town has emerged as one of the few major urban centers of Assam and North Eastern Region of India. Apart from the district head-quarter, Tezpur is the head-quarters of North Assam Division, 4-Corps Army Division, Air Force Station and Shashatra Seema Bal (S.S.B.). It is also the prime centre of education as Tezpur University, Defence Research Laboratory, Lokapriya Gopinath Bordoloi Institute of Mental Health, North East Regional Institute of Land and Water Management (NERIWALM), all of which are sponsored/ funded by the Government of India, are located in and around Tezpur town. As a centre of tourist attraction, Tezpur has many archaeological and cultural heritage sites, and abundance of scenic beauty. It has close proximity to Kaziranga National Park and other wild life sanctuaries/ parks in Assam and Arunachal Pradesh. Tezpur is one of the prime trade & commerce centres in North Assam.

Tezpur town is situated on the north bank of river Brahmaputra, 181 KM away from Guwahati, the capital of Assam and within $26^0 38'$ N latitude and $92^0 48'$ E longitudes. (Further details are provided in Annexure - **VIII**)



Map 3.1 **Map showing the location of the study area**

CHAPTER - IV

DATA ANALYSIS

CHAPTER - IV

DATA ANALYSIS

4.1 DEMOGRAPHIC DETAILS:

Q16 to Q23 of the questionnaire elicited details about the respondents and the demographic profile is as follows.

Q16. Majority of the respondents (86%) resided in their own houses.

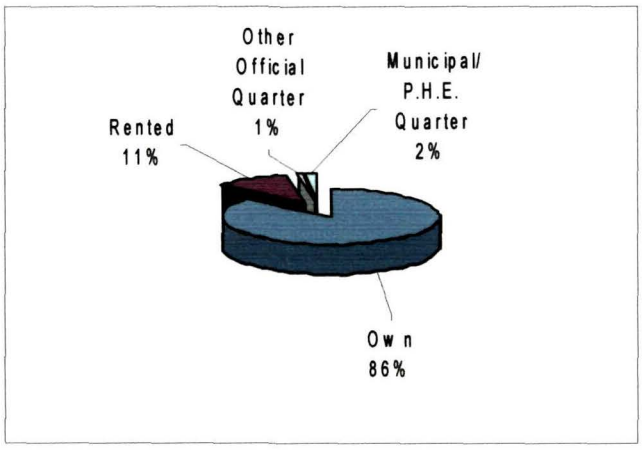


Fig. 4.1.1 **Ownership of Building**

Q17. 94.75 % respondents had their own arrangements for water supply service.

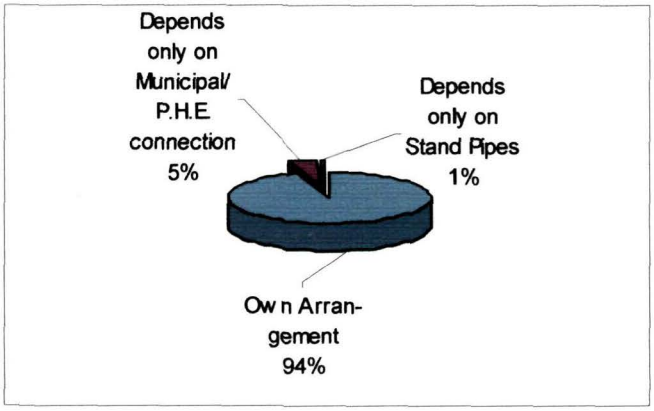


Fig. 4.1.2.1 **Water Supply Arrangement -1**

The sample predominantly had ring well[1] (45%), followed by ring well and a home connection (19%). A small portion (8%) had ring well and a piped water[2] facility.

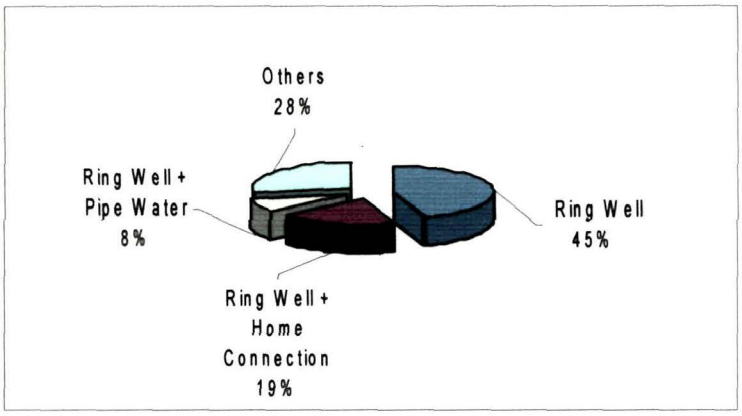


Fig. 4.1.2.2 **Water Supply Arrangement -2**

Q18. The average size of the household of individual samples was 5.7[3]. [Institutions do not figure here.]

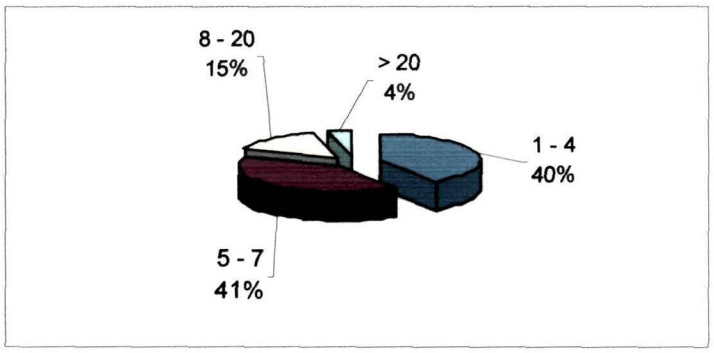


Fig. 4.1.3 **Household size**

[1] Ring Well is a dug well of built type. Instead of constructing the side wall, pre-cast R.C.C. rings are placed upto the bottom to prevent seepage of water from sides.
[2] Piped Water is an arrangement of water that flows through pipes of the water supply system, from the service provider to the consumers' home.
[3] Calculation is at Annexure – XIII a).

Q19. The break-up of respondents by their occupation was as follows -

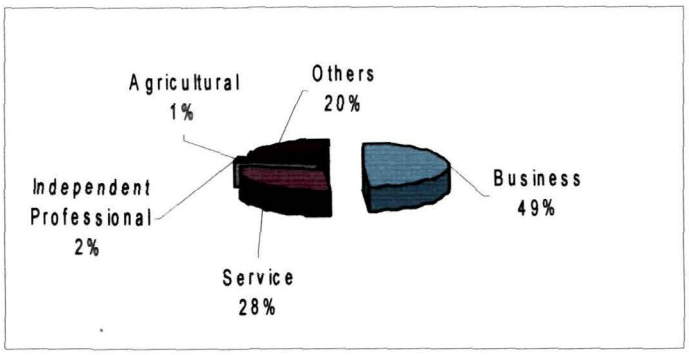


Fig. 4.1.4 **Occupation**

A large number of the respondents were business person (49%). This was followed by service holders (28%).

Q20. Majority of the respondents (40%) earned less than Rs.10,000/- per month .

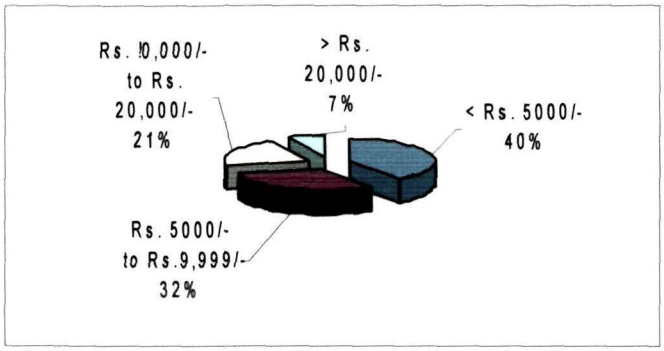


Fig. 4.1.5 **Monthly Income**

The average monthly income of individual samples was Rs. 7822.74/-[4].

[4] Calculation is at Annexure – XIII b)

Q21. The educational qualification of the home-manager[5] was as follows -

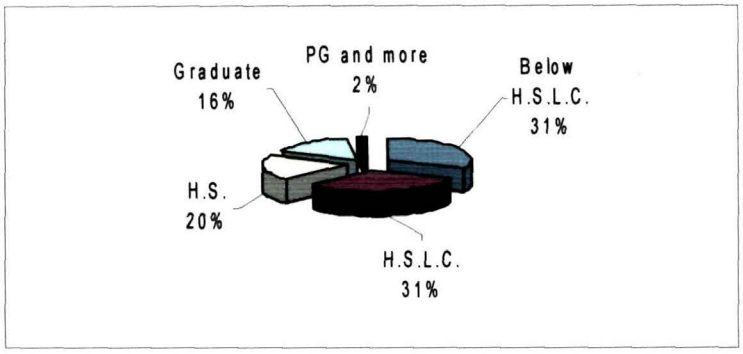


Fig. 4.1.6 **Educational Qualification of Home-managers**

Majority of the home-managers were not degree holders and a substantial number of respondents (31%) did not even have the basic qualification of High School Leaving Certificate (H. S. L. C.)

Q22. The respondents as per consumer category were -

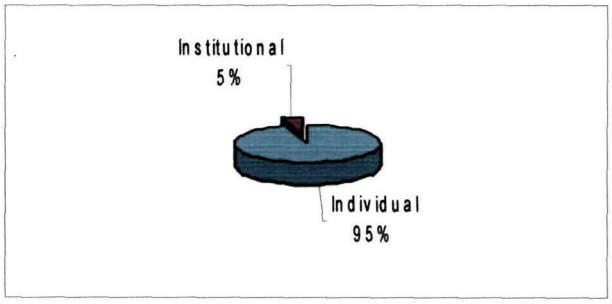


Fig. 4.1.7 **Consumer categorywise respondents**

95% of the respondents were individual households.

[5] Home-manager refers to the housewife or the lady of the household.

Q23. The respondents as per locality were -

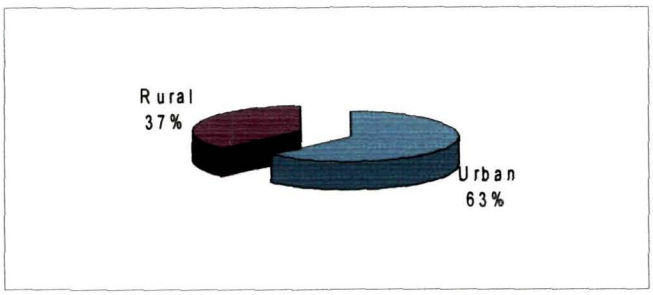


Fig. 4.1.8 **Localitywise respondents**

Majority of respondents (63%) were from urban area.

Thus the average respondent of the sample was a household located in urban area having a family size of 5.7 and average monthly income of Rs. 7822.74/-
The sample break-up is as follows -

Consumer Category / Area	Individual	Institutional	Total
Urban	238	16	254
Rural	141	5	146
Total	379	21	400

Table 4.1.1 **The Sample**

4.2 EXISTING WATER SUPPLY INFRASTRUCTURE:

The existing water supply scenario in TUA can be summarized from the data collected from secondary sources as follows –

Sl. No.	Town/ Village	Water Supply Scheme		Connections			Yearly Av. O&M Cost (Rs. in Lakhs)	Duration of Supply Hours Per day
		Year of Func-tioning	Capacity In MLD[6]	Home Connections	Institutional Connection	Stand Pipes		
1.	Tezpur		9.00	1002	53	20	25.94	4
2.	Barika Chuburi		0.10	210	-	21	1.50	4
3.	Bamun Chuburi	-	-	-	-	-	-	-
4.	Majgaon	1986	0.18	122	1	17	1.50	4
5.	Dekargaon	-	0.10	-	-	-	-	-
6.	Parbatia Gaon	1989	0.08	20	-	20	1.50	4
7.	Deori Gaon	1991	0.11	25	-	35	1.50	4
8.	Hazarapar Dekar Gaon	-	-	-	-	-	-	-

Table 4.2.1 **Existing Water Supply Scenario in the study area**
Source: Tezpur Municipal Board, Public Health Engineering Department, Tezpur, 2005

The coverage of piped water supply in Tezpur Town as well as in the surrounding village in very poor. In town area the coverage is only 6.53 %[7] and in village areas the coverage is only 7.05 %[8] and overall it is only 6.66%[9]. These percentages may improve a bit high if population covered by stand pipes is taken into account.

Both in Town and village areas, the duration of supply is 4(Four) hours per day as per official record but in reality it is observed that there is only one hour of water supply in the morning and irregular supply of water for near about an hour in the evening.

[6] MLD=Million Litres per Day
[7] (1002/15345) * 100 = 6.53%
[8] (376/5336) * 100 = 7.05%
[9] (1378/20681) * 100 = 6.66%

Sometimes water is supplied without any treatment. Moreover, the supply is also not uniform.

The stand pipes are not conveniently/ proportionately distributed and in some places these are located far away from the households which lead to high water loss as stand pipes are without having a stop cork.. So, in these areas people do not want to collect water from street taps except for bare necessity.

Water supply in the case study area is at a subsidized rate. At present all the water supply schemes in this area depend on grant. The revenue generated from connection charge and monthly tariff are not enough to cover the maintenance cost of the scheme.

For the Tezpur Water Supply Scheme HUDCO had sanctioned an amount of Rs. 795.00 Lacs as loan assistance, of which Rs. 701.70 Lacs was released to the Assam Urban Water Supply and Sewerage Board (AUWSSB) in 1991. (Further Details about AUWSSB are provided at Annexure – **IX**) After completion of 100% work of land acquisition, 50% work of the intake point, 10% work of raw water pumping main and 40% work of treatment plant, the scheme had stopped as the contractor engaged by the Board had lodged a court case in the Hon'ble Gauhati High Court, Guwahati seeking compensation for price escalation. Till date the case has not been settled. The old water supply scheme constructed by PHED in the year 1970 and run jointly by Tezpur Municipal Board and District Administration is catering to the water supply needs in a partial manner.

The following table shows the receipt and expenditure of Tezpur Municipal Board for the last five financial years from 2003-04 to 2007-08.

Year	Total Receipts (Rs. In Lakhs)	Total Expenditures (Rs. In Lakhs)
2003-04	19.30	17.84
2004-05	13.99	16.31
2005-06	10.18	11.10
2006-07	13.87	17.24
2007-08	16.34	19.66

Source: Tezpur Municipal Board, 2008

Table 4.2.2 **Receipt and expenditure of Tezpur Municipal Board for the last five financial years**

The income is generated through water tax, connection charge, bulk supply of water and monthly tariff and the expenditure made for payment of staff salary, repairing in the distribution network, buying of purification material like alum etc. and interestingly it was found out that the electrical bills had not been paid for years together. Inspite of non-payment of electricity bills, it was reported that Assam State Electricity Board (ASEB) has been continuing to supply power because of the assurance given by the District Administration of Sonitpur District, Assam, India. The table also shows that from 2004 onwards, expenditure has been higher than income.

Q1. The respondents were asked to give their reactions to statements pertaining to municipal/ PHE water supply[10]. The responses were:

Sl. No.	Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	The quantity of water received is inadequate.	4.4%	8.8%	10.2%	35.0%	41.6%
2.	The water received, contains excessive iron.	1.5%	15.3%	19.0%	51.8%	12.4%
3.	The water received is found to be muddy sometimes.	0.0%	11.7%	19.0%	56.2%	13.1%
4.	Water supply timings are irregular.	1.5%	7.3%	15.3%	35.8%	40.1%
5.	Water pressure is inadequate.	2.2%	16.8%	14.6%	40.1%	26.3%
6.	The water supply depends on power supply.	0.0%	1.5%	16.1%	30.7%	51.8%
7.	Additional water is collected from other sources to meet the demand.	1.5%	0.7%	13.1%	36.5%	48.2%
8.	The monthly tariff is too high.	21.9%	19.0%	38.0%	8.0%	13.1%
9.	The concerned authority does not respond promptly to the complaints.	0.0%	2.9%	28.5%	35.8%	32.8%
10.	Disconnection is done now and then.	24.1%	16.8%	43.1%	11.7%	4.4%
11.	Privatization will lead to better operation and maintenance of the existing system.	0.0%	0.0%	24.1%	27.7%	48.2%

Table 4.2.3 **Perception about existing municipal/PHE Water Supply**

From the above table, we can draw the following inferences. The respondents perceived the water quantity to be inadequate and water supply timings to be irregular. The water pressure was also felt to be inadequate. Most respondents were aware that water supply was dependent on electricity. Regarding water quality the

[10] Municipal water refers here the water supplied by Tezpur Municipal Board through pipe network and PHE water refers the water supplied by Public Health Engineering Department, Government of Assam through pipe network. .

respondents felt that it contained excessive iron and was at times muddy. The respondents had to collect water from other sources to meet their needs.

A small minority (21.1%) felt that the tariff was too high; 40.9% did not agree to this and 38% remained indifferent. It was perceived that water supply authorities did not respond promptly to complaints. A few respondents thought that disconnection of water supply occurred now and then. 75.9% of respondents believed that privatization would lead to better operation and maintenance of the existing schemes, 24.1% were indifferent and it is significant to note that not a single respondent disagreed on this issue.

Q2. The respondent's perceptions about their own water supply were:

Sl. No.	Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	The water contains excessive iron.	3.2%	3.2%	21.1%	60.9%	11.6%
2.	The water contains some foreign particles.	4.2%	5.0%	34.0%	50.4%	6.3%
3.	The water sometimes has foul odour.	10.8%	4.2%	64.6%	20.1%	0.3%
4.	Without treatment, one should not use this water for treatment.	0.0%	0.0%	20.3%	74.7%	5.0%
5.	Money is spent on water purification.	0.0%	0.0%	22.7%	72.6%	4.7%
6.	Water dries up and becomes muddy during winter.	0.0%	0.0%	14.5%	33.5%	52%

Table 4.2.4 **Perception about own Water Supply**

The following inferences can be drawn, from the above table. Regarding water quality, the respondents felt that it contained excessive iron as well as some foreign particles. A few respondents thought that the water sometimes had foul odour; majority were neutral on this issue.

It was perceived that without treatment the water could not be used for drinking and money was spent in this process. Most significantly not a single respondent disagreed to these. 85.5% respondents agreed to the water shortage/ muddy water during winter, 14.5% were indifferent and significantly no respondent disagreed in this case also.

Q3. The respondent's perceptions about stand pipes were:

Sl. No.	Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	A lot of time is spent standing in queue.	0.0%	0.0%	9.5%	47.6%	42.9%
2.	Stand pipes are located at a distance from the house.	0.0%	0.0%	4.8%	61.9%	33.3%
3.	Only drinking water is collected from it.	0.0%	4.8%	9.5%	42.9%	42.9%

Table 4.2.5 **Perception about Stand Pipes**

From the above table, the following inferences can be drawn. The respondents perceived that waiting time was long and the locations of stand pipes[11] were located far from the houses and most significantly no respondent disagreed to these.

A small minority (4.8%) did not feel that only drinking water was collected from stand pipes; 85.8% agreed to this and 9.5% remained indifferent.

The above responses do not tell us whether the perceptions are uniform across different demographic profile. It was important to understand whether the perceptions were same or differed in terms of locality and consumer category. Therefore, two hypotheses were tested for the questions 1 to 3. The results of Levene's test for equality of means in respect to locality are presented in the following tables.

$\mathbf{H}_0$: The perceptions of respondents are independent of the locality.

$\mathbf{H}_1$: The perceptions of respondents are dependent on the locality.

[11] Stand pipes are water taps generally provided at road side for poor people who can not afford to have a home connection.

Statements Q.1 (with home connection)	Mean Scores		t	df	Sig[12] (2tailed)	Remarks
	Urban	Rural				
1. Adequacy of water	3.91	4.18	1.42	116.55	0.16	Not Rejected
2. Iron content	3.28	4.12	6.72	126.81	0.00	Rejected
3. Mud content	3.54	4.00	3.53	132.09	0.00	Rejected
4. Supply timings	3.98	4.20	1.27	135.00	0.21	Not Rejected
5. Water pressure	3.61	3.90	1.56	114.25	0.12	Not Rejected
6. Dependent on power supply	4.22	4.52	2.50	134.90	0.01	Rejected
7. Collection of additional water	4.18	4.48	2.25	131.97	0.03	Rejected
8. Monthly tariff	3.06	2.12	4.45	135.00	0.00	Rejected
9. Response to complaint	3.99	3.98	0.06	135.00	0.96	Not Rejected
10. Disconnection	2.86	2.02	4.57	135.00	0.00	Rejected
11. Privatization	4.09	4.50	2.88	135.00	0.00	Rejected

Table 4.2.6 **Mean Scores of Perception on Municipal/PHE Water Supply, Localitywise**

Statements Q.2 (own water supply)	Mean Scores		t	df	Sig (2tailed)	Remarks
	Urban	Rural				
1. Iron content	3.68	3.86	2.30	371.99	0.02	Rejected
2. Foreign particles	3.43	3.60	1.98	349.41	0.049	Rejected
3. Foul odour	2.95	2.94	0.06	377.00	0.95	Not Rejected
4. Treatment of water	3.78	3.97	3.96	340.92	0.00	Rejected
5. Money is spent on purification	3.73	3.97	5.00	339.25	0.00	Rejected
6. Water dries up during winter	4.33	4.45	1.67	377.00	0.095	Not Rejected

Table 4.2.7 **Mean Scores of Perception on own Water Supply, Localitywise**

Statements Q.3 (Using Stand Pipe)	Mean Scores		t	df	Sig (2tailed)	Remarks
	Urban	Rural				
1. Time spent in queue	5.00	4.00	3.30	20.00	0.00	Rejected
2. Location of stand pipe	4.80	4.08	2.30	20.00	0.03	Rejected
3. Collecting only drinking water	4.70	4.08	1.48	20.00	0.16	Not Rejected

Table 4.2.8 **Mean Scores of Perception on Stand Pipes, Localitywise**

From the above analysis, it can be concluded that respondents localitywise, had different lines of thinking regarding existing services of water supply. Out of 11

[12] Significance (2 tailed) < 0.05 implies rejecting $\mathbf{H_0}$

statements in Q1, 6 statements in Q2 and 3 statements in Q3, the respondents irrespective of their locality perceived alike with respect to the following.

(a) Water supply is inadequate.

(b) Supply timings are irregular.

(c) Water pressure is low.

(d) Water supply authorities delay in responding to complaint.

(e) Water sometimes has foul odour.

(f) Water dries up in winter and become muddy.

(g) Water from stand pipes is collected for drinking purpose only.

The second hypothesis that was tested is as follows:

H_0: The perceptions of the respondents are independent of consumer category.

H_1: The perceptions of the respondents are dependent on consumer category.

Statements Q.1 (with home connection)	**Mean Scores**		**t**	**df**	**Sig (2tailed)**	**Remarks**
	Individual	**Institutional**				
1. Adequacy of water	3.99	4.18	1.18	28.70	0.25	Not Rejected
2. Iron content	3.54	4.09	4.40	33.94	0.00	Rejected
3. Mud content	3.68	4.00	4.08	125.00	0.00	Rejected
4. Supply timings	4.05	4.18	0.88	23.80	0.39	Not Rejected
5. Water pressure	3.71	3.73	0.05	12.82	0.97	Not Rejected
6. Dependent on power supply	4.34	4.18	0.64	135.00	0.53	Rejected
7. Collection of additional water	4.29	4.27	0.13	16.65	0.90	Not Rejected
8. Monthly tariff	2.69	3.00	2.63	125.00	0.01	Rejected
9. Response to complaint	3.98	4.00	0.20	125.00	0.84	Not Rejected
10. Disconnection	2.52	3.00	4.72	125.00	0.00	Rejected
11. Privatization	4.22	4.45	1.33	14.94	0.20	Not Rejected

Table 4.2.9 **Mean Scores of Perception on Municipal/PHE Water Supply, Consumer Categorywise**

Statements Q.2 (own water supply)	Mean Scores		t	df	Sig (2tailed)	Remarks
	Individual	Institutional				
1. Iron content	3.71	4.24	4.96	29.34	0.00	Rejected
2. Foreign particles	3.49	3.57	0.41	377.00	0.68	Not Rejected
3. Foul odour	2.94	3.05	1.62	68.37	0.11	Not Rejected
4. Treatment for drinking water	3.84	4.05	3.92	33.34	0.00	Rejected
5. Money spent on purification	3.81	4.00	7.12	357.00	0.00	Rejected
6. Water dries up during winter	4.42	3.67	4.73	377.00	0.00	Rejected

Table 4.2.10 **Mean Scores of Perception on own Water Supply, Consumer Categorywise**

From the above analysis, it can be concluded that the respondents, consumer wise, had different lines of thinking regarding existing services of water supply. Out of the 11 statements in Q1 and 6 statements in Q2, the respondents thought alike with respect to the following.[13]

(a) Water supply is inadequate.

(b) Supply timings are irregular.

(c) Water pressure is inadequate.

(d) Additional water collected from other sources to meet the demand.

(e) Water supply authorities delay in responding to complaint.

(f) Privatization will lead to better operation & maintenance of the existing schemes.

(g) Water sometimes has foreign particles.

(h) Water sometimes has foul odour.

Q13. The respondents were asked if they had suffered from water borne diseases.

Suffering from water borne diseases?	No. of respondents	%
Yes	250	62.5
No	150	37.5

Table 4.2.11 **Water borne diseases**

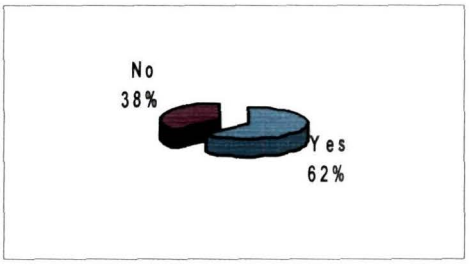


Fig. 4.2.1 **Water borne diseases**

Majority of the respondents (62%) had suffered from water borne diseases.

[13] Q3 is not included for hypothesis testing as institutional customers do not use the street stand pipes.

Q14. The respondents were asked about their average monthly expenditure for the treatment of water borne diseases.

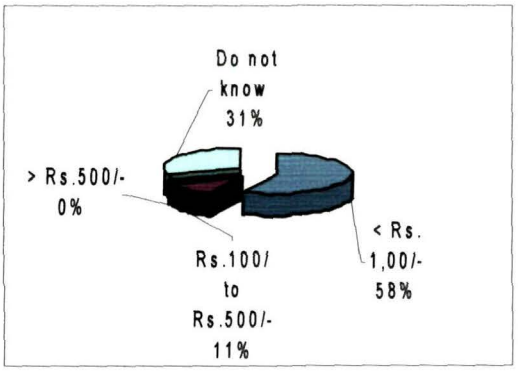


Fig. 4.2.2 **Expenditure incurred on Water borne diseases**

Sl. No.	Av. Monthly Expenditure for the treatment of water borne diseases	No. of respondents	%
1.	< Rs. 1,00/-	143	57.2
2.	Rs.100/- to Rs.500/-	28	11.2
3.	> Rs.500/-	1	0.4
4.	Do not know	78	31.2

Table 4.2.12 **Expenditure incurred on Water borne diseases**

The majority of the respondents (57.2%) spent below Rs.100/- for treatment of water borne diseases. On an average, the individual respondents spent Rs. 95.03[14] per month for the treatment of water borne diseases.

4.3 EXPECTATION FROM A NEW WATER SUPPLY SCHEME:

Q4. The respondents were asked to give their reactions to statements pertaining to new water supply scheme that would be installed in their localities. The responses were:

[14] Calculation is at Annexure – XIII c).

Statements	1	2	3	4	5	6	7
i) It should be 24 hours continuous supply.	0.0%	0.0%	0.0%	0.0%	0.0%	10.5%	89.5%
ii) The water to be supplied should be hygienically safe and aesthetically attractive.	0.0%	0.0%	0.0%	0.0%	0.0%	13.0%	87.0%
iii) Instead of a big project, there should be a number of small projects.	2.8%	2.3%	3.8%	29.0%	14.3%	11.0%	37.0%
iv) Urban/ Rural local body like Municipalities/ Gaon Panchayats should be involved in its implementation.	41.8%	4.3%	1.5%	42.0%	3.8%	0.5%	6.3%
v) PHED/UWSSB/District Administration should be involved in its implementation.	32.3%	3.0%	2.5%	8.8%	0.8%	2.5%	50.3%
vi) Community level registered society/Private Organization should be involved in its implementation from conception.	64.3%	8.3%	2.3%	22.8%	0.0%	0.8%	1.8%
vii) Community level registered society/Private Organization should be should be involved in implementation of the project from construction stages.	33.5%	4.5%	1.0%	15.5%	0.5%	5.0%	40.0%
viii) Community level registered society/Private Organization should be should be involved in operation & maintenance of the project.	0.0%	0.0%	0.0%	0.5%	0.5%	7.5%	91.5%
ix) Consumers should be allowed to finance the scheme if required	18.3%	2.0%	0.5%	21.8%	9.5%	14.0%	34.0%
x) Connection charge/ monthly tariff should be fixed by the consumers through societies.	0.0%	0.0%	0.3%	6.8%	20.3%	11.0%	61.8%
xi) Monthly tariff should be collected through computerized collection centers proposed to be set up at some suitable locations.	2.5%	0.8%	3.0%	31.0%	37.0%	5.3%	20.5%
xii) Grievance handling should be prompt.	0.0%	0.0%	0.5%	1.0%	30.0%	18.3%	50.3%
xiii) Water supply service should not be a subsidized one	8.8%	1.3%	0.3%	13.0%	9.0%	9.8%	58.0%
xiv) Financial transparency should be maintained.	1.5%	1.5%	2.0%	3.5%	37.3%	19.5%	34.8%
xv) Routine quality check of water must be done and consumers must be informed.	1.5%	1.3%	2.5%	3.3%	33.0%	22.0%	36.5%
xvi) Provisions must exist for solving legal disputes.	1.5%	2.3%	3.0%	8.8%	40.3%	17.3%	27.0%

Table 4.3.1 **Perceptions about New Water Supply of Scheme**

The mean scores of the above statements are:

Statements	Mean Scores[15]
i) It should be 24 hours continuous supply.	6.90
ii) The water to be supplied should be hygienically safe and aesthetically attractive.	6.87
iii) Instead of a big project, there should be a number of small projects.	5.31
iv) Urban/ Rural local body like Municipalities/ Gaon Panchayats should be involved in its implementation.	1.95
v) PHED/UWSSB/District Administration should be involved in its implementation.	4.51
vi) Community level registered society/Private Organization should be involved in its implementation from conception.	2.88
vii) Community level registered society/Private Organization should be should be involved in implementation of the project from construction stages.	4.20
viii) Community level registered society/Private Organization should be should be involved in operation & maintenance of the project.	6.90
ix) Consumers should be allowed to finance the scheme if required	4.80
x) Connection charge/ monthly tariff should be fixed by the consumers through societies.	6.27
xi) Monthly tariff should be collected through computerized collection centers proposed to be set up at some suitable locations.	4.97
xii) Grievance handling should be prompt.	6.17
xiii) Water supply service should not be a subsidized one	5.74
xiv) Financial transparency should be maintained.	5.71
xv) Routine quality check of water must be done and consumers must be informed.	5.77
xvi) Provisions must exist for solving legal disputes.	5.44

Table 4.3.2 **Mean Scores of the Perceptions on New Water Supply of Scheme**

In terms of the mean score, if the statements are prioritized, then the top ten requirements from a new water supply scheme are as follows.

(1) 24 hours continuous supply and involvement of Community level registered society/ Private Organization in operation & maintenance of the project.

(2) Hygienically safe and aesthetically attractive water.

(3) Consumers participation in fixing monthly tariff/ connection fee.

[15] Mean Score, the mean of the scores given by the respondents against a statement was calculated using SPSS 11.0 Version.

(4) Promptness in grievance handling.

(5) Routine quality checking.

(6) No to subsidized water.

(7) Financial transparency.

(8) Provision for solving legal disputes.

(9) Number of small projects.

(10) Computerized monthly tariff collection centers.

Q5. The respondents were asked as to how they would avail the proposed water supply scheme. The responses were -

Response	No. of respondents	%
Personal Connection	357	89.3
Community level taps	4	1.0
Not avail	39	9.8

Table 4.3.3 **Availing of Water Supply Scheme**

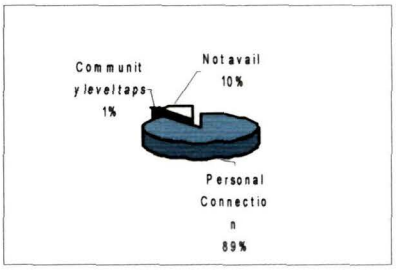


Fig. 4.3.1 **Availing of Water Supply Scheme**

The majority of the respondents (89%) would like to avail a personal connection. A Chi- square test was done to find out whether the responses were independent of locality, income, consumer category and ownership of building.

Response Vs Locality

$\mathbf{H}_0$: The response to the choice of availing water supply scheme is independent of the locality.

$\mathbf{H}_1$: The response to the choice of availing water supply scheme is dependent on locality.

Localities / Responses	Rural	Urban	Total
Avail	129	232	361
Not avail	17	22	39

Pearson $\chi 2$	= 0.937
df	= 1
Asymp. Sig., p[16]	= 0.333

Table 4.3.4 **Locality Vs Availing of WaterSupply Scheme**

Since p >.05, the null hypothesis could not be rejected i.e. the responses for availing a water supply connection was independent of locality.

Response Vs Income

$\mathbf{H}_0$: The response to the choice of availing water supply scheme is independent of income.

$\mathbf{H}_1$: The response to the choice of availing water supply scheme is dependent on income.

Income / Responses	<5,000	5,000-10,000	>10,000	Total
Avail	141	115	105	361
Not Avail	19	14	6	39

Pearson $\chi 2$	= 3.380
df	= 2
Asymp. Sig., p	= 0.184

Table 4.3.5 **Income Vs Availing of Water Supply Scheme**

Since p >.05, the null hypothesis could not be rejected i.e. the responses for availing a water supply connection was independent of income.

Response Vs Consumer Category

$\mathbf{H}_0$: The response to the choice of availing water supply scheme is independent of consumer category.

$\mathbf{H}_1$: The response to the choice of availing water supply scheme is dependent on consumer category.

[16] Asymp. Sig, p < 0.05 means rejecting $\mathbf{H}_0$

Consumer category / Responses	Individual	Institutional	Total
Avail	342	19	361
Not Avail	37	2	39

Pearson $\chi 2$	= 0.001
df	= 1
Asymp. Sig., p	= 0.971

Table 4.3.6 **Consumer Category Vs Availing of Water Supply Scheme**

Since p >.05, the null hypothesis could not be rejected i.e. the responses for availing a water supply connection was independent of consumer category.

Response Vs Ownership of the building

$\mathbf{H}_0$: The response to the choice of availing water supply scheme is independent of the ownership of the building.

$\mathbf{H}_1$: The response to the choice of availing water supply scheme is dependent on ownership of the building.

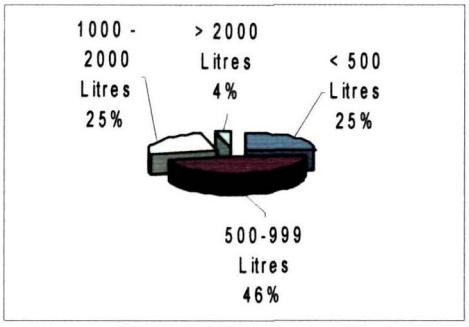
Ownership / Responses	Own	Rented	Quarter	Total
Avail	313	40	8	361
Not Avail	32	5	2	39

Pearson $\chi 2$	= 0.001
df	= 1
Asymp. Sig., p	= 0.971

Table 4.3.7 **Ownership of the building Vs Availing of Water Supply Scheme**

Since p >.05, the null hypothesis could not be rejected i.e. the responses for availing a water supply connection was independent of ownership of the building.

Q6. The respondents were asked about their requirement of water per day.



Sl. No.	Water Requirement	No. of respondents	%
1.	< 500 Litres	89	24.7
2.	500 -999 Litres	167	46.3
3.	1000 - 2000 Litres	91	25.2
4.	> 2000 Litres	14	3.9

Fig. 4.3.2 **Requirement of Water**

Table 4.3.8 **Requirement of Water**

The majority of the respondents (46.3%) assessed their daily requirement as between 500 to 999 litres of water per day. On an average the requirement was 881.37 litres[17] per household per day and 2013.15 litres[18] per institution per day.

Q7. The following table shows the amount of investment that the respondents were willing to make in a water supply scheme.

Sl. No.	Investment	No. of respondents	%
1.	< Rs. 5,000/-	115	31.9
2.	Rs. 5,000/- to Rs. 9,999/-	39	10.8
3.	Rs.10,000/- to Rs.20,000/-	7	1.9
4.	> Rs. 20,000/-	2	0.6
5.	No Investment	198	54.8

Table 4.3.9 **Investment in Water Supply Scheme**

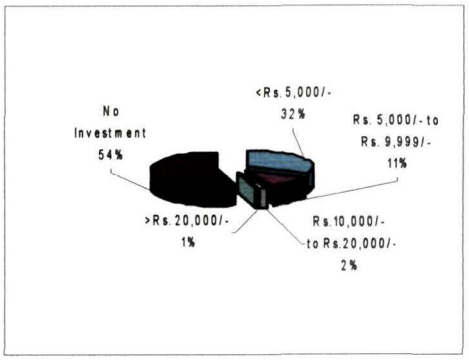


Fig. 4.3.3 **Investment in Water Supply Scheme**

The majority of the respondents (54.8%) were not willing to invest. A chi-square test was done to find out if the investment amount was independent of income.

$\mathbf{H}_0$: The response to the choice of investment in a water supply scheme is independent of income.

$\mathbf{H}_1$: The response to the choice of investment in a water supply scheme is dependent on income.

Investment Vs Income

Investment \ Income	<5,000	>5,000	Total
< Rs.5,000	26	89	115
> Rs.5,000	5	43	48
Not Invest	110	88	198

Pearson $\chi 2$	= 52.255
df	= 2
Asymp. Sig., p	= 0.000

Table 4.3.10 **Investment in Water Supply Scheme Vs Income**

[17] Calculation is at Annexure – XIII d).
[18] Calculation is at Annexure – XIII d).

Since p < .05, the null hypothesis could be rejected i.e. the response for investment in a water supply scheme was dependent on income.

Q8. The respondents were asked if they wanted return from their investment in the water supply scheme.

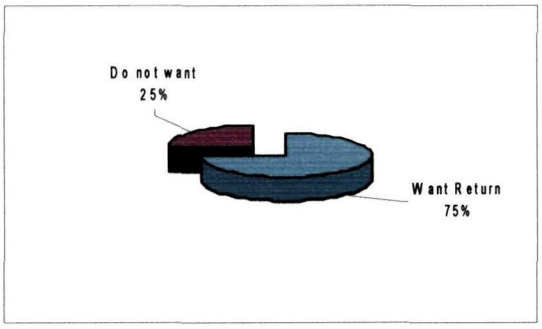


Fig. 4.3.4 **Return from Investment**

Return from investment	No. of respondents	%
Want Return	140	85.9
Do not want Return	23	14.1

Table 4.3.11 **Return from Investment**

The majority of the respondents (85.9%) wanted return from their investment. A chi-square test was done to find out if the need for return from investment was independent of income.

H $_0$: The response to the expectation from investment in a water supply scheme is independent of income.

H $_1$: The response to the expectation from investment in a water supply scheme is dependent on income.

Income / Responses	<10,000	>10,000	Total
Want return	85	55	140
Not Want return	10	13	23

Pearson $\chi 2$	= 2.414
df	= 1
Asymp. Sig., p	= 0.120

Table 4.3.10 **Return from Investment Vs Income**

Since p >.05, the null hypothesis could not be rejected i.e. the expectation of a return from the investment was independent of respondent's income.

Q9. The respondents were asked about the form of return that they wanted from their investment in the water supply scheme

Sl. No.	Form of Return	No. of respondents	%
1.	Deduction from monthly tariff	30	21.4
2.	Share of the profit earned	13	9.3
3.	Fixed rate of return	11	7.9
4.	Both Sl. Nos. 1 & 2	65	46.4
5.	Both Sl. Nos. 2 & 3	1	0.7
6.	Both Sl. Nos. 3 & 1	19	13.6
7.	All i. e. Sl. Nos. 1, 2 & 3	1	0.7

Table 4.3.11 **Form of Return from Investment**

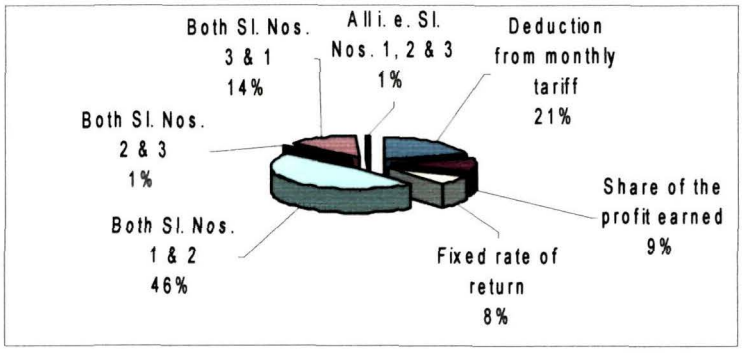


Fig. 4.3.5 **Form of Return from Investment**

The majority of the respondents (46.4%) wanted return from their investment in the form of both deduction from monthly tariff, and share of the profit earned.

Q10. The respondents were asked about the desired amount of connection fee[19], to be charged for a 'personal connection'.

[19] Connection fee: The consumers will have to pay the connection charges at actual cost covering cost of ferrule cock, saddle piece, water meter and labour cost for laying service line from the main reservoir to the meter at the consumers' end, as estimated by the water supply authority.

Sl. No.	Connection Fee	Individual	Institutional
1.	< Rs. 1,000/-	212	7
2.	Rs.1,000/- to Rs.1,999/-	109	7
3.	Rs.2,000/- to Rs.2,500/-	21	1
4.	Rs.2,500/- to Rs.5,000/-	0	4

Table 4.3.12 **Connection Charge**

Majority of the respondents (60.7%) felt that connection fee should be less than Rs.1,000/-. The average worked out to Rs. 926.17/-[20] for individual consumers and Rs. 1665.79[21] for institutional consumers.

Q11. The respondents were asked about the basis for fixing monthly tariff.

Sl. No.	Basis for Monthly tariff	No. of respondents	%
1.	Monthly fixed rate	124	34.3
2.	As per meter reading	168	46.5
3.	Both Sl. No. 1 & 2	69	19.1

Table 4.3.13 **Basis of Monthly Tariff**

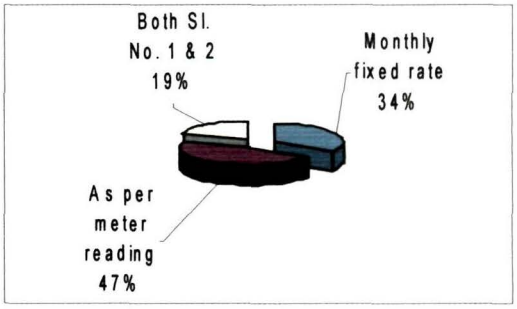


Fig. 4.3.6 **Basis of Monthly Tariff**

The majority of the respondents (46.5%) wanted to pay monthly tariff as per meter reading i.e. litres consumed per month.

Q12. The following table shows the amount of monthly tariff opted by the respondents.

[20] Calculation is at Annexure – XIII e).
[21] Calculation is at Annexure – XIII e).

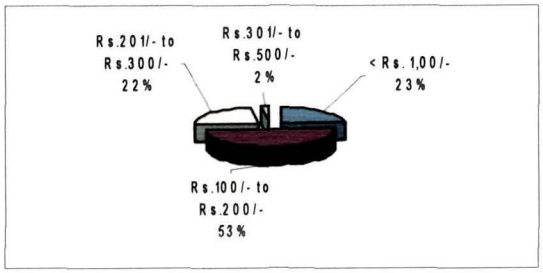


Fig. 4.3.7 **Monthly Tariff**

Sl. No.	Monthly Tariff	Individual	Institutional
1.	< Rs. 1,00/-	83	1
2.	Rs.100/- to Rs.200/-	188	1
3.	Rs.201/- to Rs.300/-	71	10
4.	Rs.301/- to Rs.500/-	0	7

Table 4.3.14 **Monthly Tariff**

The majority of the respondents (52.4%) wanted the monthly tariff to be in the range of Rs. 100/- to Rs. 200/-. The average worked out to Rs. 146.49[22] for individual consumers and Rs. 289.47[23] for institutional consumers. Further analysis was done to find out if the proposed monthly tariff was independent of present water supply provision, number of family members and monthly income.

H $_0$: The monthly tariff opted for is independent of the present water supply provision.

H $_1$: The monthly tariff opted for is dependent on the present water supply provision.

Provisions / tariff	Ring well	Own pipe water	Street tap	Piped water connection	Tube well	Total
<200	142	37	19	54	21	273
>200	23	32	1	30	2	88

Pearson $\chi 2$	= 40.865
df	= 4
Asymp. Sig., p	= 0.000

Table 4.3.15 **Monthly tariff Vs Present Water Supply Provision**

Since $p < .05$, the null hypothesis could not be accepted i.e. the proposed monthly tariff was dependent on present water supply provision.

H $_0$: The monthly tariff opted for is independent of the number of family members.

H $_1$: The monthly tariff opted for is dependent on the number of family members.

[22] Calculation is at Annexure – XIII f).
[23] Calculation is at Annexure – XIII f).

Tariff \ Member	Upto 7	More than 7	Total
<200	242	31	273
>200	51	37	88

Pearson $\chi 2$	= 40.999
df	= 1
Asymp. Sig., p	= 0.000

Table 4.3.16 **Monthly tariff Vs Number of Family Members**

Since p < .05, the null hypothesis could not be accepted i.e. the proposed monthly tariff was dependent on number of family members.

H $_0$: The monthly tariff opted for is independent of income.

H $_1$: The monthly tariff opted for is dependent on income.

Tariff \ Income	<5,000	5,000-10,000	>10,000	Total
<100	55	23	6	84
100-200	76	67	46	189
>200	10	25	53	88

Pearson $\chi 2$	= 78.688
df	= 4
Asymp. Sig., p	= 0.000

Table 4.3.15 **Monthly tariff Vs Income**

Since p < .05, the null hypothesis could not be accepted i..e. the proposed monthly tariff was dependent on the income of the respondents.

Q15. The respondents were asked about their willingness to participate in Operation & Maintenance functions of a water supply scheme.

Willingness to participate	No. of respondents	%
Yes	238	65.9
No	123	34.1

Table 4.3.16 **Willingness to Participate**

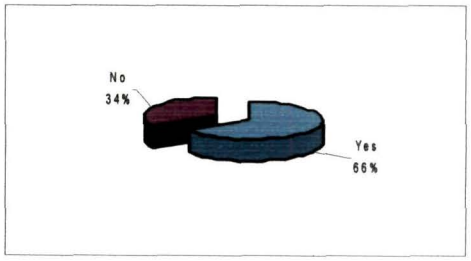


Fig. 4.3.8 **Willingness to Participate**

The respondents wished to participate in the following manner –

Participation in	No. of respondents	% to total Participation
Participate in 1	13	5.46
Participate in 2	2	0.84
Participate in 1& 2	81	34.03
Participate in 3	1	0.42
Participate in 1 & 3	9	3.78
Participate in 2 & 3	7	2.94
Participate in 1, 2 & 3	63	26.47
Participate in 4	3	1.26
Participate in 1& 4	18	7.56
Participate in 2 & 4	1	0.42
Participate in 1,2&4	4	1.68
Participate in 3 & 4	1	0.42
Participate in 1, 2, 3 & 4	8	3.36
Participate in 1 & 5	2	0.84
Participate in 2 & 5	1	0.42
Participate in 1, 2 & 5	2	0.84
Participate in 3 & 5	1	0.42
Participate in 4 & 5	7	2.94
Participate in 1, 4 & 5	10	4.20
Participate in 3, 4 & 5	1	0.42
Participate in 1, 2, 3, 4 & 5	3	1.26
Total	238	100.00

Participation in

1. Minimizing water loses & theft.
2. Ensuring timely deposit of monthly tariff.
3. Repairing minor damages in the distribution network.
4. Handling complaints.
5. Quality control checks.

Table 4.3.17 **Participation in different O & M functions**

The highest category of preferred mode of participation was in helping to minimize water loss and theft and ensuring timely deposit of monthly tariff. This is followed by wanting to do the above as well repairing minor damages in the distribution network.

CHAPTER - V

FINDINGS & CONCLUSIONS

CHAPTER – V

FINDINGS AND CONCLUSIONS

5.1 FINDINGS

5.1.1 DEMAND FOR WATER SUPPLY IN THE STUDY AREA:

On an average, the water demand in the study area (as per survey) was 840.88 litres per day per household i.e. 154.62 lpcd[1] which was almost equal to the CPHEEO recommendation of 135 lpcd for towns with sewerage system plus 15% unaccounted for water. As TUA is not having a sewerage system, the per capita demand for water here should be 70 lpcd as per CPHEEO recommendation (Annexure - **X**)

62.5% of the respondents had reported that they suffered from water borne diseases which also indicates the requirement for safe drinking water in the study area.

Only 31.5% respondents of the study area were found to have access to municipal/ PHE water, 4.5% respondents were dependent only on that and 94.75% had their own water supply arrangements in the study area.

[1] litres per capita per day

Sl. No.	Statement	Water Supply Arrangement	Mean Score
1.	The Quantity of water is inadequate.	Municipal/PHE	4.01
2.	Water Pressure is inadequate.	,,	3.72
3.	Additional water is collected from other sources to meet the demand	,,	4.29
4.	Water dries up and becomes muddy during winter.	Own arrangement	4.37

Table 5.1.1 **Perception on Water Adequacy (from Municipal/PHE connection as well as own arrangement)**

From the above responses, it can be concluded that respondents received water less than their requirement, either from municipal/PHE water supply scheme or own water supply arrangement.

Again the respondents, using standpipes, also did not receive water as per their needs. This is evident from the following statements -

Sl. No.	Statement	Mean Score
1.	A lot of is spent in standing in the queue	4.45
2.	Only drinking water is collected from it.	4.36

Table 5.1.2 **Perception on Water Adequacy (from stand pipes)**

Although the majority of respondents (94.75%) had their own arrangement of water supply service, yet 89.25% of them wanted to have connections from the proposed water supply scheme. This indicates that there exists a huge untapped demand for piped water supply in TUA area.

This fulfills the first objective of this study.

5.1.2 GAP BETWEEN EXISTING AND DESIRED WATER SUPPLY SERVICE:

The majority of the respondents with home connections as well as having own arrangement of water supply perceived that the water they received/used, contained excessive iron content and mud, and foreign particles.

The following statements can be clubbed together as per respondents' priority -

Sl. No.	Statement	Water Supply Arrangement	Mean Score
1.	The water received is found to be muddy sometimes.	Municipal/PHE	3.71
2.	The water received, contains excessive iron content.	,,	3.58
3.	Water dries up and becomes muddy during winter.	Own arrangement	4.37
4.	Without treatment, one should not use this water for drinking.	,,	3.85
5.	The water contains excessive iron content.	,,	3.75
6.	The water contains some foreign particles.	,,	3.50
7.	The water sometimes has foul odour.	,,	2.90

Table 5.1.3 **Perception on Water Quality (from Municipal/PHE connection as well as own arrangement)**

From all the above statements, it can be concluded that the water received/used by the respondents was not safe. From Secondary Data, the results of laboratory test of water samples of the study area showed that municipal/PHE supplied water was bacteriologically highly unsatisfactory. (Annexure - **XI**) The researcher also carried out a similar test in the laboratory of Molecular Biology and Bio-Technology (MBBT) Department of Tezpur University and found that the supplied water is bacteriologically unsatisfactory. On the other hand, from the proposed water supply scheme, the respondents wanted that the supplied water should be safe and aesthetically attractive.

Again majority of respondents with home connections perceived the existing water supply as irregular. The timing of the availability of piped water was dependent on power supply. This was evident from the following responses -

Sl. No.	Statement	Mean Score
1.	The water supply depends on power supply.	4.33
2.	Water supply timings are irregular.	4.06

Table 5.1.4 **Regularity of Water Supplied by Municipality/PHE**

From the Secondary Data, it was revealed that there was only one hour of supply in the morning and irregular supply of water for near about an hour in the afternoon, that too, if there was power supply. On the other hand, from the new water supply scheme, the respondents wanted 24 hours continuous supply.

In the context of operation & maintenance of the existing water supply service, the following responses were obtained -

Sl. No.	Statement	Water Supply Arrangement	Mean Score
1.	Privatization will lead to better O&M of the existing system.	Municipal/PHE	4.24
2.	Concerned authority does not respond promptly to the complaints.	,,	3.99
3.	The monthly tariff is too high.	,,	2.72
4.	Disconnection is done now and then.	,,	2.55
5.	Money is spent on water purification.	Own arrangement	3.82

Table 5.1.5 **O & M of Municipal/PHE water supply service as well as own arrangement**

From these statements, it can be concluded that the respondents felt that the concerned authority did not respond promptly to the complaints, privatization was perceived to lead to better O & M of the existing system and interestingly respondents agreed on spending money for water purification purpose. On the other hand, respondents wanted that the proposed scheme should be operated and maintained by the community level registered society (mean score = 6.90), the connection charge/ monthly tariff to be fixed by consumers (mean score = 6.27) and grievance handling should be prompt (mean score = 6.17).

The following gap can be seen -

- The existing water supply was inadequate in terms of quantity and the supply timings were irregular. Users desired to have a 24-hours continuous supply.
- Users of the existing water supply scheme as well as respondents having their own water supply arrangements found that the water to be high in iron content. They desired to have safe and aesthetically attractive water.
- From secondary data it was found that the existing monthly tariff for urban and rural users was fixed without consulting consumers. However the users felt that monthly tariff must be fixed in consultation with the consumers.
- Users of the existing water supply schemes felt that grievance handling was not prompt. They desired to have prompt grievance handling mechanism. The present O & M does not appear to be satisfactory as is evidence from the fact that there is no prompt response to complaints.
- Users of the existing water supply schemes felt that privatization would lead to better operation & maintenance of the schemes. They also desired that Community level registered society or Private Organization should be involved in operation & maintenance of the proposed water supply scheme in the study area.

Some other findings are -

- Respondents localitywise and consumer categorywise had different perceptions regarding the existing water supply service.
- The need to avail the new water supply scheme was independent of locality, income, consumer category and ownership of building.

It can be inferred that although the respondent thought differently as per locality as well as consumer category regarding existing water supply services, yet they would avail the water supply scheme irrespective of locality, consumer category, income and ownership of building.

This fulfills the second objective of this study.

5.1.3 WILLINGNESS TO PAY:

In the context of willingness to pay attitude of the households in the study area both in terms of monthly tariff and towards project cost, the majority of respondents (54.8%) did not want to invest in the scheme. Although 45.2% respondents wanted to invest in the scheme, the investments were dependent on their income. Majority of them 85.9% wanted return on investment in the form of both deductions from monthly tariff and shares from the profit earned.

46.5% of the respondents wanted to pay monthly water tariff as per meter reading. Majority of the respondents (60.7%) felt the connection fee should be less than Rs. 1000.00 and on an average it worked out as Rs. 925.67 for individual consumers and Rs. 1644.34 for institutional consumers. Again majority of respondents wanted to pay monthly tariff in the range of Rs. 100.00 to Rs. 200.00 and on an average it worked out to Rs. 146.47 for individual consumers and Rs. 289.71 for institutional consumers. It is to be mentioned here that 62.5% of respondents who suffered from water borne diseases spent on an average Rs. 94.53 per month on treatment of diseases and

majority of respondents (77.36%) having own water supply service agreed on spending money for water treatment. All these revealed that the respondents were willing to pay for water supply service.

The 'Cash Flow After Tax' calculation showed that a monthly tariff of Rs. 150.00, would be enough to cover the O & M cost of the proposed scheme. (Annexure - **XII**)

Respondents' willingness to pay monthly water tariff was dependent on present water supply provision, number of family members and income.

This fulfills the third objective of this study.

5.1.4 APPROPRIATE MECHANISM:

For an appropriate mechanism, to ensure success of future water supply projects in TUA area, majority of respondents (65.9%) wanted to participate in operation and maintenance of the new water supply scheme and 34.03% of them wanted to participate both in minimizing water losses and theft as well as ensuring timely deposit of water tariff. This will lead to incorporation of the fourth P (i.e. People) in the existing 3P model (i.e. Public - Private - Partnership)

Majority of respondents (47.6%) appeared not to prefer the involvement of Urban/ Rural local body like Municipality/ Gaon Panchayats in implementation process of the proposed project. Involvement of Community level Registered Society/ Private Organization in the conceptualization process for a water supply scheme was also not favoured. However the respondents favour the role of a private water service provider as far as operation and maintenance is concerned. Respondents also wanted to be involved in repairing minor damages in the distribution network.

Based on the above a mechanism is put forward.

5.1.5 PROPOSED MECHANISM:

At present, Tezpur Municipal Board runs the water supply scheme that was constructed by PHED, Government of Assam, in 1958 and upgraded by AUWSSB in 1991. Tezpur Municipal board collects the monthly tariff and deposits in a bank account operated by the District Administration, Sonitpur, Assam. From the revenue thus generated, District Administration meets the following expenses like salaries to the staff, repairing in the distribution network, buying purification materials, and payment of electricity bills.

On the other hand, rural water supply schemes in TUA area are constructed as well as run by PHED. For operation and management of these schemes, there exists a committee formed among the consumers with President (from the consumer's side) and the Executive engineer of the Division of PHED is the Member-Secretary. The committee collects the monthly tariff and deposits in a bank account operated jointly by the President and Member-Secretary. The committee uses this money for repairing expenses and buying of purification material. But interestingly payment of staff salary and payment of electricity bill are borne by PHED.

It is seen that the operation and maintenance mechanism of the existing water supply services in TUA area have been dealing with only collection of monthly tariff, repairing in the distribution network and buying of purification material, but from the primary survey it is revealed that respondents wished to participate in minimizing water losses and theft, ensuring timely deposit of tariff. A small minority wanted to take part in handling complaints as well as quality control checks. Again the respondents wanted that community level registered society/ private organization should be involved in O & M of the project, monthly tariff should be fixed by the consumers through society, results of the routine quality check of supplied water should be published, instead of one big project there should be number of small projects, computerized tariff collection centers should be established at convenient locations for the proposed water supply scheme in TUA area.

The operation and management of small water supply schemes can be easily handled as compared to a big one. The topography of TUA (undulating with ups and down here and there) hinders the continuous laying of distribution network and to do so will be costly. Thus, instead of one big water supply scheme for whole TUA, urban planner/ water supply authority should go for a number of small schemes. As respondents wanted, the schemes should be implemented public authority like PHED or AUWSSB.

The Operation and Management Committee can be constituted schemewise with members from the consumers. The committee can look after the following activities –

i) Fixing monthly tariff/ connection fee.
ii) Ensuring timely deposit of monthly tariff.
iii) Buying of purification materials.
iv) Payment of staff salary.
v) Payment of electricity bill.
vi) Repairing in the distribution network.
vii) Minimizing water losses and theft.
viii) Publicity of results of routine quality checks of supplied water.
ix) Publicity of profit and loss account.
x) Feedback and constant touch with Water Supply Authority.

The above suggestions are based on the responses provided to Q4 and Q15 of the questionnaire.

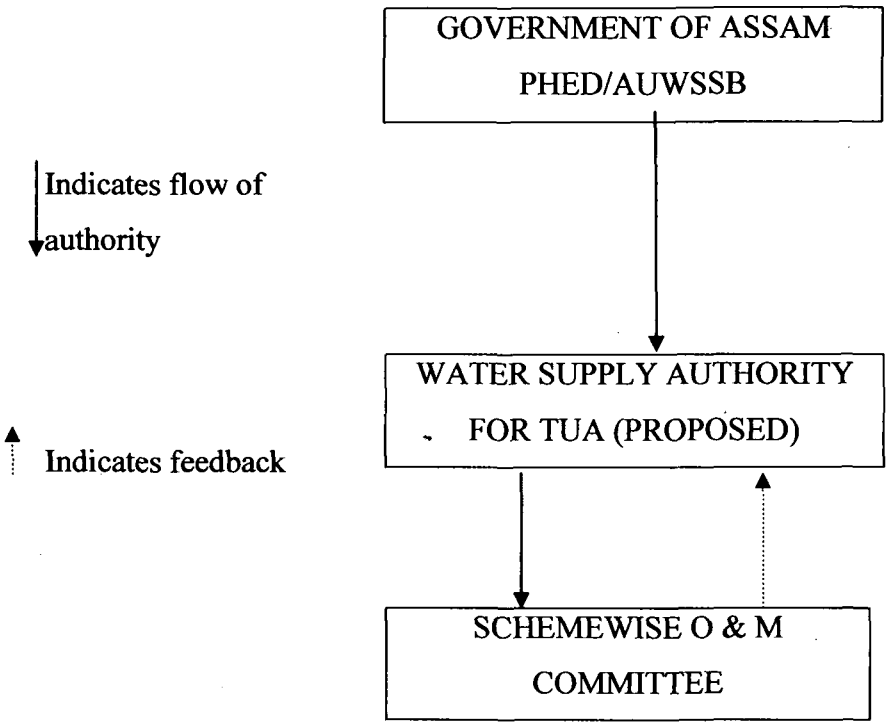


Fig 5.1 **Proposed Mechanism**

This fulfills the fourth objective of this study.

5.2 COMMUNICATING TO STAKEHOLDERS:

The Government of Assam, through the Public Health Engineering Department / Assam Urban Water Supply & Sewerage Board, can be made aware of the latent demand for drinking water in TUA area, the NPV analysis can be used to highlight the fact that if the project cost is met by the government then the revenue generated will be enough to cover the O & M cost. The customers can be motivated to avail such a service by pointing out the following facts-

(i) Level of water contamination and it being unfit for drinking.

(ii) The cost of availing safe drinking water vis-à-vis the cost of treatment of water borne diseases.

As TUA area consists of both rural and urban areas, the necessity for constitution of one separate authority to keep constant touch with government implemental agencies as well as Operation & Management Committees can be intimated to the PHED/ AUWSSB. The requirements of the consumers like 24-hours continuous water supply, safe and aesthetically attractive drinking water, adequate quantity, adequate pressure, location for stand pipes etc. can be brought to the notice of the authority and these be executed by the implementing agencies.

The consumers can be motivated to form an Operation and Management Committee to work in some areas of operation and management like fixing of monthly tariff, depositing monthly tariff in time, reducing water losses and theft, buying of purification materials, making payment of staff salary & electricity bill, repairing in the distribution network, making necessary arrangement for publicity of results of routine quality checks of supplied water as well as profit & loss account. The Committee can be motivated by pointing out the loopholes of the present water supply services' like-

(i) Supply is intermittent,

(ii) Supplied water is unsafe drinking,

(iii) No promptness in responding to complaints.

5.3 CONCLUSION:

The existing water supply schemes in TUA were constructed with government grants and have been running without recovering the operating cost. As a result water supply has been intermittent, and unsafe for drinking (Source: Tezpur Municipal Board & PHED, Tezpur). The fact that 62.5% of the respondents suffered from water borne diseases and 4.5% had depended only on home connections highlighted the need for treated and safe water supply system.

The WTP of the consumers for a new water supply scheme in TUA will help in proper pricing of future water supply services. The urban planners/ urban water

supply authorities and other stakeholders can take into consideration this WTP of the consumers in the study area (which is dependent on present water supply provision, number of family members and income) while planning the water supply schemes.

The respondents appeared to be willing to participate in some of the operational process of the water supply schemes and this is a very healthy sign. People's participation will go a long way in ensuring the success of future water supply projects.

As 54.8% of the respondents do not want to invest in the project cost of future water supply schemes in TUA, other financing options like grants from Government of India must be sought for the capital cost of the scheme. NPV calculations, assuming public participation in equity and term loan, worked out to be negative. However if government grant is considered the NPV works to be positive.

5.4 CONTRIBUTION OF THE STUDY:

The study has highlighted the requirements of the consumers of water supply service. The areas of participation preferred by the users offer an indication of the possibility of the involvement of "People" in the existing concept of "Public-Private-Partnership". Very few studies in India have focused on this aspect. Additionally the study has also taken into consideration the "Willingness to Pay" factor, not only for monthly tariff but also project cost. The study concludes that urban infrastructure financing cannot be achieved by mobilizing resources from household sector only. Government grants are required to provide basic urban services in this region of India. Urban planners can take into account the willingness to pay and willingness to participate in a water supply scheme, while planning water supply schemes in this region. The policy implication of the study is that the inhabitants of TUA are willing to pay for improved water supply service if it is provided for an affordable price. But it is not clear whether the benefits of use of such policies outweigh the operation and management (O&M) costs or not.

5.5 SCOPE FOR FUTURE STUDY:

Further study can be done to analyze Social Cost Benefit for such type of infrastructure projects.

Moreover study can be taken to find out proper mechanism for community based water supply scheme from conceptualization stage to implementation stage with the help of community level finance.

A study can also be carried out to arrive at how the capital cost of a water supply project could be minimized by constructing in a phased manner with room for flexibility.

A study can be carried out to examine the financial implications if there are two types of supplied water - (i) 100% safe water, for drinking only and (ii) water after the removal of excessive iron content only, for other purposes except drinking.

REFERENCES & BIBLIOGRAPHY

REFERENCES
& BIBLIOGRAPHY

Books

Agthe D. E, Billings R. B. & Buras N. (2003). Managing Urban Water Supply. *Kluwer Academic Publishers.* 2003. 304 pages.

Anton D. J. (1993). Thirsty Cities: Urban environments and water supply in Latin America. *IDRC.* 1993. 197 pages

Biswas A. K. & Tortajada C. (2005). Water pricing and public-private partnership. *Taylor & Francis.* 2005. 223 pages.

Black T.R. (1999). Doing Qualitative Research the Social Sciences: An Integrated Approach to Research Design, *Measurement and Statistics. London*: Sage

Cummings R.G, Brookshire D.S, & Shulze W.D. (1986). Valuing Environmental Goods. *New Jersey: Rowman and Allanheld.*

Duggal K. N. (1998 ed.). Elements of Public Health Engineering. Third Edition. *S. Chand & Company (Pvt.) Ltd.*

India Infrastructure Report. (2001). Issues in Regulation and Market Structure, *3iNetwork, Oxford University Press,* 236-277.

Iyyar M. J. (2008). Urban Water Supply & Sanitation: A Management Perspective. *Icfai University Press.* 244 pages.

Ministry of Urban Development. New Delhi (1999). Manual on Water Supply and Treatment, Third edition, *Central Public Health Environmental and Engineering Organisation.*

Schlager E, & Lopez-Gunn E. (2005). Collective systems for water management: is the Tragedy of the Commons a myth? Water crisis: myth or reality? *In: Llamas R, Rogers P (eds), A.A. Balkema, The Netherlands.*

United Nations. (1997). Guidebook on Private Sector Participation in Water Supply and Sanitation. *Economic and Social Commission for Asia and the Pacific.*

World Bank. (1994). World Development Report, 1994. Infrastructure for Development. *Oxford University Press, New York.*

Conference Presentations

Baker C, Lentz R. & Curry S. (2006). Strategy of Widespread Implementation of Numerous, Independent Small Scale Household Water Treatment Programs. *World Water week in Stockholm. Beyond the River: Sharing Benefits and Responsibilities.* August 20-26, Stockholm International Water Institute.

Banda B, Farolfi S. & Hassan R. (2004). Determinants of Quality and Quantity Values of Water for Domestic Uses in the Steelpoort Sub-basin: A Contingent Valuation Approach. *Proceedings of the conference: Water Management for Local Development*, Loskop Dam, 8-11 November 2004.

Braadbaart O. & Maarten B. (1997). Public Water PLC's for Low-Income Countries. *Water Sector and Utility Management Group, Sanitary and Environmental Engineering Department*. Draft of a paper prepared for presentation at the World Bank. Delft: IHE.

Flack J. E. & Howe C. W. (1990). URBAN WATER SUPPLY RELIABILITY. A paper presented in CONSERV 90, The National Conference and Exposition Offering Water Supply Solutions for the 1990s, National Ground Water Information Centre, August 12 – 16, 1990, Phoenix Civic Plaza, Phoenix, Arizona.

McConnell J & Ducci J (1998). Valuing Environmental Quality in Developing Countries: Two Case Studies. Paper Presented at Applied Social Science Association, Atlanta, GA.

Njiru C. & Sansom K. (2001). Strategic marketing of urban water services. *A paper presented in 27th DEDC Conference*, Lusaka, Zambia, 2001 on People and System for water, Sanitation and health.

Nurul Islam A.K.M., Kitawaki H, & Rahman A.H. (1994). Willingness to pay/use for water supply and sanitation. *Paper presented in the 20th WEDC conference Colombo*, 1994 on Affordable water supply and sanitation.

Rosado M. (1998). Willingness to pay for drinking water in urban areas of developing countries. *Paper presented to the AAEA annual meetings, Salt Lake City, Utah, USA*, August, 1998.

Roy J. (2003). An Economic Analysis of Demand for Water Quality: A Case from Kolkata City. *Paper Presented at the conference on Market Development of Water & Waste Technologies through Environmental Economics,* 30th-31st October 2003, New Delhi.

Sharma S. (1998). Resource Management for Water Supply and Sanitation Sector. Sixth National Convention of Engineers on Resource Management for Infrastructure Development. December 3-4. Katmandu: *Federation of Engineering Institutions of South and Central Asia.*

Suresh V. (1998a). Indian experience in urban water supply and sanitation. *A country presentation/case study presented in the ESCAP sub-regional workshop on Private Sector Involvement in the Water Supply and Sanitation,* New Delhi, April, 1998.

Suresh V. (1998b), Key Issues in Urban Infrastructure Financing- Commercialization. *Paper presented in the World Mayors Conference on New Role of Mayors in a changing Global Scenario, organized by the All- India Institute of Local Self Government, held in Jaipur, India* on 10th of January, 1998.

World Bank. (2006). Delhi Water Supply & Sewerage Services: Coping costs, Willingness to pay and affordability. *A paper presented by Smita Misra, Sr. Economist, SASEI, World Bank.*

Government Reports

Government of Assam. (2007). Revised Master Plan For Tezpur - 2031 (Draft), *The Assam Gazette,* No. 401, 28th December, 2007

Government of India. (2002). Tenth Five Year Plan Report, *Planning Commission of India.* New Delhi

Government of India. (2002). National Water Policy, 2002. *Ministry of Water Resources* Government of India. New Delhi.

Government of India. (2002). Water Supply and Sanitation: India Assessment 2002. A report by WHO-UNICEF for the Government of India. *Planning Commission of India.* New Delhi.

Journals

Altaf M.A, & Hughes J.A. (1994). Measuring the demand for improved urban sanitation services: results of a contingent valuation study in Ouagadougou, Burkina Faso. *Urban Studies*, 31(4): 1763-1776.

Altaf M.A, Whittington D, Jamal H. & Smith V.K. (1993). Rethinking rural water supply policy in the Punjab, Pakistan. *Water Resources Research*, 29(7): 1943-1954.

Amritalingam CH. (1999). Public-Private Partnership for financing of Infrastructure, *Spatio-Economic-Development record*: 6(4),Jul-aug. 1999, 7-12.

Anton D. (1993). Thirsty Cities: Urban Environments and Water Supply in Latin America. Ottowa: *International Development Research Center*.

Asthana A. (1997). Where the water is free but the buckets are empty: demand analysis of drinking water in rural India. *Open Economic Review*, 8(2): 137-149.

Bahri A. (2001). Urban and peri-urban water-related relationships: closing the loops. *Environmental Management and Health*, Vol. 12 No. 4, 2001, 364-376

Balachandharan G. (2001). Urban Decentralization, Case Study West Bengal, edited version of the paper presented at the Good Urban Governance Compaign, India Launch, Organised by Government of India and UNCHS (Habitat), 4-6 Sep, 2001, New Delhi in *Spatio-Economic-Development record*: 8(5), Oct. 2005, 18-24

Bala M, Mauskopf J. & Wood L. (1999). Willingness to Pay as a Measure of Health Benefits. *Pharmacoeconomics* 15(1): 9-18.

Bhandari B, Grant M. & Pokharel D. (2005). Sustainable community water: managing supply systems in the mid-hills of Nepal. *Water Policy* 7(2): 201-214.

Bhandari B. & Wickramanayake B. (2001). Community management and water quality in rural water supply system in Nepal. *Asia-Pacific Journal of Rural Development* 10(2): 53-67.

Bohm R. A, Essenburg T. J, & Fox W. F. (1993). Sustainability of Potable Water Services in the Philippines, *Water Resources Research*, 29(7), 1955-1963.

Braadbaart O. (2005). Privatizing Water and Wastewater in Developing Countries: Assessing the 1990s' Experiments. *Water Policy*, 7(4): 329-344.

Cameron T.A. (1988). A New Paradigm for Valuing Nonmarket Goods Using Referendum Data: Maximum Likelihood Estimation by Censored Logistic Regression. *Journal of Environmental Economics and Management* 15: 355-379.

Cameron T.A. & James M.D. (1987). Efficient Estimation Methods for 'Closed-Ended' Contingent Valuation Surveys. *Review of Economics and Statistics* 69(2): 269-276.

Chiplunkar A. & Bhatnagar R. (2002). Resource Mobilization and Public Private Partnership in Urban Water Supply and Sanitation Sector. *Shelter. Vol. 5, No. 1. A HUDCO-HSMI Publication.*

Cronbach L. (1951). Coefficient alpha and internal structure of tests. *Psychometrika* 16(3): 297-334.

Dalluisen J. & Nijhamp P. (2002). Critical factors for achieving multiple goals with Water tariff systems: Combining limited data sources and expert testimony. *Water Resources Research*, 38(7): 701-711.

Dzikus A. (1996). Willingness to pay: Assessing Community Water Demand. *Countdown to Istanbul, Habitat II,* February 1996, Vol. 1, No. 6.

Farolfi, S. Mabugu, R.E. & Ntshingila, S.N. (2007). Domestic Water Use and Values in Swaziland: A contingent Valuation Analysis. *Agrekon*, Vol 46, No.1 (March, 2007), 157-170.

Galiani, Sebastian, Paul G. & Schargrodsky E. (2005). Water for Life: The Impact of the Privatization of Water Services on Child Mortality, *Journal of Political Economy,* Vol.113 (1): 83-120.

Guha S. (2008). Valuation of Clean Water Supply by Willingness to Pay Method in a Developing Nation: A Case Study in Calcutta, India, *Journal of Young Investigators.* 2005. Volume 17.

Hanemann W.M. (1984). Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses. *American Journal of Agricultural Economics* 66(3): 332-341.

Hassanein A. G, & Khalifa R.A. (2007). Financial and operational performance indicators applied to public & private water and waste water utilities, *Engineering, Construction and Architectural Management,* 14(5): 479-492.

Hoehn J. P. & Krieger D. J. (2000). An Economic Analysis of Water and Wastewater Investments in Cairo, Egypt. *Evaluation Review. Vol. 24, No. 6: 579 – 608.*

Howe C. W. & Smith M. G. (1993). Incorporating Public Preferences in Planning Urban Water Supply Reliability. *Water Resources Research* 29(10): 3363-3369.

Howe, C. W. & Dixon J. A. (1993). In Water Project Design and Operation in the Third World, An Economic Perspective. *Water Resources Research*, 29(7): 1889-1894.

Kaliba A, Norman D, & Chang Y. (2003). Willingness to pay to improve domestic water supply in rural areas of central Tanzania: implications for policy. *International Journal of Sustainable Development and World Ecology* 10(2): 119-132.

Lammerink M. (1998). Community managed rural water supply: experiences from participatory action research in Kenya, Cameroon, Nepal, Pakistan, Guatemala and Colombia. *Community Development Journal* 33(4): 342-352.

Larbi G. A. (1998). Contracting-out in Public health and water services in Ghana, *International Journal of Public Sector Management*, 11 (2/3), 154-163.

Lewis M. A. & Miller T. R. (1987). Public-private partnership in water supply and sanitation in Sub-Saharan Africa. Health Policy and Planning. Volume 2 (1): 70-79

Lopez-Gunn E. (2003). The role of collective action in water governance: a comparative study of groundwater user associations in La Mancha aquifer (Spain). *Water International.* 28(3): 367-378.

Lopez-Gunn E. & Cortina L. (2006). Is self-regulation a myth? Case study on Spanish groundwater user associations and the role of higher-level authorities. *Hydrogeology Journal.* 14(3): 361-379.

Mansfield C, Johnson F.R. & Houtven G. Van. forthcoming. The Missing Piece: Valuing Averting Behavior for Children's Ozone Exposures. *Resource and Energy Economics.*

Manski C. (1977). The structure of random utility models. *Theory and Decision* 8: 229-254.

Marrett S. (2002). Deconstructing Household's Willingness-to-pay for Water in Low-income Countries. *Water Policy* 4: 157-172.

McCloskey D. & Ziliak S. (1996). The Standard Error of Regressions. *Journal of Economic Literature.* 34(1): 97-114.

McFadden D. (1976). The Revealed Preferences of a Government Bureaucracy: Empirical Evidence. *Bell Journal of Economics* 7: 55-72.

McPhail A. A. (1994). Why don't households connect to the piped water system? Observations from Tunis, Tunisia. *Land Economics*, 70(2): 189-196.

Mehta M. (1993). Pricing of Water Supply. *All India Housing Development Association Journal.* February, 1993, 136-155

Mehta M. (1995). Increasing Urban Infrastructure Investments Through Capital Markets. *Spatio-Economic-Development record*: 2(4), Jul-Aug 1999, 23-37

Montginoul M. (2007). Analysis the Diversity of Water Pricing Structures: The Case of France. *Water Resources Management*, 21(5): 861-871.

Neumayer E. (2001). Convergence in access to safe water and adequate sanitation: An analysis across countries and time. International Journal of Water, 1 (2), 2001, 210 - 216.

Ngowi A.B. (1997). Community-managed infrastructure facilities. *Facilities*, Volume 15, Number 12/13, December 1997, 323-330.

Nieswiadomy M. (1992). Estimating Urban residential Water demand: officials of price structure, conservation and education. *Water Resources Research,* 28(3): 609-615.

Nyoni M. J. M. (1999). Water Pricing issues in a developing Country, *International Journal of Social Economics*, 26 (1/2/3): 441-454.

Oca Soto Montes de G. & Bateman I. J. (2006). Scope sensitivity in households' willingness to pay for maintained and improved water supplies in a developing world urban area: Investigating the influence of baseline supply quality and income distribution upon stated preferences in Mexico City, *Water Resources Research,* 42, W07421, doi: 10.1029/2005WR003981.

Ogden S. & Clarke J. (2005), Customer disclosures, impression management and the construction legitimacy, corporate reports in the UK privatized water industry, *Accounting, Auditing & Accountability Journal*, Vol. 18, No.3, 2005, 313-345.

Patra B. & Pradhan B. (2005). Design of an environmental information system for monitoring water and air quality in urban areas. *Disaster Prevention and Management,* 14(3): 326-342.

Pattanayak S. K, Yang J.-C, Whittington D, & Bal Kumar K. (2005). Coping with unreliable public water supplies: averting expenditures by households in Kathmandu, Nepal. *Water Resources Research* 41(2):1-11.

Piper S, & Martin W. E. (1997). Household Willingness to Pay for Improve Rural Water Supplies; A Comparison of Four Sites. *Water Resources Research* 33(9), 2153-2163.

Rahaman A. S, Everett J. & Neu D. (2007). Accounting and the move to privatize water services in Africa. Accounting, Auditinh & Accountability Journal. Vol 20. No. 5 : 637-670

Raje D, Dhobe P, & Deshpande A. (2002). Consumer's willingness to pay more for municipal supplied water: a case study. *Ecological Economics* 42(3): 391-400.

Ravallion M. & Wodon Q. (1999). Poor areas or only poor people? *Journal of Regional Science* 39(4): 689-711.

Roy K. C. & Tisdell C. A. (1999). Conservation and Prudent Management are the key to the preservation of the Environment, The Case of Water Resources and the Indian Situation. *International Journal of Social Economics*, 26 (1/2/3), 274-289.

Shaoul J. (1997). The Power of Accounting: Reflecting on water privatization, *Accounting, Auditing & Accountability Journal*, 10 (3), 382-405

Singh B, Ramasubban R, Bhatia R, Briscoe J, Griffin C, & Kim C. (1993). Rural Water Supply in Kerala, India: how to emerge from a low-level equilibrium trap. *Water Resources Research*, 29(7): 1931-1942.

Sukumaran Nair M. P. (2004). Public Health Issues Relating to Drinking Water and Soft Drinks. *Good Governance India,* Vol. 2, Jan – Feb 2004.

Sullivan C. (2002). Calculating a water poverty index. *World Development* 30(7): 1195-1210.

Sullivan C, Meigh J, & Giacomello A. (2003). The water poverty index: development and application at the community scale. *Natural Resources Forum* 27(3): 189-199.

Tati G. (2005). Public-private partnership (PPP) and water-supply provision in urban Africa: The experience of Congo-Brazzaville. Development in Practice. Volume 15 (3 & 4). 316-324.

Venkatachalam L. (2005). Demand-Side Versus Supply-Side Approach: The Case for Sustainable Management of Water Supply in Developing Countries – A Case Study, In: Chenoweth J and Bird J (Eds.). *Business of Water Supply and Sustainable Development, Green Management International Publisher*, Sheffield, UK, 238-250.

Whittington D. (1998). Administering Contingent Valuation Surveys in Developing Countries. *World Development.* 26(1): 21-30.

Whittington D, Briscoe J, Mu X. & Barron W. (1990a). Estimating the willingness to pay for water services in developing countries: a case study of the use of contingent valuation surveys in Southern Haiti. *Economic Development and Cultural Change,* 293-311.

Whittington D, Okarafor A, Okore A & McPhail A. (1990b). Strategy for cost recovery in the rural district sector: a case study of Nsukka District, Anambra State, Nigeria. *Water Resources Research,* 26(9): 1899-1913.

Whittington D, Smith V.K, Okorafor A, Okore A, Lium L. & McPhail A. (1992). Giving respondents time to think in contingent valuation studies: a developing country application. *Journal of Environmental Economics and Management,* 22(3): 205-225.

Whittington D, Lauria D. T, Choe K, Hughes J.A. & Swarna V. (1993a). Household sanitation in Kumasi, Ghana: a description of current practices, attitudes, and perceptions. *World Development,* 21(5): 733-748.

Whittington D, Lauria D. T, Wright A, Choe L, Hughes J.A. & Swarna V. (1993b). Household demand for improved sanitation services in Kumasi, Ghana: a contingent valuation study. *Water Resources Research,* 29(6): 1539-1560.

Whittington D, Pattanayak S. K., Yang, J.-C, & Kumar K. (2002). Household demand for improved pipe water services: evidence from Kathmandu, Nepal. *Water Policy* 4(6):531-556.

Whittington D, Davis J, & McClelland E. (1998). Implementing a demand-driven approach to community water supply planning: a case study of Lugazi, Kenya. *Water International* 23(3):134-145

Williams J.R. (1983). Towards community managed drinking water schemes in Nepal. *Waterlines,* Vol. 2 No. 2, October.

World Bank Water Demand Research Team. (1993). The demand for water in rural areas: determinants and policy implications. *The World Bank Research Observer* 8(1): 47-70.

Yamout G. & Jamali D. (2007). A Critical assessment of a proposed public private partnership (PPP) for the Management of Water Services in Lebanon, *Water Resources Management,* 21(3): 611-634.

Young, R.A. (1973). Price elasticity of demand for municipal water: a case study of Tueson, Arizona, *Water Resources Research*, 9(12): 1068-1072.

Newspapers

Dainik Asam. (2004). Guwahatir Jalasankat Mochanar Prachestat Agrasar 'Brahmajal'. Dainik Asam. May 22, 2004. *Guwahati, India:* Dainik Asam..

UN Reports. (2008). UN says half the world's population will live in urban areas by end of 2008. *The Associated Press. Published February, 26.* 2008.

Reports

Alaerts G. J, Blair T.L. & Hartvelt F.J.A. (1991). A Strategy for Water Sector Capacity Building. *International Institute for Hydraulic and Environmental Engineering (IHE), United Nations Development Program (UNDP).* New York: UNDP.

Black M. (1994). Mega-Slums: the coming sanitary crisis. *Water Aid discussion paper. London: Water Aid.*

Brocklehurst C. (2002). Setting the Stage: The Process of Preparing for Pro-poor Water Sector Reforms in Kathmandu. *Field Note. Washington, DC: Water and Sanitation Program*, The World Bank.

Brook-Cowen P. (1997). Getting the Private Sector Involved in Water: What To Do in the Poorest of Countries, Private Sector. *Note No. 102, January 1997. Washington: World Bank.*

DFID. (1998). Lessons Learned from NGO Experiences in the Water Sector. from the *Water and NGOs Workshop, 21 January 1998. London:DFID.*

Estache A, Foster V., & Wodon Q. (2002). Accounting for Poverty in Infrastructure Reform: Learning from Latin America's Experience. *WBI Development Studies No 23950.*

Fox W. F. (1994). Strategic Options for Urban Infrastructure Management. Urban Management Programme Paper, 17. *Published for the Urban Management Programme by the World Bank. Washington D.C.*

Gentry, Bradford S, & Lisa O. Fernandez. (1997). Evolving Public-Private Partnerships: General Themes and Urban Water Examples. *To the OECD Workshop on Globalization and the Environment: New Challenges for the Public and Private Sectors. Paris: OECD.*

Hartvelt, Frank & Anton D. (1997). Financing Community Water Supply: Loans, Guarantee Funds and Supporting Institutions. *UNDP Discussion Paper.* UNDP: New York.

Hearne, Robert R. & Johnstone N. (1997). Private Sector Participation in the Provision of Water and Sanitation Services and Realization of Environmental and Social Objectives. *International Institute for Environment and Development (IIED):* London.

Idelovitch, Emanuel, & Ringskog K. (1995). Private Sector Participation in Water Supply and Sanitation in Latin America. *World Bank*: Washington, DC.

IIED. (1998). Private Sector Participation in Water and Sanitation Services: Balancing Economic, Environmental and Social Goals. *International Institute for Environment and Development.* London: IIED.

International Finance Corporation. (1996). Financing Private Infrastructure: Lessons of Experience, *World Bank,* Washington DC.

IRC International Water Supply and Sanitation Centre. (1996). Best Practices: Water Supply, Sanitation and Solid Waste Collection Services in Low Income Urban Areas. *IRC: The Hague.*

James S. (1998). Creative Inter-Sectoral Partnering for Urban Supply Systems in Developing Countries, UNDP/Yale Collaborative Programme, 1998, Research Clinic, New Haven, 1998.

Lee, Terence, & Andrei J. (1997). Progress in the Privatization of water-related public services: a country-by-country review for Mexico, Central America. Chile: *UN Economic Commission for Latin America and the Caribbean.*

Littlechild S. (1986). Economic regulation of Privatized Water Authorities. *Department of the Environment, HMSO,* London.

McIntosh, Arthur C. & Cesar E. Yniguez, Editors. (1997). Second Water Utilities Data Book: Asian and Pacific Region. Manila: *Asian Development Bank.*

Mitchell R. & Carson R. (1989). Using Surveys to Value Public Goods: The Contingent Valuation Method. *Washington, DC: Resources for the Future*, Inc.

Mody, Ashoka, & Haarmeyer D. (1997). Tapping the Private Sector: Reducing Risk to Attract Expertise and Capital to Water and Sanitation. *World Bank Discussion Paper. Washington: World Bank.*

Paul S. (1987). Community Participation in Development Projects. *The World Bank Experiences, discussion papers* No.6, World Bank Washington, DC.

Rivera D. (1996). Private Sector Participation in the Water Supply and Wastewater Sector. Washington: *IBRD/World Bank.*

Roth G. (1987). Private Provision of Public Services in Developing Countries. Washington: *IBRD/World Bank.*

Van Wijk C. (1997). Constraints and Key Approaches in Water Supply and Sanitation for Low Income Urban Neighborhoods. *From the First Meeting of the Task Force on O&M of Urban Water Supply and Sanitation Systems in New Delhi,* 4 September 1997.

Varley R. C.G, (1995). Financial Services and Environmental Health: Household Credit for Water and Sanitation. USAID Applied Study 2. Washington, DC: *USAID, Environmental Health Project.*

Walker J. (1993). Preparing for Private Sector Participation in the Provision of Water Supply and Sanitation Services. *WASH Technical Report No. 84.* Environmental Health Project. Washington: USAID.

Water Supply and Sanitation Collaborative Council. (1997). Final Report of the Working Group on Community Management and Partnerships with Civil Society, presented to *the Fourth Global Forum.*

WHO. (1992): The international drinking water supply and sanitation decade, End of decade review. *World Health Organization,* 1992.

Saunier B.M. (1991). The Private Sector and Capacity Building in the Management of Water Supply Enterprises. *In A Strategy for Water Sector Capacity Building by Alaerts G.J, Blair T.L, and Hartvelt F.J.A. eds. New York: UNDP.*

World Health Organization. (2002). The World Health Report 2002: Reducing risks, promoting healthy life, Geneva, *the World Health Organization.*

World Resources Institute. (1997). The Urban Environment. Washington, DC: *World Resources Institute.*

World Bank. (2004). Drinking Water, Sanitation, and Electricity. *World Development Report, 2004.*

World Bank. (1996). Participation Sourcebook. Washington, DC: IRBD/ *The World Bank.*

Websites

Asian Development Bank (2001). Tariff, Subsidies & Development Funding, Chapter 11. (www.adb.org/Documents/Books/Asian_Water_Supplies/chapter11.pdf)

Asian Development Bank. (2000). Part Two,Water Supply Sector Report. (www.asiandevbank.org/Documents/Books/Developing_Best_Practices/Water_Supply/Part2_Water_Supply.pdf)

Asian Development Bank. (2003). Report And Recommendation Of The President To The Board Of Directors On A Proposed Loan To Indian For The Urban Water Supply And Environmental Improvement In Madhya Pradesh Project November 2003, *Asian Development Bank RRP: Ind 32254.* (http://www.adb.org/Documents/RRPs/IND/rrp_ind_32254.pdf)

Asian Development Bank. (2000). Report and Recommendation Of The President To The Board Of Directors On A Proposed Loan To India For The Calcutta Environmental Improvement Project November 2000, *Asian Development Bank RRP: Ind 29466* (http://www.adb.org/Documents/RRPs/IND/rrp-29466-ind.pdf)

Asthana A.N. (1995). Demand Analysis of Rural Water Supply in Central India, *21st WEDC Conference Kampala, Uganda* (http://wedc.lboro.ac.uk/conferences/pdfs/21/Asthana.pdf)

Bhandari B, & Grant M. (2007). User satisfaction and sustainability of drinking water schemes in rural communities of Nepal. *Sustainability: Science, Practice, & Policy* 3(1):12-20. (http://ejournal.nbii.org/archives/vol13iss 1/0604-017.bhandari.html.)

Kaliba A.R, Norman D & Yang-Ming C. (2002). Willingness to pay to Improve Domestic Water Supply in Rural Areas of Central Tanzania: Implication for Policy. Department of economics, Kansas State University, Submitted to *The International Journal of Sustainable Development and World Ecology.* http://www.uaex.edu/akaliba/Documents/p03-3.pdf

Katz T. & Sara J. (1998). Making Rural Water Supply Sustainable: Recommendation from a global study. *UNDP-World Bank* http://www.its.caltech.edu/~el05/readings/rural_wate.pdf

Kinfe G.E. & Berhanu A. (2007). Valuing Water Supply Service improvements in Addis Ababa on Manual Request to *Kinfeg @ yahoo.com*

Singh R, Franceys R. & Kumar V (2003) Water Supply Projects. A Case Study of Varanasi and Chandauli Districts. *The Journal of the Institution of India* V: 84, Sept 2003 http://www.ieindia.org/publish/en/0903/sept03en6.pdf

World Bank. (2006). India, Water Supply and Sanitation, Bridging the Gap Between Infrastructure and Service. *Background Paper, Urban Water Supply and Sanitation, World Bank Report.*
(http:// www - wds.worldbank.org/external/default/WDSC content server/WDSP/IB/ 2006/10/10/000011823-2006 10 10 171344/Rendered/PDF/358360 REVISED 01 No Urban 01 PUBLIC 1. pdf.)

Working Papers

FAO CORPORATE DOCUMENT REPOSITY. (2000). Application of the contingent valuation method in developing countries A Survey. *FAO ECONOMIC AND SOCIAL DEVELOPMENT PAPER*, 146

Pathak P. (1996). Pricing and Cost Recovery of Urban Services: A Case Study of Four Indian Cities. *FIRE (D) Working Paper. Series No. 3*

Pattanayak S. K, Yang J.-C, Jones K, Gunatilake H, Berg C. van den, Agrawal C, Bandara H, & Ranasinghe T. (2005). Poverty Dimensions of Water, Sanitation and Hygiene in Southwest Sri. Lanka. *RTI Working Paper.*

Pattanayak S. K, Jones K, Berg C. van den, Yang J.-C, & Houtven. (2006). The Use of Willingness to Pay Experiments: Estimating demand for pipe water connections in Sri Lank., *World Bank Policy Research Working Paper 3818*, January 2006.

Pattanayak S. K, Yang J.-C, Whittington D, Kumar B, Subedi G, Gurung Y, Adhikari K, Shakya D, Kunwar L, & Mahabuhang B. (2001). Willingness to Pay for Improved Water Services in Kathmandu Valley. *Submitted to The World Bank, Water and Sanitation Program,* August, 2001.

Sills E.O, Pattanayak S.K, & Whittington D. (2004). Water Supply coverage and cost recovery in Kathmandu: Understanding the role of time preferences and credit constrains. *RTI Working Paper.*

Whitehead J, Pattanayak S.K, Houtven G. L. Van and Gelso B. (2003). Combining Revealed and Stated Preference Data to Estimate the Non market Value of Ecological Services. An Assessment of the Science. *RTI Working Paper.*

Whittington D, Davis J, Miasono H. and Pollard R. (1995). Urban sewer planning in developing countries and the neighborhood deal: a case study of Semarang, Indonesia. *UES Working papers, The World Bank,* Washington, DC.

Yang J.-C, Pattanayak S.K, and Foster V. (2003). Inequality Subsidized? Distributional Incidence of Water Sector Tariffs in Kathmandu, Nepal. *Discussion Paper 03_05.* Research Triangle Park, NC: RTI International.

Yang J.-C, Pattanayak S.K, Johnson F.R., Mansfield C, Jones K.M, and Berg van den C. (2005). Un-packaging Demand for Urban Water Supply: Evidence from Conjoint Surveys in Sri Lanka. *RTI Working Paper.*

ANNEXURES

ANNEXURE – I

Urban Population in India, 1901 – 2001

Year	Population (million)	Percentage of Urban to total Population	Decadal growth rate (%)
1901	29.9	10.8	-
1911	25.9	10.3	(-)13.4
1921	28.1	11.2	8.5
1931	33.5	12.0	19.2
1941	44.2	13.9	31.9
1951	62.4	17.3	41.2
1961	78.9	18.0	26.4
1971	109.1	19.9	38.3
1981	159.5	23.3	46.2
1991	217.6	25.7	36.4
2001	285.9	27.8	31.4

Source: Census of India, 1901 to 2001

ANNEXURE – **II**

INFRASTRUCTURE FINANCING OPTIONS ADOPTED BY OTHER COUNTRIES

A) UNCHS (HABITAT): INTEGRATED URBAN WATER RESOURCE AND INFRASTRUCTURE MANAGEMENT:

The United Nations Centre for Human Settlement (Habitat) launched its Settlement Infrastructure and Environment Programme (SIEP), with the objective to improve living environment of Human settlements by assisting governments and communities to achieve the settlement infrastructure related goals of Agenda 21 (UN conference on Environment and Development 1992 in Rio de Janeiro popularly known as Earth Summit) charts a new path for sustainable water resource management in an environmentally sound manner. The project "integrated management of water resources and environmental infrastructure" is funded mainly by the Governments of Denmark, Germany and the Netherlands (DANIDA) and launched in 1993. The unique approaches in two important areas of this project are (i) it recognizes the interdependence of water supply, sanitation, drainage and waste management and deals with them in a integrated way and (ii) it brings together all the relevant institutions and beneficiaries such as national and local authorities, NGO's, Communities and the private sector in a particular city, through workshops to discuss and identify their water problems and prioritize their needs.

This approach ensures the full involvement of the beneficiaries in accordance with their needs. It also promotes the transfer of responsibility from the traditional public sector institutions to the private sector and communities to provide funds for investments participate in planning, management operation and maintenance of services. The project is generally implemented in three phases—(1) research

diagnosis phase with the participation of all stakeholders analyzing the current practices for management of water resources and environmental infrastructure, identifying and prioritizing the problem and developing a strategy for improvement. (2) Generation of management and implementation tools and policy option of the particular city, but which can be solved similar problems in other city already solved This makes use of community self surveys to determine services they require, willingness to pay for each services etc. (3) Building capacity of institution through training to apply tools already develop and implementation of pilot projects to test them. This may lead to bi and multilateral financing for projects. As one of the objectives of this project is to provide sustainable services, it promotes cost recovery as an integral part of all interventions to improve self reliance and reduce dependence an external support. It also focuses on way of sustaining the research base by promoting wastage minimization.

B) UNITED NATIONS ENVIRONMENT PROGRAMME: URBAN WATER RESOURCES IN PERI URBAN AREAS:

United Nation Environment Programme (UNEP) launched a programme "Integrated Urban Water Resources Management in Peri Urban Areas" in 1996. It seeks to promote multi-agency approach to the provision of services and management of water resources in peri-urban areas, equity and efficiency in water consumption between and among competing sectors like agriculture, domestic and industrial; institutional reforms and board based partnership among public and private sectors and committees, UNEP is striving to promote environmentally sustainable development and use of water resources for the benefit of humankind. It is also responsible for global mandate on water and chairs the United Nations Inter Agency Task Force on water. UNEP has been dealing high 'Fair Share' allocation of water among competing uses and users in co-operation with global, regional and sub-regional organization in Africa.

C) THE WATER SUPPLY AND SANITATION COLLABORATIVE COUNCIL:

From a resolution taken in United Nation in 1991, the Water Supply and Sanitation Collaborative Council had formed which is an innovative mechanism, but it is not a United Nations body. The council meets at two-year intervals to provide a forum for the exchange of experiences, views and agree on common approaches for advancing progress in water supply and sanitation. The Council's statement (Prepared for Habitat II delegates, under the heading "Water and Sanitation; Today's Action, Tomorrow's Hope for Millions") calls for fundamental changes in approach and much higher levels of invest in water supply and sanitation provision. It says that 'mobilizing and assisting low-income urban communities to obtain and use hygienic sanitation facilities need to be a high priority in settlement planning. Again it speaks "Governments need to initiate and donors need to support capacity building programmes and participating techniques which will equip them to effect the necessary in institutional, legislative and operational reforms.

D) WATER AID – BRITISH APPROACH:

British water Industry created Water Aid in 1981 in response to the United Nations sponsored International drinking Water Supply and Sanitation Decade (1981-1990), to work with some of the poorest communities at the grass roots. The approach of World Aid is Unique and it does not implement projects by own but by local Organizations. The local organization may be the non-governmental Organizations (NGOs) including churches and woman groups or central / state government departments. Water Aid insists on major and active participation on a self-help basis by these who will benefit from the project.

Water Aid is a small player on the global stage with an annual income of £ 7.6 million; its direct support can only even have a modest impact but this investment have a radical impact on the policies of other, much larger organization. For example,

between 1984 and 1995, Water Aid spent £ 3.0 million for development of a water and sanitation programme in Ghana – money invested in simple and practical water systems built and maintained by local organizations and benefiting lacs of people. That investment include a very beneficial dividend as US $ 28 million loan from the World Bank to help more Ghanaians gain access to safe water and Sanitation. Through the World Aid has been associated with rural areas, it plans to increase the involvement in the urban and peri-urban environment.

E) PARTICIPATORY BUDGETING: LATIN AMERICAN APPROACH:

Participatory Budgeting (PB) enables the population to define the use of public resources, generally a portion of the investment budget. Here the population has the opportunity to discuss and decide the budget and public policies i.e. it combines direct democracy and representative democracy. Participating Budgeting has been adopted by large no. of cities in Latin America, through it was started in handful of Brazilian cities in early 1990s. It has been adopted by more than 200 cities now in Latin America. European cities have started adopting PB. Though PB processes one still driven by local authorities and concentrates in cities, it has gone beyond the municipal sphere, they occur at various levels—(i) within a "Portion" of Municipal boundaries e.g. in the rural "parroquias" of Cuenca in Equador (ii) at state or provincial level e.g. some Peruvian provinces have taken up PB (iii) at national level e.g. a recent constitutional reform in Peru was followed by legislation on decentralization and local governments which facilitating legal framework for PB. PB is an integral part of the Global Campaign on Urban Governance, supported by UN-HABITAT. PB contributes to good governance as (i) it increases equity through a higher percentage of the budget being allocated to pro-poor policies and programmes, (ii) it strengthens democracy enabling people to formally participate in city planning and public policies, (iii) it contributes accountability because in PB budgets and accounts are made public and sometimes the same happens for tender and public contracts. When projects are implemented through committees composed of delegates, corruption ends

to drop dramatically (iv) it improves security reducing conflict among different groups at the time of participation in budgeting.

PB does not speak about the role of city councilors in it and they generally feel threatened by it reducing their established power and shake the foundation of their constituencies.

ANNEXURE – **III**

GOVERNMENT OF INDIA WATER SUPPLY, INSTITUTIONAL STRUCTURE, POLICIES AND PROGRAMMES:

In India, the Central Government is responsible for the regulation and development of inter state river and river basins for the interest of the public. The Ministry of Urban Development is the principal department of Central Government that coordinates urban water supply sector activities with the help of Central Public Health and Environmental Engineering Organization (CPHEEO). Ministry of Health and Family Welfare ministry of water resources ministry of environment and Trade and the planning commission extend to assistance to Ministry of Urban Development (MoUD). Ministry of water resources deals with regulation of ground water. At present no ministry plays the role of economic regulator of urban water supply. In India urban water supply is a state subject. State Governments lay down policies for the allocation of water for different purpose and established institutional system. The institutional arrangement may vary from state to state. The urban water supply related issues have been dealing by State Level Public Health Engineering Departments (PHEDs), Specialized State Level Water Supply Boards, Specialized City Level Boards, Municipal Corporations and Urban Local Bodies. Water supply for domestic, industrial and commercial purposes is one of the 18 functional responsibilities of ULBs as per Constitutional Amendment Act, 1992. But till today the responsibilities for planning and implementation of urban water supply programmes in cities without own water supply board had to carry out by state level water supply board and PHEDs .Again though the operation and maintenance of urban water supply programme, after completion, to be carries out by ULBs but often state level entities have to carry out operation and maintenance of it due to lack capacity and incentives of ULBs.

Only Delhi, Chennai, Hyderabad and Bangalore have semi autonomous water supply board i.e. nominated boards with limited functional autonomy and Kolkatta and

Mumbai Municipal Corporation have separate department to deal with water supply operation. Other ULBs have either no deal with water supply or have merged with other municipal services. Merging with other services leads to absence of transparency and accountability. As a result urbanites have low level of water supply services.

Government of India, in its first Five Year Plan had included provisions of water supply services as a development priority but till the first National Water Policy was formulated in 1987, drinking water was not given priority over other water uses. National Water Policy, 1987 also stated that the water rates should cover a portion of fixed cost and the annual maintenances and operation charges. National Water Policy, 2002 advocated for the new approaches to water management including re-inforcement that drinking water is the top priority over competing water uses, monitoring and enforcement water quality measures etc. It also introduced the concept of private sector participation, commercialization and cost recovery. Ninth Five Year Plan (1997-2002) has included extension of water services to the entire population; reinforcing the Constitutional Amendment, enhancing financial viability through full cost recovery etc.

Government of India had launched the programme "Accelerated Urban Water supply programme (AUWSP)" in 1993-94 aiming to extend water supply services for class IV to VI cities and towns. The funding pattern for this programme is 50% of the programme funds are provided by Central Government and 50% by the State. State level Committees select the towns to be covered under this scheme. Selection of towns depends on low per capita water supply, deep or contaminated water sources, high incidence of water borne diseases and draught prone areas. The Detailed Project Report (DPR) to be submitted for getting selection under this scheme should highlight (i) provision of sustainable Operation & Maintenance mechanism, (ii) sustainable water tariff approved by state governments, (iii) provision of 5% contribution towards the project cost from the ULBs. Till January, 2003 total no. of towns that got sanction for water supply scheme was 796 out of which 298 towns had completed or

commissioned the scheme under AUWSP in India but the conditions laid down in the DPR are not followed by any ULBs at the implementation of the project..

Public Health Engineering Training, Research and Development Program was initiated by Government of India in 1956 through CPHEEO. This centrally managed program aims at providing training to the employees of states, ULBs and mega cities about public health components of water supply projects. During 1989-2002 nearly 16000 public health engineers had been trained for which an amount of Rs. 83 Million had spent from the allotted amount of Rs. 100 Million.

ANNEXURE – **IV**

CURRENT FINANCING PRACTICES IN URBAN INFRASTRUCTURE DELIVERY IN INDIA:

The 5 year Plans and Annual Plans of Central Government, State Government and local bodies earmarks fund for urban infrastructure development in India. The resources have been supplemented with funds from LICI, World Bank, other multilateral and bi-lateral programmes (ADB, OECT, KFW, ODA (DFID), DANDIA, CIDA, SIDA, EU, USAID etc.) routed through Central / State governments to supplement the plan allocations partly as grants and partly as loans. Thus all these funds passed on to states, then to the projects as a part of budgetary system, the commercialization of projects/ recovery of costs for beneficiaries could not be effectively introduced. Repayments of loans, if any, were generally book adjustment. In many cases, these loans remained in books of accounts ultimately to be adjusted or written off by the state / central Government and so commercial institutions do not want to finance this type of projects. The existing financing arrangement has led to a situation of inappropriate incentive at the borrower's end and resultant inefficient utilization of funds. Moreover urban local bodies are unable to generate their own contribution to project resources, as they do not have operating surpluses.

Through the budgetary provisions for urban water supply and sanitation steadily increased from 1st Five year Plan (1951-56) to 10th Five year Plan (2002-2007), it has been found to be highly inadequate. As per CPHEEO (Central Public Health and Environmental Engineering Organization), investment requirement for urban water supply during tenth plan will be Rs. 28,240 crores, but as amount of Rs. 1000 crores only has been earmarked in tenth plan for this purpose. The gap points out the need of mobilization of resources.

ANNEXURE – V

MUNICIPAL BOND:

Municipal Bonds are debt instruments floated by local governments or related agencies for borrowing on commercial terms directly from market. Repayment of the bonds is based on general credit and taking powers of issuing government. Quality of bonds depends upon the power to impose taxes and quality of tax base. If the urban local bodies are allowed to freely price its services, instead of being forced to follow government guidelines, it will lead to an increase in investor confidence. Investor confidence will arise from the fact that the right price being charged (minus subsidy) will generate enough revenue to enable the municipality to redeem debentures alongwith interest. This will go a long way in increasing quality of bonds. Municipal Bond could become the mainstay of urban infrastructure sector provided the Central and State Government enact enabling legislation and develop an effective institutional framework, for the development of bond market.

In the United States, Municipal Bonds account for nearly 70% of the capital financing for infrastructure through General Obligation Bond and Revenue Bond. In India, Ahmedabad Municipal Corporation (AMC), decided to improve the network of water and sewage facilities but resource crunch faced by the Gujarat Government limited the state Government grant. AMC decided to introduce Municipal Bond to access debt market. It was the first time in South Asia that a local self government accessed the capital market through a municipal Bond. AMC received an amount of Rs. 1046.7 million by issuing 1,000,000 secured redeemable bonds of Rs. 1000.00 each. CRISIL, India's oldest and largest rating agency rated AMC's Municipal Bond as AA (High Safety).

In India, Indore Municipal Corporation (IMC), India launched a programme "Mayor at your doorstep" as a mechanism for meeting people alongwith all the officials and elected members in the ward and resolving the specific problems of each ward. Contributions from citizens were 36% of the total cost of project "Construction of lanes and by lanes identified by the community" which was raised to 40% later on. The identified road stretch is approved by the Mayor in Council and the Public Works Department prepares the bill of quantities. The community contributes either by cash or by providing some of the materials through the residents association. The technical assistance is provided by the IMC for designing and implementating the task.

ANNEXURE – **VI**

PUBLIC- PRIVATE- PEOPLE'S PARTNERSHIP: PROSPECTS AND CONSTRAINTS:

To counter the inadequate urban infrastructure Public Private Partnership (PPP) options have emerged through different models like Build-operate-transfer (BOT), Build-Operate-Own-Transfer (BOOT), Build-Operate-Lease-Transfer (BOLT), Design-Build (DB), Design- Build-Operate (DBO), Design-Build-Finance (DBF), Design-Build -Operate-Finance (DBOF), Concession, operation and management (O&M). The PPP approach helps local bodies to gain private sector innovation in terms of technology of financial and management expertise. All PPP projects are not success stories, because the local body has to consider various factors in selecting the kind of PPP arrangement suitable for a particular project. Thus, there is a need to engage the 4th P-People in the partnership process to sustain the arrangement through civic groups, foundation, institutions and other organizations. Community based organization must have a role in supporting some of the operational system related to O&M of urban infrastructures. People participation in PPP combines social responsibility, local knowledge and job generation concerns of the public sector for success of the partnership.

The Private Finance Initiative (PFI) in U.K. was announced in 1992. It aims in achieving closer partnership between the public and private sectors for provision of public services. The cost of the private sector is covered by a payment either from public users, Government or a mixture of both over a period of time.

The Community Mortgage Programme (CMP) of Philippines is an innovative financing programme designed to enable the poor to acquire land and facilitate provision of services. It was conceived as a mortgage programme based on principal of community responsibilities and guarantees.

ANNEXURE – **VII**

Questionnaire for Studying Consumer's Perceptions about 'water supply'

Dear Respondent

I am a research scholar of the Deptt. of Business Administration, School of Management Sciences, Tezpur University (Assam), doing my research on the topic "A study of Water Supply Infrastructure in Tezpur Urban Agglomeration Area, Assam, India". For this purpose, a study is being conducted to study consumers' perception about 'Water supply'. Your responses will be kept confidential and used only for academic purpose. Your co-operation is highly solicited.

Thank you.

Sincerely yours,

(JATIJIBAN BORA)
Research Scholar
Deptt. of Business Administration
Tezpur University, Tezpur

Please put (√) tick mark in the appropriate box.
(SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree)

1. If you possess a municipal / PHE water supply connection, how will you read to the following statements? Else please skip and go to the next question.

	Statement	SD	D	N	A	SA
i)	The quantity of water received is inadequate.					
ii)	The water received, contains excessive iron.					
iii)	The water received is found to be muddy sometimes.					
iv)	Water supply timings are irregular.					
v)	Water pressure is inadequate.					
vi)	The water supply depends on power supply.					
vii)	Additional water is collected from other sources to meet the demand.					
viii)	The monthly tariff is too high.					
ix)	The concerned authority does not respond promptly to the complaints					
x)	Disconnection is done now and then.					
xi)	Privatization will lead to better operation and maintenance of the existing system.					

2. If you possess a ring well / tube well / own piped water supply, how will you react to the following statements? Else please skip and go to the next question.

	Statement	SD	D	N	A	SA
i)	The water contains excessive iron.					
ii)	The water contains some foreign particles.					
iii)	The water sometimes has foul odour.					
iv)	Without treatment, one should not use this water for drinking.					
v)	Money is spent on water purification.					
vi)	Water dries up and becomes muddy during winter.					

3. If you collect water from municipal / PHE stand pipe, how will you react to the following statements? Else please skip and go to the next question.

	Statement	SD	D	N	A	SA
i)	A lot of time is spent standing in the queue.					
ii)	Stand pipes are located at a distance from the house.					
iii)	Only drinking water is collected from it.					

4. If a new water supply scheme is going to be installed in your locality, how important would the following factors be? (I implies 'very low in importance', 7 implies 'very high in importance')

	Statement	1	2	3	4	5	6	7
i)	It should be 24 hours continuous supply.							
ii)	The water to be supplied should be hygienically safe and aesthetically attractive.							
iii)	Instead of a big project, there should be a number of small projects.							
iv)	Urban / Rural local body like Municipalities / Gaon Panchayats should be involved in its implementation.							
v)	PHED / UWSSB / District Administration should be involved in its implementation.							
vi)	Community level registered society / Private Organization should be involved in implementation of the project from conception.							
vii)	Community level registered society / Private Organization should be involved implementation of the project from construction stages.							
viii)	Community level registered society / Private Organization should be involved in operation and maintenance of the project.							
ix)	Consumers should be allowed to finance the scheme if required.							
x)	Connection charge / monthly tariff should be fixed by the consumers through societies.							
xi)	Monthly tariff should be collected through computerized collection centers proposed to be set up at some suitable localities.							
xii)	Grievance handling should be prompt.							
xiii)	Water supply service should not be a subsidized one							
xiv)	Financial transparency should be maintained.							
xv)	Routine quality check of water must be done and consumers must be informed.							
xvi)	Provisions must exist for solving legal disputes.							

5. How will you avail the proposed new water supply scheme to be set up in your locality?

1. Personal connection ☐
2. Community level tap ☐
3. Will not avail ☐

6. As per your assessment, what will be your requirement of water in a day?

1. Less than 500 litres ☐
2. 500 litres to 999 litres ☐
3. 1000 litres to 2000 litres ☐

7. How much would you be willing to invest in the proposed new water supply scheme to be set up in your locality?

1. Less than Rs. 5,000/- ☐
2. Rs. 5,000/- to Rs. 9,999/- ☐
3. Rs. 10,000/- to Rs. 20,000/- ☐
4. More than Rs. 20,000/- ☐
5. Will not invest ☐

8. If you invest, do you want any return from your above investment?

1. Yes ☐
2. No ☐

9. If 'yes' to question No. 8 please indicate in what form you would like the return (You may tick more than one):

1. Deduction from monthly tariff. ☐
2. Share of the profit earned from the scheme. ☐
3. Fixed rate of return ☐
4. Any other (please specify) ☐

10. According to you, what should be the connection fees for a 'personal connection'? (i.e. cost of pipes, plumbing works etc.)

1. Less than Rs. 1,000/- ☐
2. Rs. 1,000/- to Rs. 1,999/- ☐
3. Rs. 2,000/- to Rs. 2,500/- ☐
4. Between Rs. 2,500/- and Rs. 5,000/- ☐

11. In your opinion, what should be the basis for fixing monthly water tariff?

1. Monthly fixed rates ☐
2. As per meter reading ☐
3. As per meter reading + fixed component ☐

12. According to you, what should be the amount of monthly tariff?

1. Less than Rs. 100/- ☐
2. Rs. 100/- to Rs. 200/- ☐
3. Rs. 201/- to Rs. 300/- ☐
4. Between Rs. 300/- and Rs. 500/- ☐

13. Have you or any of your family members / employees occasionally suffered from any water borne diseases?

1. Yes ❒
2. No ❒

14. If 'yes' to question No. 13 what is the average monthly expenditure for the treatment of water borne diseases?

1. Below Rs. 100/- ❒
2. Rs. 100/- to Rs. 500/- ❒
3. More than Rs. 500/- ❒
4. Do not know ❒

15. In which of the following activities, would you like to participate in a 'water supply scheme' in your locality for its operation and maintenance? (You may tick more than one)

1. Minimizing water losses and theft ❒
2. Ensuring timely deposit of monthly tariff ❒
3. Repairing minor damages in the distribution network ❒
4. Handling complains ❒
5. Quality control checks ❒
6. No participation ❒

Demographic Profile (Please provide your personal details)

16. The building that you presently occupy is:

1. Own ❒
2. Rented ❒
3. Official Quarter other than municipal / P.H.E. ❒
4. Municipal / P.H.E. Quarter ❒

17. Present water supply provision in your house / organization (You may tick more than one):

1. Ring well ❒
2. Own pipe water supply ❒
3. Municipal / PHE Street tap ❒
4. Municipal / PHE personal connection ❒
5. Tube well ❒

18. No. of members in the household / organization:

1. 1 – 4 ❒
2. 5 – 7 ❒
3. 8 – 20 ❒
4. More than 20 ❒

19. Occupation of the head of the household / nature of work of the organization:

1. Business ❒
2. Service ❒
3. Independent Professional ❒
4. Agriculture ❒
5. Others ❒

20. Average monthly income of the household / revenue of organization:

1. Less than Rs. 5,000/- ❒
2. Rs. 5,000/- to Rs. 9,999/- ❒
3. Rs. 10,000/- to Rs. 20,000/- ❒
4. More than Rs. 20,000/- ❒

21. Educational qualification of the house wife (Only for individual respondents):

1. Below H.S.L.C. ❒
2. H.S.L.C ❒
3. H.S. ❒
4. Graduate ❒
5. P.G. and more. ❒

22. Name:.....

23. Locality: Ward No .....Village.....

Date :.....

Time :.....

ANNEXURE – **VIII**

In mythology Tezpur, with its surrounding territories was known as 'Sonitpur', which was ruled by King 'Bana' of Mahabharata era. It is believed that the present Tezpur town was the site of the great battle fought between Lord Krishna and Lord Shiva. Lord Krishna fought for his grandson 'Anirudh' who wanted to marry 'Usha', the daughter of King 'Bana'. 'Bana" being a great devotee of Lord Shiva had Lord Shiva fight on his side. The battle resulted in great bloodspread and for that the place was named as Sonitpur or Tezpur (Sonit/ Tez in Assamese means blood). At present the town and its surrounding areas have plenty of evidences of mighty kingdom of 'Bana'; Bamuni Hill, Agnigarh, Mahabhairab Temple, Bhairabi Temple are some of them.[1]

The growth of population and its decadal variation in TUA is as given below-

Year	POPULATIONS								
	Tezpur town	Barika Chuburi	Bamun Chuburi	Majgaon	Dekar Gaon	Parbatia Gaon	Deori Gaon	Hazarapar Dekar Gaon	TUA
1971	39,870	1,659	1,186	2,237	527	1,762	1,437	473	49,151
1991	55,084 (38.16)	3,705 (123.33)	1,537 (29.60)	5,157 (130.53)	1,147 (117.65)	2,689 (52.61)	1,538 (7.03)	816 (72.52)	71,673 (45.82)
2001	80,576 (46.28)	6,277 (69.42)	3,972 (158.43)	6,820 (32.25)	1,665 (45.16)	3,426 (27.41)	1,687 (9.69)	941 (15.32)	1,05,364 (47.01)

Source: Census of India (1971), (1991), (2001)

[1] Government of Assam (2007), The Assam Gazette, No. 401, 28th December, 2007

ANNEXURE – **IX**

Assam Urban Water supply and Sewerage Board (AUWSSB) had started functioning with effect from January/1989 as per Assam Urban Water supply and Sewerage Board Act, 1985. The functions of the board are – (i) the promotion and operation of schemes for supply of water, storm water drainage, sewerage treatment and its disposal, (ii) any other function entrusted to the board by the state government and local authorities. The power of the Board includes – (i) to take over all the responsibilities, power, control, facilities, services and administration within the urban areas from the local bodies relating to water supply, sewerage and sewage disposal so as to provide safe drinking water, efficient sewerage and storm drainage services to the people of those areas, (ii) to investigate, plan and prepare schemes for water supply, sewerage and storm water drainage services in urban areas in consultation with the local authorities and carry out their execution.

Till now, the Board has taken loan from HUDCO for 11 schemes although the total number of sanctioned schemes is 14. The Board has taken Rs. 4551.51 Lacs from HUDCO as loan assistance for the 11 schemes. Again 12 water supply schemes under AUWSP as well as 2 more under Non Lapsable Central Pool of Resources (NLCPR) have been being implemented by the Board in different towns of Assam.

The problems of AUWSSB are – i) high interest rate of HUDCO (about 15% to 17%), ii) slow progress of work due to problem in land acquisition, poor soil condition, longer rainy season, transportation bottlenecks, insurgency problem, iii) much lower home connections than the designed one, iv) erratic electric power supply or power supply at low voltage leads to difficulty in running the treatment plant, reducing water pressure etc.

Annexure – **X**

RECOMMENDED PER CAPITA WATER SUPPLY LEVELS FOR DESIGNING SCHEMES

Sl. No.	Classification of towns/cities	Recommended Maximum Water Supply Levels (lpcd)
1.	Towns provided with piped water supply but without sewerage system.	70
2.	Cities provided with piped water supply where sewerage system ii existing/contemplated.	135
3.	Metropolitan and Mega cities provided with piped water supply where sewerage system is existing/contemplated.	150

Note:

(i) In urban areas, where water is provided through public standpipes, 40 lpcd should be considered.

(ii) Figures exclude "Unaccounted for Water" (UFW) which should be limited to 15%.

(iii) Figures include requirements of water for commercial, institutional and minor industries. However the bulk supply to such establishment assessed separately with proper justification.

Source: CPHEEO Manual, 1999

ANNEXURE – **XI**

REPORT ON BACTEROLOGICAL ANALYSIS

GOVT.OF ASSAM
OFFICE OF THE STATE PUBLIC HEALTH LABORATORY:
-GUWAHATI-
111

REPORT ON BACTERIOLOGICAL ANALYSIS.

Sample sent by : Asstt.Chemist,Mobile Laboratory,Tezpur

Sender's ref.No. : 03/MWM/ML/Tez/01/11, dt. 5.11.01

Date of sampling : 5.11.01

Date of receipt : 7.11.01

Date of Examination : 7.11.01

Sample by : Asstt.Chemist,Mobile Laboratory,Tezpur

Lab.Ref.No.	Particulars of samples	Results		
		R.Chlorine (Cl) mg/l	Coliform MPN/100 ml	E.coli MPN/100 ml
1469/01	Water from River Brahmaputra, water treatment Plant,Agnigarh, up.Tezpur	Nil	2400	460
1470/01	Tap water,Treatment Plant,Agnigarh, Bown	Nil	2400	1100
1471/01	Tap water from Ganesh Mandir, Ward No.8	Nil	2400	460
1472/01	Tap water from A.S.E.B.Tinisli Ward No.5	Nil	2400	1100
1473/01	Tap water from Chouk Bazar, Ward No.5	Nil	2400	460

Remarks: Bact 1469/01 to 1473/01 Bacteriologically highly Unsatisfactory.

for PUBLIC ANALYST TO THE GOVT.OF ASSAM:BAMUNIMAIDAN:GUWAHATI-21.

ANNEXURE – **XII**

CALCULATIONS SHOWING THE NPV OF THE PROPOSED WATER SUPPLY SCHEME IN TUA

Assumptions & Detailed Break-up:

- Projected Population as per revised master plan published by Government of Assam has been given below:

Year	Urban TUA	Rural TUA	Total TUA
2011	1.12 Lakhs	0.33 Lakhs	1.45 Lakhs
2021	1.51 Lakhs	0.43 Lakhs	1.94 Lakhs

- Water requirement as per CPHEEO (70 litres/ capita/ day). The Survey average was 881 litres/ household/ day.

Year	Water Requirement
2011	145000 * 70 = 10.15 MLD
2021	194000 * 70 = 13.58 MLD

- Cost of initial investment of the Project has been taken from Tenth Five Year Plan report of the Government of India, and price escalation till date has been incorporated. As per the report, the cost for 1 MLD capacity water supply project varies from Rs. 0.81 Crores to 2.03 Crores, in the year 1999.
  Taking the average, it comes as = $\frac{0.81 + 2.03}{2}$ = Rs. 1.42 Crores.
  Considering a price escalation of 6% per year , as per government norms, the cost for 1 MLD capacity water supply project in the year 2008 works out as:
  $1.42 * (1.06)^9$ = Rs. 2.40 Crores
  Hence, total fund requirement = 13.58 * Rs. 2.40 Crores = Rs. 3259,00,000.00
  (Since total requirement by 2021 will be 13.58 MLD)

- Expected Connections:

  90% of the household will apply, in 2011: 0.90 * 29000 = 26100 nos.

  in 2021: 0.90 * 38800 = 34920 nos.

  (Survey average was 89.25%)

- Contribution towards initial investment:

  As per the survey, 45% of respondents showed willingness to invest in the project cost. The majority of households, those who wanted to avail the water supply service, wanted to invest, on an average, Rs. 5000.00 towards the project cost. Hence, funding from households works out to

  45% * (90% * 29000) * Rs.5000.00 = Rs. 587, 25, 000.00

  The balance fund i.e Rs. 3259,00,000.00 - Rs. 587,25,000 = Rs. 2671,75,000 would be arranged as Government grants.

- Operation & Maintenance cost has been taken from the average cost borne by Tezpur Municipal Board during the last five financial years from 2003-04 to 2007-08 (About Rs. 20.00 per Kilo Litres per Month)

  For 2011 – 2020: Rs. 2,00,000.00 per MLD per Month (Rounding off to nearest Lakhs)

  For 2021 – 2035: Rs. 2,50,000.00 per MLD per Month (Rounding off to nearest Lakhs)

- Connection fee to be charged at Rs. 1000.00 (Survey Average was Rs. 925.67).
- Monthly fee to be charged at Rs. 150.00 (Survey Average was Rs. 146.47).

Calculation of NPV:

Year	Revenue		O & M Cost	Depreciation	EBIT	Tax @ 12.36%	PAT	CFAT	PVIF	CFAT* PVIF
	Connection fee	Monthly Tariff								
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	26100000	46980000	24360000	19554000	29166000	3604918	25561082	45115082	0.9091	41014121
2		46980000	24360000	18087450	4532550	560223.18	3972327	22059777	0.8264	18230200
3		46980000	24360000	16730891	5889109	727893.8	5161215	21892106	0.7513	16447539
4		46980000	24360000	15476074	7143926	882989.2	6260936	21737010	0.6830	14846378
5		46980000	24360000	14315369	8304631	1026452	7278179	21593548	0.6209	13407434
6		46980000	24360000	13241716	9378283.8	1159155.9	8219128	21460844	0.5645	12114646
7		46980000	24360000	12248587	10371413	1281907	9089506	21338093	0.5132	10950709
8		46980000	24360000	11329943	11290057	1395451	9894606	21224549	0.4665	9901252
9		46980000	24360000	10480198	12139802	1500480	10639323	21119521	0.4241	8956789
10		46980000	24360000	9694183	12925817	1597631	11328186	21022369	0.3855	8104123
11	34920000	62856000	62856000	8967119	48068881	5941314	42127567	51094686	0.3505	17908687
12		62856000	62856000	8294585	13821415	1708327	12113088	20407673	0.3186	6501885
13		62856000	62856000	7672491	14443509	1785218	12658291	20330782	0.2897	5889828
14		62856000	62856000	7097054	15018946	1856342	13612604	20709658	0.2633	5452853
15		62856000	62856000	6564775	15551225	1922131	13629093	20193868	0.2394	4834412
16		62856000	62856000	6072417	16043583	1982987	14060596	20133013	0.2176	4380944
17		62856000	62856000	5616986	16499014	2039278	14459736	20076722	0.1978	3971176
18		62856000	62856000	5695712	16920288	2091348	14828940	20524652	0.1799	3692385
19		62856000	62856000	4806034	17309966	2139512	15170455	19976889	0.1635	3266221
20		62856000	62856000	4445581	17670419	2184064	15486355	19931936	0.1486	2961886
21		62856000	62856000	4112162.5	18003838	2225274.3	15778563	19890726	0.1351	2687237
22		62856000	62856000	3803750	18312250	2263394	16048856	19852606	0.1228	2437900
23		62856000	62856000	3518469	18597531	2298655	16298876	19817345	0.1117	2213597
24		62856000	62856000	3254584	18861416	2331271	16530145	19784729	0.1015	2008150
25		62856000	62856000	3010490	19105510	2361441	16744069	19754559	0.0923	1823346

NPV = $\sum$ CFAT * PVIF - Initial Cost = Rs. 2240,03698.00 – Rs. 3259,00000.00 = (-) Rs. 1018, 96302.00

(Discount Rate=10%)

Columnwise Calculations:

- Column (2), Connection Fee: 26100 * Rs.1000.00 for 2011-2020 &
  34920 * Rs.1000.00 for 2021-3035

- Column (3), Monthly tariff: 26100 * Rs.150.00 * 12 for 2011-2020 &
  34920 * Rs. 150.00 * 12 for 2021-3035

- Column (4), O & M Cost: Rs. 2,00,000.00 * 12 * 10.15 for 2011-2020 &
  Rs. 2,50,000.00 * 12 * 13.58 for 2021-3035

- Column (5), Depreciation (Cost of Machinery = 80% of the Cost of initial investment of the Project)

Year	Cost of machinery	Depreciation* @ 7.5%	Year	Cost of machinery	Depreciation* @ 7.5%
1	260720000	19554000	14	94627392.5	7097054.77
2	241166000	18087450	15	87530338.06	6564775.35
3	223078550	16730891.3	16	80965562.71	6072417.2
4	206347658.8	15476074.4	17	74893145.5	5616985.91
5	190871584.3	14315368.8	18	69276159.59	5195711.97
6	176556215.5	13241716.2	19	64080447.62	4806033.57
7	163314499.4	12248587.5	20	59274414.05	4445581.05
8	151065911.9	11329943.4	21	54828833	4112162.47
9	139735968.5	10480197.6	22	50716670.52	3803750.29
10	129255770.9	9694182.82	23	46912920.23	3518469.02
11	119561588.1	8967119.1	24	43394451.21	3254583.84
12	110594469	8294585.17	25	40139867.37	3010490.05
13	102299883.8	7672491.28			

*Depreciation has been calculated using Written Down Value Method

- Column (6), EBIT= Column (2) + Column (3) - Column (4) - Column (5)

- Column (7), Tax= 0.1236*Column (6)

- Column (8), PAT= Column (6) - Column (7)

- Column (9), CFAT= Column (8) + Column (5)

- Column (10), PVIF

Sl. No.	Equity/ Debt	Amount	Cost	Proportion	WACC
(1)	(2)	(3)	(4)	(5)	(6)
1.	Equity	Rs. 587,25000.00	0.08	0.18	0.08*0.18+ 0.82*0.1052 =10%
2.	Debt	Rs. 2671,75000.00	0.12 * (1- 0.1236)[2] = 0.1052	0.82	

Hence, PVIF = $1 / (1 + 10\%)^n$, n = 1 to 25 years

Payback period is a little less than 13 years.

If government grant is used in lieu of debt, the cost of grant will be zero. Hence the WACC will work out to 1.44% and the NPV will be positive by an amount of Rs. 2557,51333.00

[2] Post Tax Cost of Debt.

ANNEXURE – XIII

a) Calculation for the average size of the household of individual samples

Sl. No.	Class intervals	Mid of Class x_i	Frequency f_i	$x_i f_i$
1.	1 - 4	2.5	162	405
2.	5 - 7	6.0	161	966
3.	8 - 20	14.0	55	770
4.	> 20 (21 – 25)	23.0	1	23

N = 379

Hence, the average size of the household of individual samples $\frac{\Sigma x_i f_i}{N} = \frac{2164}{379} = 5.7$

b) Calculation for the average monthly income of individual samples

Sl. No.	Class intervals	Mid of Class x_i	Frequency f_i	$x_i f_i$
1.	0 - 4,999	2499.5	160	399920
2.	5,000 - 9,999	7499.5	126	944937
3.	10,000 - 19,999	14999.5	78	1169961
4.	20,000 - 40,000	30000.0	15	450000

N = 379

Hence, the average monthly income of the individual samples

$\frac{\Sigma x_i f_i}{N} = \frac{2964818}{379} = Rs.7822.74$

c) Calculation for the average monthly expenditure on water borne diseases by individual samples

Sl. No.	Class intervals	Mid of Class x_i	Frequency f_i	$x_i f_i$
1.	0 - 99	49.5	142	7029
2.	100 - 499	299.5	28	8386
3.	500 - 1000	750.0	1	750
			N = 171	

Hence, the average monthly expenditure on water borne diseases by individual samples

$$\frac{\Sigma x_i f_i}{N} = \frac{16165}{171} = \text{Rs.}94.53$$

d) Calculation for the average water requirement of the households

Sl. No.	Class intervals	Mid of Class x_i	Individual		Institutional	
			Frequency f_i	$x_i f_i$	Frequency f_{ii}	$x_i f_{ii}$
1.	0 - 499	249.5	89	22205.5	0	0.0
2.	500 - 999	749.5	164	122918.0	3	5996.0
3.	1000 - 1999	1499.5	83	124458.5	8	11996.0
4.	2000 - 4000	3000.0	6	18000.0	8	24000.0
			N = 342		19	

Hence, the average water requirement of the households, litres per day

$$\frac{\Sigma x_i f_i}{N} = \frac{287582}{342} = 840.88$$

And the average water requirement of the institutions, litres per day

$$\frac{\Sigma x_i f_{ii}}{N} = \frac{41992}{19} = 2210.10$$

d) Calculation for the average connection fee

Sl. No.	Class intervals	Mid of Class x_i	Individual		Institutional	
			Frequency f_i	$x_i f_i$	Frequency f_{ii}	$x_i f_{ii}$
1.	0 - 999	499.5	212	105894.0	7	3496.5
2.	1000 - 1999	1499.5	109	163445.5	7	10496.5
3.	2000 - 2499	2249.5	21	47239.5	1	2249.5
4.	2500 - 5000	3750.0	-	-	4	15000.0
			N = 342		19	

Hence, the average connection fee of the household samples

$$\frac{\Sigma x_i f_i}{N} = \frac{316576}{342} = \text{Rs. } 925.67$$

Hence, the average connection fee of the institution al samples

$$\frac{\Sigma x_i f_{i\,i}}{N} = \frac{31242.5}{19} = \text{Rs. } 1644.34$$

d) Calculation for the average monthly tariff

Sl. No.	Class intervals	Mid of Class x_i	Individual		Institutional	
			Frequency f_i	$x_i f_i$	Frequency f_{ii}	$x_i f_{ii}$
1.	0 - 99	49.5	83	4108.5	1	49.5
2.	100 - 200	150.0	188	28200.0	1	150.0
3.	201 - 300	250.5	71	17785.5	10	2505.0
4.	301 - 499	400.0	-	-	7	2800.0
			N = 342		19	

Hence, the average monthly tariff of the household samples

$$\frac{\Sigma x_i f_i}{N} = \frac{50094}{342} = \text{Rs. } 146.47$$

Hence, the average monthly tariff of the institution al samples

$$\frac{\Sigma x_i f_{i\,i}}{N} = \frac{5504.5}{19} = \text{Rs. } 289.71$$