IMPACT OF WATER SAFETY PLAN ON MUNICIPAL WATER SUPPLY SYSTEM IN SELECTED POURASHAVAS

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The research titled "Impact of Water Safety Plan on Municipal Water Supply System in Selected Pourashavas", Submitted by Alauddin Ahmed, Roll No: 0413042509, Session April 2013 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Master of Science in Environmental Engineering held on 07 January 2017.

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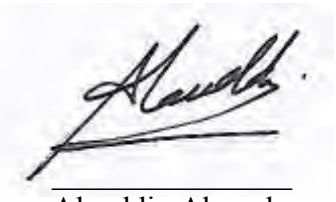
CANDIDATE'S DECLARATION

It is hereby declared that this project or any part of it has not been submitted elsewhere for the award of any degree or diploma.



Alauddin Ahmed

Dedicated

to

my parents

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LIST OF ABBREVIATIONS

BUET	Bangladesh University of Engineering University & Technology
DALY	Disability Adjusted Life Year
DPHE	Department of Public Health Engineering
GDWQ	Guidelines for Drinking-water Quality
HACCP	Hazard Analysis and Critical Control Point
HBT	Health Based Target
JMP	Joint Monitoring Programme
LGD	Local Government Division
MDG	Millennium Development Goal
MoLGRD&C	Ministry of Local Government, Rural Development and Cooperatives
NGO	Non-Government Organizations
NHPS	National Hygiene Promotion Strategy
NSWSS	National Strategy for Water Supply and Sanitation
NTU	Nephelometric Turbidity Unit
O&M	Operation and Management
PSU	Policy Support Unit
PTW	Production tubewells
PWS	Piped Water Supplies
PWSS	Pourashava Water Supply Section
QA	Quality Assurance
SDG	Sustainable Development Goal
SDP	Sector Development Plan
SOP	Standard Operating Procedure
SWAp	Sector Wide Approach
TLCC	Town Level Coordination Committee
WHO	World Health Organization
WSF	Water Safety Framework
WSP	Water Safety Plan
WTP	Water Treatment Plant

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ABSTRACT

An effort was made in this research to assess the impact of WSP in municipal piped water supply systems based on identified key indicators. A quality assurance tool was developed to carry out auditing of WSPs that indicates the maturity of any WSP, implemented in urban-piped water supplies. Finally, the QA audit tool was used in selected two municipal towns to carry out a gap analysis of the implemented WSPs in comparison to ideal scenario. The results of indicator based WSP impact assessment and WSP audit were validated against findings from water quality test results and household survey findings.

The key research questions that were answered through the research include whether WSP have affirmative impact on realizing health-based outcomes and if WSP implemented in different type of urban-piped water supply systems can be audited on a common ground so that maturity of different WSPs can be compared. The indicator based assessment showed positive outcome and impact of WSP in both Chandpur and Chapai-Nawabganj Pourashava.

In Chandpur, level of operations and management practices increased to 24 from 8 out of 40 points. The cost recovery has improved as revenue collected per consumer has increased to 128 BDT/consumer from 68 BDT/consumer in last one year. Stakeholders' knowledge and understanding have also increased from 12 to 19 out of 25. Percentage of treated water samples compliant with microbial water quality targets increased to 90 with WSP compared to 80 without WSP. Diarrheal incidence rate also decreased to 24 percent from 34 percent at that stages.

Operations and management practices in Chapi-Nawabganj increased to 17 from 8 out of 40 points. However, operating cost of produced water increased by 0.34 BDT/cubic-meter mainly due to increase in electricity tariff over time. Understanding of water supply system by the stakeholders has been increased from five to 25 on a scale of 25. Eighty percent water samples are compliant with

microbial water quality targets with WSP, which was 50 percent without WSP. Diarrheal incidence rate has also gone down from 37 percent to 29 percent. WSP audit performed using the QA tool scored 93 and 98 out of 120 in Chandpur and Chapai-Nawabganj respectively. This indicated that the WSP maturity in both the water supply systems stands as ‘Good’.

The QA tool has high prospect to be used in the country and region as WSP audits become increasingly important due to its integration with regulatory environment. The tool can be further tailored to suit all scheme types and levels of sophistication.

CHAPTER 1

INTRODUCTION

1.1 Background

Ensure environmental sustainability, the 7th goal of Millennium Development Goal (MDG) has resulted significant improvement in the access to improved drinking water due to achievement of its target 7C, 'Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation'. Worldwide 2.6 billion people have gained access to improved drinking water sources since 1990, but 663 million people are still left behind. In Bangladesh, around 20 million people do not use improved water sources and only about 18 million people have access to piped water supplies at premises (JMP 2015). At least 1.8 billion people globally use a source of drinking water that is fecally contaminated. Furthermore, water scarcity affecting more than 40 percent of the global population and is projected to rise. Over 1.7 billion people are currently living in river basins where water use exceeds recharge. Each day, nearly 1,000 children die due to preventable water and sanitation-related diarrheal diseases and the associated health burden is primarily borne by the populations in developing countries.

Drinking water safety, in addition to microbial risks, may also be compromised by chemical and radiological constituents. Endemic and epidemic disease derived from unsafe water supply affects everyone in the planet. Outbreaks of waterborne disease continue to occur in both developed and developing countries, leading to loss of life, disease and economic burden for individuals and communities. Strategies to improve water quality, in conjunction with improvements in excreta disposal and personal hygiene can be expected to deliver substantial health gains among people of all age. The talk of the time, United Nations' Sustainable Development Goals (SDGs) includes a commitment through its Goal 6, 'Ensure access to water and sanitation for all' that calls for achieving various targets. The targets directly related to safe water supply are-

- By 2030, achieve universal and equitable access to safe and affordable drinking water for all;
- By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally;
- By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity;
- Support and strengthen the participation of local communities in improving water and sanitation management.

Furthermore, the human right to water and sanitation (UN 2010) places a clear responsibility on Governments to ensure access to safe and adequate water supplies. Although better health protection is reason in its own right for the adoption of strategies to improve drinking-water quality, international policy is also a key factor. Water suppliers have a duty of care to persons utilizing the water or service that they supply and therefore, need to be aware of the regulatory and policy framework within which they must operate including common law, statute, policy, guidelines and best management practice.

The water suppliers must comprehend that wide range of chemical and microbial contaminants may be found in drinking water, some of which have adverse health effects on consumers. These can ingress from a number of sources including the water treatment process. Understanding the nature of contamination sources and it way of entering the water supply is critical for assuring water safety. For instance, arsenic has become a major national and international concern in groundwater where it occurs from a geological source and generally controlled through source selection.

The multiple barrier approach can be an important strategy to provide safe drinking water for the consumers the application of which is often neglected to the actual water treatment process. As the detection and enumeration of pathogenic microorganisms from microbially contaminated water is both difficult and costly reliance has traditionally been placed on the examination for fecal originated bacterial (Dufour et al. 2003). However, contamination is not limited to bacteria and illness may result from exposure to pathogenic viruses or protozoa, both of which have different environmental behavior and survival characteristics. This, coupled with the fact that testing of water immediately prior to, or within, distribution (end product testing) can only highlight a potential health problem after the water has been consumed, has led to the recognition of the need to adopt additional approaches to assuring water quality and safety. The World Health Organization's Guidelines for Drinking-water Quality (GDWQ) (WHO 2011) aim to protect public health and a key way to ensure this is through the adoption of a water safety plan.

The GDWQ recommends that countries should apply a 'Water Safety Framework (WSF)' approach, the prime focus of which is 'Water Safety Plan (WSP)', to ensure drinking water safety. Following WHO's recommendation the Government of Bangladesh has already developed the 'Water Safety Framework (WSF) in Bangladesh' (LGD 2011) and DPHE with the technical and financial support from the WHO in Bangladesh implemented Water Safety Plans in various Pourashava (municipal) piped water supply systems of the country (Mahmud et el. 2005). However, the WSP process as detailed out in the WSF of Bangladesh is not similar to the process detailed out in the Water Safety Plan Manual of WHO (WHO 2009). Hence, the phenomena are of important concern for public health and demand further investigation and analysis which is the primary aim of this research.

1.2 Objectives of the Study

The objectives of this research are

- to assess the impact of Water Safety Plan (WSP) in Pourashava piped water supply systems to realize the health based targets set in terms of water quality;

- to develop a quality assurance model based on identified key indicators on WSP; and
- to carry out a gap analysis of the implemented WSPs in comparison to ideal scenario based on developed quality assurance model.

1.3 Significance of the Project

The outcome of the study will be

(i) Indicator based impact of WSP and status of health based targets in selected water supplies;
(ii) A tool to measure the impact of WSPs in different water supply systems; and
(iii) A set of recommendations for the water supplies for making the WSPs more effective in supplying safe water to the consumers.

1.4 Organization of the Report

The contents of the remainder of this report are divided into four chapters. The contents of those chapters are described briefly in the following section.

Chapter 2 outlines detailed literature review on water safety plan and its status in Bangladesh. Chapter 3 presents the detail methodologies including research sites and setup. Chapter 4 illustrates development and process of indicator analysis for WSP impact assessment while Chapter 5 outlines development and use of a Quality Assurance Model for WSP auditing. Chapter 6 describes the outputs and findings of the study. Finally, the conclusions and recommendations for future improvement are discussed in Chapter 7.

CHAPTER 2

LITERATURE REVIEW

2.1 Advancement of WSP

A number of initiatives across the world in the mid 1990's began to investigate whether the so called "end of pipe" standard setting approach to protect drinking water quality was the right way forward for the 21st century. This discussion began to come together in two main international forums. Firstly, the updating of the highly influential 3rd revision of the WHO guidelines on Drinking-water Quality, and in parallel, development of "The Bonn Charter for Safe Drinking Water", of which the latter was adopted and published by IWA. Both documents detailed a framework for safe drinking water in which the importance of establishing health-based targets, developing water safety plans and undertaking independent surveillance are stressed. The joint launch of these two documents in September 2004 marked a critical milestone in the provision of updated worldwide best practice advice on how the global challenge of providing safe drinking water could be met. The event also paved the way for the development of a strategic partnership between IWA and WHO to promote and support the adoption of the framework over subsequent years.

Overall goal of the Bonn Charter was: "Good safe drinking water that has the trust of consumers". To secure this goal the Charter set out nine key principles which need to be adopted by all those contributing to the provision and operation of water supply systems. These include specific references to institutional and governance issues and particularly the roles and responsibilities of the different actors involved in the whole water supply process. The key principles are

1. Management of the whole water supply chain should always be set in the context of management of the whole water cycle, including, but not limited to:
    - Management of water resource provision, including, where necessary, resource augmentation;

- Management of water and land interactions, taking into account agricultural practices and urban development;
- The collection and treatment of wastewater.

2. Systems to ensure drinking water quality should not be based solely on end-of-pipe verification (testing against predetermined standards). Rather, management control systems should be implemented to assess risks at all points throughout water supply systems and to manage such risks;
3. Such an integrated approach requires close co-operation and partnership between all stakeholders including governments, independent regulatory authorities, water suppliers, local public authorities, health agencies, environmental agencies, land users, contractors, plumbers and manufacturers of relevant materials and products, and consumers themselves;
4. Open, transparent and honest communication between all stakeholders is essential to developing trust. It contributes to the development of effective water supply systems;
5. The roles and responsibilities of the different institutions contributing to the delivery of safe and reliable drinking water need to be clearly defined and ensure complete coverage of the system from catchment to consumer. Governments should establish the legal and institutional arrangements necessary to assign appropriate responsibilities among the various parties;
6. The way in which decisions are made relating to standards for the quality and reliability of water supplies should be transparent;
7. Water should be safe, reliable and aesthetically acceptable. In progressively realizing the goals, however, the standards applied may legitimately vary from location to location and over time;
8. The price of water should be set so that it does not prevent consumers from obtaining water of sufficient quantity and quality to meet fundamental domestic needs;
9. Any system for assuring drinking water quality should:
    - Be based on the best available scientific evidence;

- Be sufficiently flexible to take account of the different legal, institutional, cultural and socio-economic situations of different countries.

Worldwide the principal starting points for the setting of water quality standards are the World Health Organization Guidelines (WHO). The Guidelines are, in large part, health risk assessments and are based on scientific consensus, best available evidence and broad expert participation. The need for harmonisation in the development of the three water-related guideline areas ((i) Guidelines for Drinking-water Quality, first published in 1984-1985; (ii) Guidelines for the Safe Use of Wastewater, Excreta and Greywater, first published in 1973; and (iii) Guidelines for Safe Recreational Water Environments, prepared progressively from 1994 and volume 1 published in 2003) for the control of microbial hazards was recognized in the late 1990s (Fewtrell and Bartram 2001). Microbial contaminants in drinking water are not limited to bacteria and illness may result from exposure to pathogenic viruses or protozoa, both of which have different environmental behaviour and survival characteristics to bacteria. This, coupled with the fact that testing of water immediately prior to, or within, distribution (end product testing) can only highlight a potential health problem after the water has been consumed, has led to the recognition of the need to adopt additional approaches to assuring water quality and safety. Hence, the most cost-effective and protective means of consistently assuring a supply of acceptable drinking-water is the application of some form of risk management based on sound science and supported by appropriate monitoring. It is important that risk management is inclusive and, therefore, needs to cover the whole system from catchment to consumer as outlined in Figure 2-1.

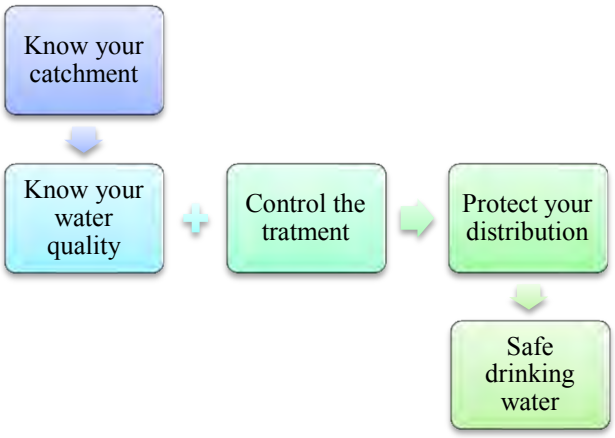

Figure 2-1: 'Catchment to consumer' approach to risk management of the safety of drinking water (adopted from Medema et al. 2003)

The risk management approach proposed in the water safety framework by WHO was based largely upon HACCP (Hazard Analysis and Critical Control Point). The principles of HACCP (which is a preventive risk management system that has been used in the food manufacturing industry for a number of decades) are based on developing an understanding of the system, prioritising risks and ensuring that appropriate control measures are in place to reduce risks to an acceptable level. These principles have been refined and tailored to the context of drinking-water following the application of HACCP by several water utilities including in the US (Barry et al. 1998) and Australia (Deere and Davison 1998; Gray and Morain 2000; Deere et al. 2001). The experience of the application of HACCP by water utilities contributed to the development of the water safety plan approach.

2.2 Definition and Process Steps of WSP

The most effective means of consistently ensuring the safety of a drinking-water supply is through the use of a comprehensive risk assessment and risk management approach that encompasses all steps in water supply from catchment to consumer. The third edition of WHO Guideline for Drinking Water Quality (WHO 2004) termed such approaches as water safety plans (WSPs).

The WSP approach has been developed to organize and systematize a long history of management practices applied to drinking-water and to ensure the applicability of these practices to the management of drinking-water quality that fits within a water safety framework (WSF) recommended by WHO. The framework for safe drinking water is a preventive management approach comprising three key components and further divided into five key elements of which the WSP encompasses elements 2 to 4, as illustrated in Table 2-1 and depicted in Figure 2-2

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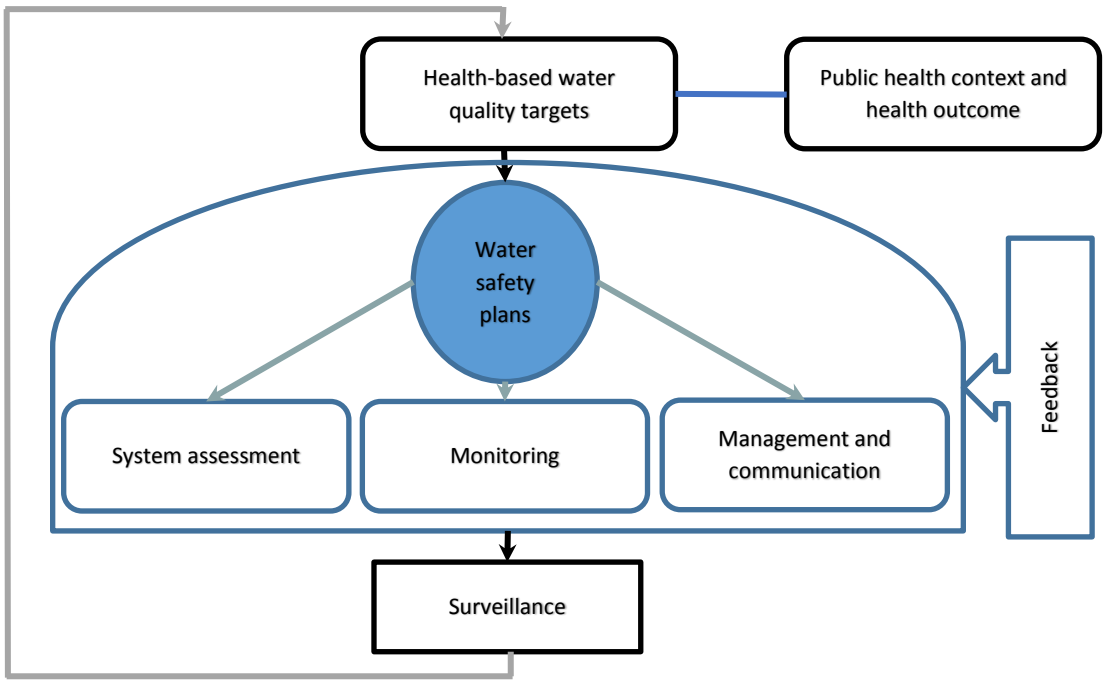


Figure 2-2: Water Safety Framework

Key components include (i) health-based targets based on an evaluation of health risks; (ii) water safety plans (WSPs) comprising of system assessment, operational monitoring and management plans; and (iii) a system of independent surveillance that verifies that the components are operating.

Table 2-1: The WHO's Framework for Drinking-water Safety.

Component	Requirements
1: Setting Health-based Targets	• Targets are based on an evaluation of health concerns and need to be set at a tolerable level for the community (e.g. are risk-based and can be coordinated with national guidelines, standards or WHO guidelines).
2: System Assessment	• An assessment is conducted to characterize the water supply system, assess risks and to determine whether the drinking-water supply (from source through treatment to the point of consumption) as a whole can deliver water that meets the health-based targets).
3: Operational Monitoring	• Monitoring of the control measures in the drinking-water supply that are of particular importance in securing drinking-water safety. Monitoring at multiple points within the system, rather than relying on end-product monitoring, provides the supplier with assurance that unsafe product does not end up with the consumer.
4: Management Plans	• Management plans are set up and encompass: o Documentation of the system assessment o Monitoring plans including normal and incident operations, upgrades, improvements and communication
5: Surveillance	A system of independent surveillance verifies that the above components are operating properly and effectively.

More specifically WSP is a continuous process of risk identification, control and monitoring in a water supply system for achieving the health based targets as illustrated in Figure 2-3.

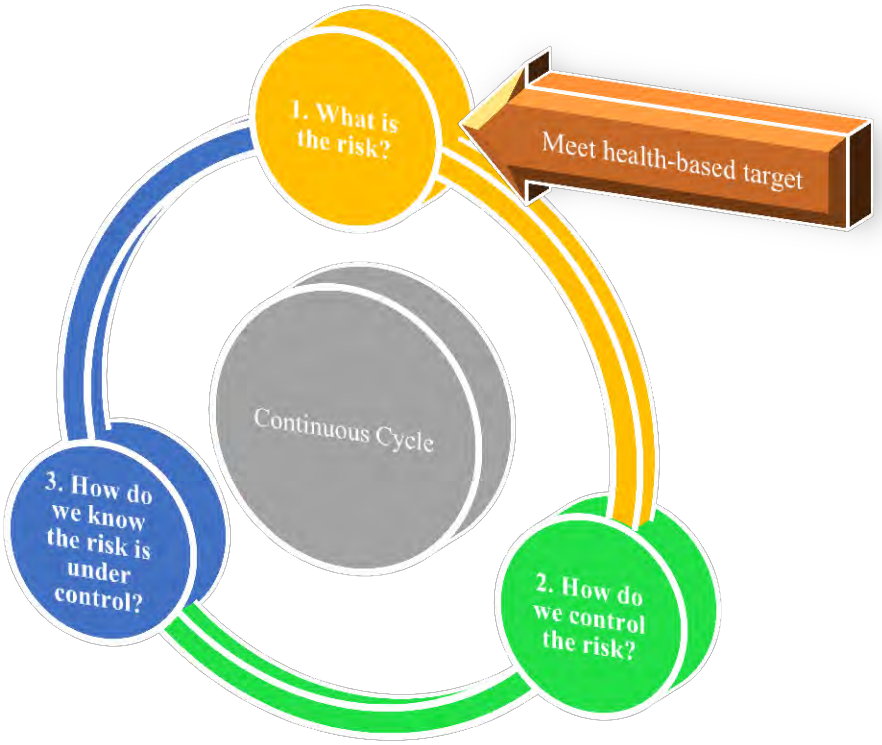


Figure 2-3: WSP: A continuous cycle of risk management

WSPs when implemented, provide the basis for system protection and process control through analyzing the risk of contamination and adopting appropriate measures to control the risk. The elements of a WSP ensures a multiple-barrier principle in all aspects of a drinking-water supply and focus on the control of abstraction, treatment and delivery of drinking-water. Though many drinking-water supplies may provide adequate safe drinking water in the absence of formalized WSPs, major benefits of developing and implementing a WSP for these supplies include the systematic and detailed assessment and prioritization of hazards, the operational monitoring of barriers or control measures and improved documentation (WHO 2010). Moreover, the continuous cycle of risk management by WSP builds an organized and structured system to minimize the chance of failure through oversight or lapse of management and for contingency plans to respond to system failures or unforeseen events that may have an impact on water quality, such as increasing severe droughts, heavy rainfall or flood events.

2.3 WSP in Bangladesh

Bangladesh made an early response to WHO's initiative of water safety plan in 2004. Through a number of orientation and consultative meetings a guiding framework was agreed by the professionals. Under this framework, generic WSPs for a range of rural water supply options were developed. Simple pictorial tools to be used by tubewell caretakers/owners were developed for risk management. Technology based targets (as Health based target) and surveillance protocol were also developed under the agreed framework.

Between 2005 and 2007 the WSPs were then field tested through pilot projects with active participation from Department of Public Health Engineering (DPHE) and different NGOs. The positive results of these pilots, together with progress in policy and institutional development, and the building of a pool of trainers formed a firm foundation for WSP scaling up in the country.

The World Health Organization, under WHO-AusAid partnership for water quality management has started introduction of Water Safety Plan Programme in six countries including Bangladesh in the Asia-Pacific region. The phase-I and phase-II of this partnership commenced in 2008 and continued till the end of 2011. These phases focused on scaling up of WSPs in the country. Major activities during this period included WSP implementation in 10 urban supplies, 15 rural supplies, and awareness campaign in rural communities that are using point sources. In addition various policy guides were developed that are presented in the following section. At present DPHE and WHO is implementing the phase-III of the programme the main focus of which is to mainstream WSP in the country.

2.4 Policy directions

Bangladesh has taken a leading role in developing the policy guides for the country on WSPs. A number of documents has been developed and at present being used by the sector stakeholders. A summary of key documents are presented below.

2.4.1 National Vetting Guidelines for WSS Sub-sector

The National Vetting Guidelines for Water Supply and Sanitation Sub-sector of Bangladesh was formulated by Policy Support Unit (PSU) that was approved by the Local Government Division (LGD), Ministry of Local Government, Rural Development and Cooperatives (MoLGRD&C) in 2009. The objective of the vetting guidelines is to ensure that all projects in the sector do not, at least, contradict or work against any of the guiding principles, which the government has adopted for the sector. The intent of the vetting guidelines was to assure that no project runs counter to any of the national policy principles but the current concerns in the sector extend beyond only the policy principles. The vetting guideline recommends LGD to check the water quality issues in every WSS projects (LGD 2009). The relevant issues to be checked at the agency level in this regard are that the project proposes to apply water safety plan at the local level as a means of water quality surveillance. The recommended indicators that should be described in the project proposal are provision for training on concept and use of water safety plan and its setup process.

2.4.2 Sector Development Plan (2011 – 2025)

The revised Sector Development Plan (SDP) of the MoLGRD&C initiated by the PSU is the strategic planning document for the WSS sector. It took an extensive, participatory and analytical approach at the national and local levels to provide a framework for planning, implementing, coordinating and monitoring all activities in the Water Supply and Sanitation sector. The document is a guideline for both the government and the development partners. At present, the SDP is for the period of 15 years (FY 2011- 25). The plan gives more emphasis on hygiene promotion and greater attention to hard to reach areas and people with additional considerations on emerging issues of water safety plan, sector wide approach (SWAp), and climate change and disaster management pertaining to WSS sector.

WSP has been identified as a holistic concept for ensuring safety of water in the SDP. WSP is different from the traditional O&M of water supply systems because it has a broader outlook and addresses safety of drinking water, right from protecting

the water source to hygienic in-house handling through continuous monitoring, preventive maintenance of the water supply systems, and promoting hygiene practices. The SDP also documented several action points on WSP (SDP 2011). The action points include advocacy and awareness raising, capacity building in sector institutions and scaling up, and mainstreaming of WSP in the country.

2.4.3 Water Safety Framework (WSF) in Bangladesh

The Government of Bangladesh has considered WHO's recommendations of applying 'Water Safety Framework (WSF)' approach to ensure drinking water safety and achieve MDGs, which would reduce the Disability Adjusted Life Years (DALYs) and hence the poverty. On this target the LGD through its PSU prepared the National Guidelines on 'Water Safety Framework in Bangladesh'. It gives utmost importance to implementation of the WSF by the service providers to supply safe drinking water to the consumers. Under the framework, it has been mentioned that all new and rehabilitation water supply projects should have a component of WSP. The document also gave importance to introduce WSPs in the existing water supply systems at the earliest possible time.

The framework listed the health based water quality targets for the country. It also provides a simple guideline for developing WSP for both piped and non-piped water supply systems with relevant examples. The WSP analyzes all potential risks, their control measures and perfect actions. Simple risk analysis tools known as sanitary inspection forms are prescribed to assess the degree of sanitary risks of the systems (WSF 2011). It also analyzes system improvement and supporting program aspect, integration of the WSP with water supply systems, implementation strategy, methodology and on-site preparation. The advocacy strategy is also provided for the management and technical staff of water supply systems. The framework also details out 'Independent Surveillance', which is a follow-up-cum-supervision exercise to improve the management function of water suppliers/providers as well as the behavioral aspects of the consumers.

2.4.4 National Hygiene Promotion Strategy for WSS Sector in Bangladesh

The National Hygiene Promotion Strategy (NHPS), is an integral part of the Sector SDP (2011-25) for water and sanitation sector in Bangladesh. It was approved by the LGD, MoLGRD&C in 2012. The NHPS provides a framework for implementation, coordination and monitoring of various activities for launching hygiene promotion at national, regional and local level. The strategy suggests that during the early phase of implementation of hygiene promotion three critical behaviors of personal hygiene, food hygiene and menstrual hygiene to be addressed (NHPS 2012). The document listed 10 key strategies where strategy four is 'National level hygiene promotion'. Under this section the paper categorically strategies integration of water safety plan (WSP) in the main stream of WASH activities.

2.4.5 National strategy for Water Supply and Sanitation

To ensure SDP implementation in a desired manner the LGD, MoLGRD&C has developed the National strategy for Water Supply and Sanitation in 2014. The strategy provides the sector context, goal and objectives, guiding principles, framework, strategic direction, institutional arrangement and implementation plan for water supply and sanitation promotion at national, regional and local level. The water supply and sanitation strategy suggests achieving the sector goal and in accordance with the guiding principles, a set of seventeen strategies have been formulated. The strategies are broadly grouped into three themes, (i) WASH Interventions: increasing the coverage and improving the quality of WASH interventions; (ii) Emerging challenges: addressing the emerging challenges in the sector; and (iii) Sector Governance: strengthening sector governance (NSWSS 2014). The first strategy of the paper is to 'Ensure safe drinking water' and supporting important guidelines in this regard are to adopt a risk management based approach for safe water, commonly known as Water Safety Plan (WSP), in all water supply programs as well as to prepare manuals, tools and guidelines on WSPs for all water supply systems in the light of the existing Water Safety Framework in Bangladesh, 2011.

CHAPTER 3

APPROACH AND METHODOLOGY

3.1 Criteria for site selection

To realize the objectives of the study several criteria has been set to select the study sites. First, only those municipal towns that are practicing water safety plan will be considered eligible. Secondly, the length of time for which the Pourashavas are practicing WSP will be deemed. Finally, the source of water supply will be taken into account.

3.2 Study sites

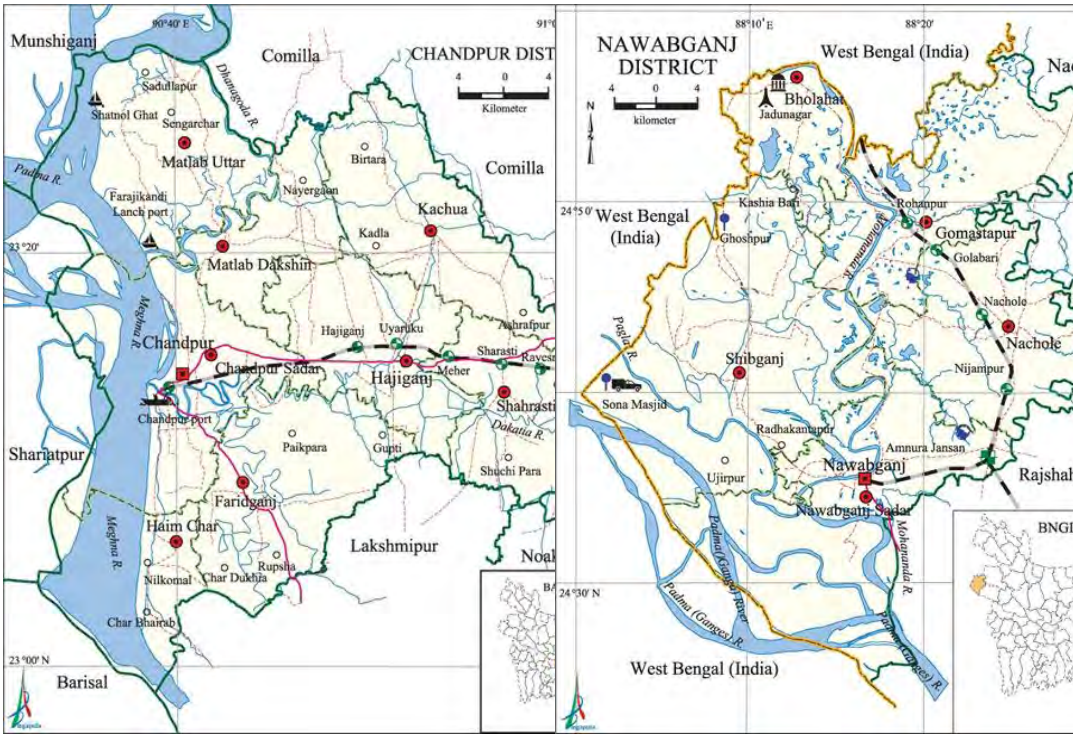
Based on the above-mentioned criteria two Pourashava piped water supply systems, have been selected for the research. These are

- Chandpur Pourashava piped water supply system; and
- Chapai-Nawabgonj Pourashava piped water supply system

A brief description of both the systems, source of water and WSP implementation period is given below.

Chandpur Pourashava piped water supply system

Chandpur Pourashava was established in 1896, which at present comprises of fifteen Wards. The piped water supply system along with surface water treatment plant in the Puran Bazar area of the Pourashava was established in 1931 by the British government that uses the water of Dakatia River as source. Later on two more treatment plant was established using the same source. DPHE-WHO implemented WSP in the system in year 2011. The total population of municipality at that time was 1,63,235 and the water supply coverage was 84%. The number of service connections was 5,965. Along with surface water the Pourashava also uses ground water for water supplies through five production wells. The overall system comprises of three surface water treatment plants including one iron removal plant, 2 overhead tanks with the capacity of 225 gallons each and 73.55 km of pipe network.



(i) Chandpur Pourashava *(ii) Chapai-nawabgonj Pourashava*

Figure 1: Study site location with inset in the MAP of Bangladesh (Image source: www.banglapedia.org)

Chapai-Nawabgonj Pourashava piped water supply system

Chapai-Nawabgonj Paurashava, divided in fifteen Wards, was established in 1903. The piped water supply system at the town was established in 1984 by DPHE and handed over to Paurashava in 1988. The WSP in this system was also implemented in 2011 by DPHE-WHO. The water supply coverage at that period was 38% having a total population of 2,49,532. The main source of water supply was groundwater from unconfined aquifer with an average depth of 32 meter. Groundwater is abstracted by 8 functional production wells out of 24 and supplied to the distribution network directly without any treatment. 16 PTWs were abandoned due to presence of arsenic. The number of household connections of the system was about 3,908 having 64.7 kilometers of pipelines within the distribution network.

3.3 WSP indicators and health based WQ targets

3.3.1 Introduction

One of the key objectives of this research work was to measure the outcomes and impacts of Water Safety Plan (WSP) implementation in Chandpur and Chapai-Nawabganj Pourashava by collecting data on selected key indicators. The indicators selection of this study are based on the general indicator groups outlined in the US Centres for Disease Control and Prevention's *A Conceptual Framework to Evaluate the Impacts of Water Safety Plans*, which divides potential WSP benefits into two groups: outcomes and impacts. Outcomes are defined as the intermediate changes that result from the WSP process, and impacts are the ultimate changes desired as a result of WSP program activities.

The selection of set of indicators was carefully made to cover the water supply system types available in the towns under the study as well as to use those for designing and implementing national WSP impact assessment programs in order to ensure quality and consistency in data collection and reporting, from site to site and year to year.

3.3.2 List of Indicators

The outcomes indicators are dived into four groups. These are

- Operational outcomes
- Financial outcomes
- Institutional outcomes
- Equity outcomes

The impact indicators are divided into two groups which are

- Water supply impacts
- Health impacts

Again, these groups are divided into subgroups. The various outcomes and impacts indicator groups and subgroups are shown in Table 3-1. The subgroups are

comprised of specific indicators based on which data collection and assessment are done. The details of each of the indicators and considerations for data collection and scoring are presented in the subsequent section.

Table 3-1: WSP outcomes and impacts indicator groups

	Indicator groups	No. of indicators
OUTCOMES	**OPERATIONAL OUTCOMES**	
	Group O1: Changes in system infrastructure	1
	Group O2: Changes in operation and management procedures	1
	FINANCIAL OUTCOMES	
	Group F1: Cost changes	2
	Group F2: Changes in cost recovery	2
	Group F3: Changes in financial support and investment	2
	INSTITUTIONAL OUTCOMES	
	Group I1: Changes in communication and collaboration among stakeholders	3
	Group I2: Changes in water supplier knowledge and understanding	2
	EQUITY OUTCOMES	
	Group E1: Changes in consideration of equity	1
IMPACTS	**WATER SUPPLY IMPACTS**	
	Group W1: Water service changes	4
	Group W2: Water quality changes	7
	Group W3: Consumer satisfaction changes	4
	HEALTH IMPACTS	
	Group H1: Changes in incidence of water-related illness	3
	Total # of indicators (between the 12 indicator subgroups) =	**32**

3.3.3 Health based water quality parameters

The water safety framework in Bangladesh (WSF 2011) set water quality priority parameters for Bangladesh after reviewing and critically analyzing the Bangladesh drinking water quality standards 1997. The framework listed 4 health based target (HBT) and one non-HBT parameters under first priority category. In addition, 35 parameters (26 HBT and nine non-HBT) were categorized as second priority. Lists of both first priority as well as second priority category parameters have been given in Table 3-2 and Table 3-3. This study considered first priority HBT to determine the impact of WSP.

Table 3-2: Health Based Parameters and Targets (first priority)

Health Based			Non-Health Based Target (acceptability)		
#	Parameters & Unit	Targets	#	Parameters & Unit	Targets
1.	Thermo-Tolerant Coliform (TTC) (N/100)	0	1.	Turbidity (NTU)	5 (urban treated) 10 (rural)
2.	Arsenic (mg/l)	0.05			
3.	Chlorine (residual) (mg/l)	0.5			
4.	Nitrate (mg/l)	50 as Nitrate			

Table 3-3: Health Based Parameters and Targets (second priority)

Health Based			Non-Health Based Target (acceptability)		
#	Parameters & Unit	Targets	#	Parameters & Unit	Targets
1.	Cadmium (mg/l)	0.003	1.	Color (TCU)	15
2.	Cyanide (mg/l)	0.07	2.	Odor	Odorless
3.	Fluoride (mg/l)	1.0	3.	pH	6.5-8.5
4.	Lead (mg/l)	0.03	4.	Hardness as $CaCO_3$ (mg/l)	200-500
5.	Manganese (mg/l)	0.4	5.	Total Dissolved Solids (mg/l)	1000
6.	Mercury (mg/l)	0.001	6.	Aluminum (mg/l)	0.2
7.	Total alpha radiation(Bq/l)	0.5	7.	Ammonia (mg/l)	1.5
8.	Total beta radiation(Bq/l)	1.0	8.	Chloride (mg/l)	<600
9.	Benzene (mg/l)	0.01	9.	Iron (mg/l) (urban) Iron (mg/l) (rural)	0.3-1 0.3-3.0
10.	Carbon Tetra Chloride (mg/l)	0.004			
11.	1,1-dichloro ethane (mg/l)	0.03			

Health Based			Non-Health Based Target (acceptability)		
#	Parameters & Unit	Targets	#	Parameters & Unit	Targets
12.	1,2-dichloro ethane (mg/l)	0.03			
13.	Tetra-chloro ethane (mg/l)	0.04			
14.	Tri-chloro ethylene (mg/l)	0.07			
15.	Chloroform (mg/l)	0.2			
16.	Barium (mg/l)	0.7			
17.	Boron (mg/l)	1.0			
18.	Copper (mg/l)	2			
19.	Nickel (mg/l)	0.05			
20.	Selenium (mg/l)	0.01			
21.	Sulfate (mg/l)	250			
22.	Phenolic compound (mg/l)	0.002			
23.	Penta-chloro-phenol (PCP) (mg/l)	0.009			
24.	2,4,6-trichlorophenol (mg/l)	0.2			
25.	Aldrin and dieldrin (µg/l)	0			
26.	Chromium (Total) (mg/l)	0.05			

3.4 Household data collection

Recently DPHE and WHO has taken initiative to improve WSP in some selected towns to make those model WSPs. Chanpur and Chapai-Nawabganj towns are also included in the project. As a part of that initiative, a situation analysis survey was carried out among the household in each of these towns. This study utilized this survey data to understand the knowledge, and practice of the consumers on safe water use. A structured questionnaire was developed to conduct the household survey at consumer that contains the following major issues:

(i) Consumer's living status and health

(ii) Present knowledge & practice of safe water use for drinking and cooking purpose

(iii) Present hygiene and sanitation practice

(iv) Level of consumer satisfaction on supplied water

Sample Size calculation:

The following formula was used for estimating sample size of randomly distributed population:

$$Sample\ size = \frac{n}{1+\frac{n}{N}} \qquad \text{in which, } n = \frac{z^2}{\frac{P(1-P)}{D^2}}$$

Where,

P = True proportion of factor in the population, or Response distribution
= 50%

D = Maximum difference between the sample mean and the population mean or Margin of error
= 5%

Z = Area under normal curve corresponding to the desired confidence level
= 1.96 with confidence level of 95%

N = Population size = number of water supply connection

There are 7500 household connections & 400 street hydrants in Chandpur Paurashava water supply. Hence, the formula yielded a sample size of 365 for Chandpur at 95% confidence level. Cluster random sampling techniques were used to cover the sample size. The Wards of the Pourashavas were considered as the clusters and with a cluster households were selected randomly for data collection. There exist different house connections based on house pattern like one-storied, multi-storied, roof based on corrugated tin as well as low income communities. In each Ward, these different types of house connections were also considered and were selected randomly during the data collection. After collecting data from field those were entered into a data entry program and statistical analysis was carried out using SPSS & MS Excel.

3.5 WSP Maturity and Quality Assurance Tool

A quality assurance (QA) tool has been developed and used under this study for conducting external or internal audits or assessments of Water Safety Plans (WSPs) in order to support assessors and to ensure consistency in assessment approach, from

site to site and year to year within a given country and beyond. This assessment complements the WSP impact assessment, as it requires an evaluation of the quality and maturity of each WSP. The following sections outlines the approach used in the QA tool for systematically evaluating WSP quality and maturity.

3.5.1 Content and Structure of the QA Tool

This tool contains 30 questions structured according to the major WSP steps described in the IWA/WHO WSP Manual (2009) and designed to gauge the quality of WSP development and degree of implementation. There is a dedicated section for each of the nine WSP elements, complete with questions and tips in the tool. The nine assessment areas / WSP elements are as below.

(i) WSP Team
(ii) System Description
(iii) Hazard Identification and Risk Assessment
(iv) Improvement Plan
(v) Operational Monitoring
(vi) Verification
(vii) Management Procedures
(viii) Supporting Programmes
(ix) Review and Revision

The corresponding scoring guidance of each element is presented in section 5.2. The tool also contains an assessment summary section for calculating the overall assessment score. The summary section allows assessors and WSP teams to see at a glance the areas of WSP strength and improvement opportunity as well as WSP maturity status. The dashboard of the QA tool is presented in Figure 3-1. The snapshot of all sections of the tool is presented in Appendix-I.

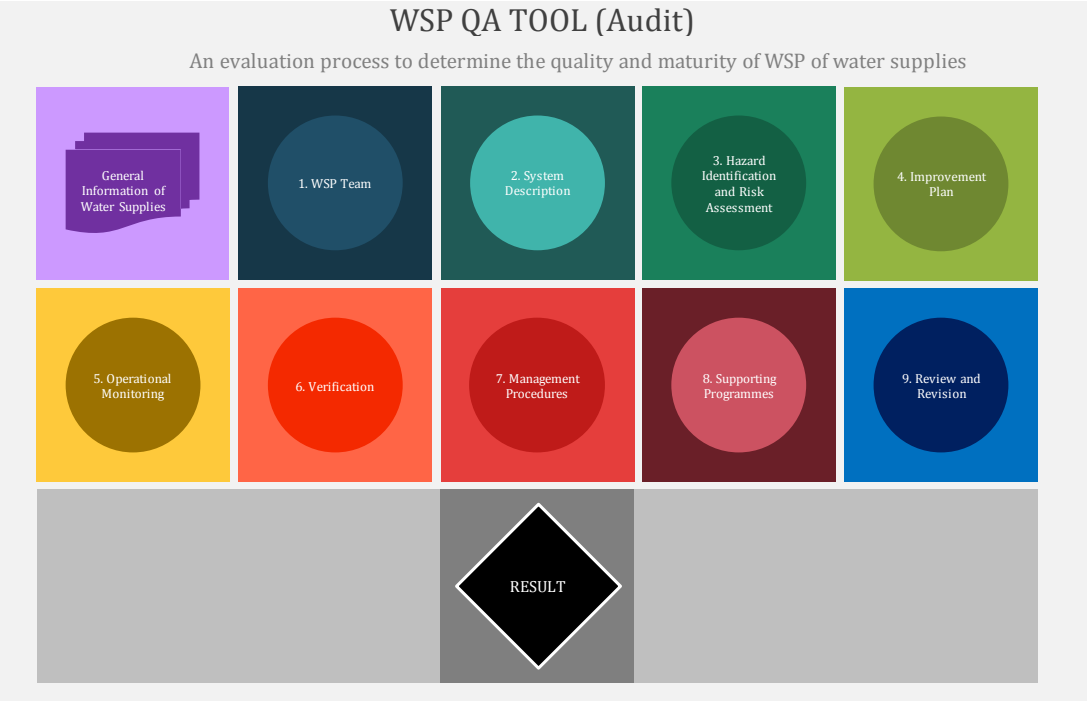


Figure 3-1: Dashboard of WSP QA Tool

The QA tool can be used to formal or informal audit of any water supply system with WSPs by an internal or external team. The audit process and accordingly the tool considers different aspects of WSP's implementation, with a view to giving advice and support as part of the implementation process by experts (auditors) based on independent, open & transparent audit scoring criteria.

CHAPTER 4

PROCESS OF WSP INDICATOR ANALYSIS

4.1 Overview

At the outset of the research a detail assessment of the WSP implementation in the selected two Pourashava water supply systems will be carryout. This will require interactive interaction with the Pourashava Water Supply Section (PWSS) as well as review of the WSP documents and project reports. To analyze the impact on health based water quality targets historical as well as current water quality data will be required. Also the impact analysis of WSPs demands identification and comparison of key indicators that can be used to generate and use a quality assurance model on WSP. Methods on data collection, water quality tests and impact indicators for quality assurance model are described below.

4.2 Analysis methodologies

4.2.1 Operational outcome indicator group

4.2.1.1 Group O1: Changes in system infrastructure

O1a – Infrastructure has been improved or added as a direct result of the WSP: Only infrastructure improvements made as a direct result of the WSP are recorded here. Any improvements not directly related to the WSP process are not included. The data was collected through interviews with water supplier staff and review of WSP document.

To ensure that the WSP does not receive "false credit" for improvements made that were not in fact a result of WSP efforts (e.g. improvements that were planned and funded prior to WSP implementation or otherwise unrelated to the WSP), for each improvement mentioned by water supplier staff quires were made on how the WSP process contributed to the improvement, and reviewed the WSP to understand if the improvements relate to the risks and improvement needs identified in the WSP. It was record "Y" where the improvements were clearly influenced by the WSP

process. Clearly for the initial or baseline assessment, the finding here should be not applicable (N/A).

4.2.1.2 Group O2: Changes in operations and management procedures

O2a – Level/strength of operations and management practices evident through documentation and implementation of relevant plans and procedures: The extent to which relevant operations and management plans and procedures have been documented, are kept current/relevant and are implemented/practiced were considered. The source of these data are relevant water supplier records, including the WSP document for post-WSP assessments.

The below mentioned plans/procedures were scored individually on a scale of 1 to 5 where, 1 indicating that a plan or procedure does not exist and 5 indicating that it is documented, current and fully implemented in practice. The total score (out of 40) was recorded as the finding.

- Operational monitoring plan (e.g. visual/sanitary inspections, water quality monitoring)
- Compliance monitoring plan (water quality monitoring of treated water to confirm compliance with water quality standards/targets)
- Consumer satisfaction monitoring
- Standard operating procedures (e.g. caretaker or operator instructions)
- Emergency response plan
- Operator or caretaker training programs
- Consumer education/training programs
- Equipment maintenance/calibration schedules

4.2.2 Financial outcome indicator group

4.2.2.1 Group F1: Cost changes

F1a – Operating costs per unit of water produced over past 12 months: This indicator was calculated by dividing the *annual operating costs (in taka)* with *unit of water produced (in cubic meter).*

F1b – Operating costs per consumer or per connection over past 12 months: This indicator was calculated by dividing the *annual operating costs (in taka)* with *number of consumers or connections*.

For baseline these indicators require data from the 12-month period prior to the start of WSP implementation. The source of the data were water supplier accounts, records and reports. The calculation carefully included all operating cost (e.g. power, treatment chemicals, water quality monitoring) and also recorded if the number of consumers or number of connections are used for indicator F1a so that the same approach is taken for all cases to allow for a direct comparison.

4.2.2.2 Group F2: Changes in cost recovery

F2a – Total revenue collected per consumer or per connection over past 12 months: To calculate this indicator the *total revenue from the water supplies over past 12 months* were divided by *the number of customers or connections*.

F2b – Total revenue as a percentage of total operating costs over past 12 months: This indicator was calculated by *dividing total revenue from the water supplies over past 12 months* with *total operating costs over past 12 months* and reported as percentage.

These indicators also require data from the 12-month period prior to the start of WSP implementation for baseline condition. Consistency was kept in using the number of consumers or number of connections for the calculation and comparison.

4.2.2.3 Group F3: Changes in financial support and investment

F3a – WSP has directly led to financial support from NGOs or donors for water supply system: Only financial support received as a direct result of the WSP are recorded. Any financial support not directly related to the WSP process are avoided. The data source for this indicator was interviews with water supplier staff, project reports/records and review of WSP.

To ensure that the WSP does not receive "false credit" for donor support that is unrelated to the WSP, attention was given to know how the WSP process attracted donor support and the WSP document was reviewed to understand if funds received relate to the hazards and improvement needs identified in the WSP. It was only recorded "Y" where financial support was clearly linked to the WSP process. If the link between financial support and WSPs is not well understood, then it was recorded uncertain. For the initial or baseline assessment, the finding here is not applicable (N/A).

F3b – Total funds/budget received from government for current year: Recorded only the amount received for water supply system operations, maintenance, management and improvements. The data were collected through interviews with water supplier staff, accounts, reports and budget documents.

This indicator captured the total water supplier budget allocation (including units) from government for routine operations, maintenance, management and improvements. Any government funds provided specifically for WSP-related projects or priorities were recorded with a note. For baseline data budget figures were collected from the year of WSP implementation.

4.2.3 Institutional outcome indicator group

4.2.3.1 Group I1: Changes in communication and collaboration among stakeholders

I1a – Number of documented water safety meetings within water supply organization in past 12 months: Meeting minutes were considered as source of data for this indicator.

I1b – Number of documented water safety meetings between water supply organization and other relevant organizations in past 12 months: The relevant stakeholders such as health and environment representatives, development partners were considered for this indicator. The town level coordination committee (TLCC) meetings were also counted.

I1c – Number of consumer water safety training or awareness raising events in past 12 months: Campaigns, rallies, awareness sessions etc. were the source of data.

Number of meetings and events or campaigns designed to increase consumer awareness of water safety issues and/or improve communication between the water supplier and consumers, e.g. training meetings or workshops, educational leaflet development and distribution were considered for these indicators.

4.2.3.2 Group I2: Changes in water supplier knowledge and understanding

I2a – Understanding of water supply system: The source of data for this indicator was a knowledge assessment/ testing of water supply staff who are responsible to protect or manage water quality, water treatment plant (WTP) and the distribution system.

After identifying appropriate personnel each individual was asked to sketch a schematic of the water supply system, from catchment to consumer, capturing all major system components and as much system information as possible (name and type of source, infrastructure at source such as pumps/dams/reservoirs, WTP components, treatment chemicals used, number and size of storage tanks, material of distribution system pipes, etc.). It was ensured that they are working independently and physically separated to disallow discussion. 15 minutes was allowed to complete the task.

All the categories bulleted below were scored using a scale of 1 to 5, with 1 indicating missing or inaccurate information and 5 indicating perfectly thorough and accurate information including all pertinent details. All individual scores were then averaged to determine the finding against each indicator.

- All sources shown and accurate
- All major source infrastructure (e.g. pumps, reservoirs or dams) shown and accurate
- All water treatment infrastructure shown and accurate

- All water storage reservoirs in distribution system shown and accurate
- Distribution pipe material(s) shown and accurate

I2b – Understanding of the hazards and hazardous events that threaten the water supply system: Data source this indicator was also a knowledge assessment/ testing of water supply staff who are responsible to protect or manage water quality, water treatment plant (WTP) and the distribution system.

The output of the previous task was utilized to calculate this indicator status. Once each individual has completed the sketch of the system, they were asked to document hazards/hazardous events that pose a threat to water quality at the appropriate location on the system sketch. Each person was asked to identify at least one hazard/hazardous event at each of the following steps a) catchment, b) WTP (if applicable) and c) distribution system. After one hazard/hazardous event has been listed at each of the 3 steps, each person was allowed to use the remaining time to list as many additional hazards/hazardous events as possible at any step in the water supply system. The time limit for this task was also 15 minutes.

All the categories bulleted below were scored using a scale of 1 to 5, with 1 indicating missing or inaccurate information and 5 indicating perfectly thorough and accurate information including all pertinent details. Also bonus two points was given for each additional unique/valid hazard/hazardous event identified in 10 minutes. All individual scores were then averaged to determine the finding against each indicator.

- At least one valid/reasonable hazard identified within the catchment
- At least one valid/reasonable hazard identified within the WTP
- At least one valid/reasonable hazard identified within the distribution system

4.2.4 Equity outcome indicator group

4.2.4.1 Group E1: Changes in consideration of equity

E1a – Extent to which equity is explicitly considered by the water supplier to provide safe water for all: Here equity refers to the moral imperative to dismantle unjust differences between all groups of people, including women and girls, men

and boys, and disadvantaged groups. Disadvantaged groups refer to people who are vulnerable, marginalized and/or discriminated against on the basis of ethnicity, religion, caste, income, age, disability, education or other factors. Interviews with water supplier particularly management staff rather than operational staff and review of relevant documents were the source of data for this indicator.

Whether or not equity has been considered in water supplier practice as outlined below was the guideline to score each bullet on a scale of 1 to 5 where 1 indicating that the step was not undertaken and 5 indicating that the step was thoroughly undertaken and is fully documented. The total score was recorded as the finding.

- Meaningful participation by women and disadvantaged groups has been prioritized/encouraged by the water supplier
- Disadvantaged groups within the community/water service area have been identified and documented
- Hazards/issues affecting disadvantaged groups have been identified and prioritized
- Priority has been given to ensuring that water supply system improvements benefit all users equitably and address systemic causes for hazards that disproportionately affect disadvantaged groups
- Monitoring data (e.g. water quality monitoring or monitoring of consumer satisfaction) is disaggregated by gender or indicators of disadvantage (e.g. income or caste)
- Emergency response plans and communication/education programs reflect consideration of the special needs of different groups in the community (e.g. considering different languages, literacy levels and physical abilities)

4.2.5 Water supply impact indicator group

4.2.5.1 Group W1: Water service changes

W1a – Hours per day (and days per week) water is provided to customers: Total hours per day and days per week water is supplied to consumers in the wettest and the driest months.

W1b – Service coverage: The piped water supply coverage in the area calculated dividing *the consumers served by supply* with *service area population* and reported as percentage.

W1c – System pressure provided: The operated system pressure including minimum, maximum and target pressure with units.

W1d – Unaccounted for water: The percentage of water loss in the system.

The source of data for all these four indicators are water supplier records and interviews with operational staff.

4.2.5.2 Group W2: Water quality changes

W2a – Number of treated water samples tested for microbial indicators over past 12 months: This is a health based target parameter of WSF.

W2b – Percentage of treated water samples compliant with microbial water quality targets or standards over past 12 months: Calculated by dividing the percent compliant samples with total number of samples.

W2c – Number of treated water samples tested for turbidity over past 12 months: This is a health based target parameter of WSF.

W2d – Percentage of treated water samples compliant with turbidity targets or standards over past 12 months: Calculated by dividing the percent compliant samples with total number of samples.

W2e – Number of treated water samples tested for disinfectant residual over past 12 months: This is a health based target parameter of WSF.

W2f – Percentage of treated water samples compliant with disinfectant residual targets or standards over past 12 months: Calculated by dividing the percent compliant samples with total number of samples.

W2g – Percentage of treated water samples compliant with targets or standards for other locally relevant parameters over past 12 months: Calculated by dividing the percent compliant samples with total number of samples.

All these indicators reference treated water samples for which national drinking-water quality standards or targets apply. However, untreated water quality data are appropriate for systems without treatment, e.g. direct supply from production tubewell. The sampling points are well documented for baseline and subsequent data comparison.

4.2.5.3 Group W3: Consumer satisfaction changes

W3a – Supplier conducts regular consumer satisfaction surveys: Assessment of consumer satisfaction on supplied water.

W3b – Percentage of consumers indicating that they are satisfied with the service provided: This is average level of consumer satisfaction calculated by dividing the *number of satisfied consumers* with *number of consumers surveyed*.

W3c – Supplier keeps a formal record of consumer complaints: Complaints recoding and response mechanism such as maintaining a register.

W3d – Complaints per consumer in the past 12 months: Calculated by diving the number of consumer complaints recorded in the past 12 months with total number of consumers and reported as percentage.

4.2.6 Health impact

4.2.6.1 Group H1: Changes in incidence of water-related illness

H1a – Diarrheal incidence rate over past 12 months calculated from health center records: Only relevant if health center keeps segregated data of supply water area and outside area.

H1b – Number of outbreaks of water-related illness (e.g. typhoid or cholera) over past 12 months: These data are based on health center records

H1c – Diarrheal incidence rate calculated from household survey results: This information was collected by reviewing the results of the household survey carried out by the water supplier or health authorities or a survey conducted before WSP implementation that includes questions on diarrheal illness.

4.2.7 Other considerations for WSP impact assessment

The following approaches were followed while carrying out the assessment in the field.

- The water suppliers were contacted well in advance of assessment visits and provided with a list of personnel and documents that need to be present for the assessment.
- When undertaking retrospective data collection, interviewees were regularly reminded that answers should reflect conditions prior to WSP implementation.
- When assigning scores for indicators attention was given to be objective and consistent.
- The same approach, inputs and logic were applied between the pre and post WSP assessments.

CHAPTER 5

DEVELOPMENT AND USE OF WSP AUDIT QA TOOL

5.1 Overview

At the outset of the research a detail assessment of the WSP implementation in the selected two Pourashava water supply systems will be carryout. This will require interactive interaction with the Pourashava Water Supply Section (PWSS) as well as review of the WSP documents and project reports. To analyze the impact on health based water quality targets historical as well as current water quality data will be required. Also the impact analysis of WSPs demands identification and comparison of key indicators that can be used to generate and use a quality assurance model on WSP. Methods on data collection, water quality tests and impact indicators for quality assurance model are described below.

5.2 Use of QA Tool

Each question in the QA tool should be scored from 0 to 4, with 4 indicating full compliance or achievement and 0 indicating little or no compliance. In most cases, scenarios that warrant a score of 0, 2 and 4 have been provided, with room for assessors to assign scores of 1 or 3 using their own discretion for situations that fall in between the pre-defined reference scenarios. This scoring guidance is designed to ensure a systematic approach to scoring to accurately capture improvement needs and support continued WSP strengthening. Scores are totaled at the end of each section, and each section is assigned a qualitative rating as shown in Figure 5-1 below. Ultimately, all section scores are summed and an overall assessment rating for the WSP is assigned.

Total score					
> 95%	> 85% - 95%	> 75% - 85%	> 65% - 75%	> 50% - 65%	≤ 50%
Excellent	Very good	Good	Average	Below average	Priority attention needed

Figure 5-1: Qualitative assessment ratings

The qualitative ratings above indicate the following:

- Excellent: Highest achievement. WSP is thorough, up-to-date and fully implemented. Water quality risks are well managed.
- Very good: WSP is generally complete, up-to-date and well implemented. Some opportunities exist to strengthen the WSP, its implementation and/or record keeping.
- Good: Major WSP elements have been generally addressed and good progress has been made to implement the WSP. Several opportunities exist to strengthen the WSP, its implementation and/or record keeping.
- Average: Major WSP elements have been generally addressed and some progress has been made to implement the WSP. Focused efforts by the WSP team are needed to strengthen the WSP, its implementation and/or record keeping to lift WSP quality above average.
- Below average: The WSP is not sufficiently complete, up-to-date and/or implemented. Attention is needed to improve water quality risk management.
- Priority attention needed: There are a number of critical gaps in the WSP and/or its implementation indicating insufficient water quality risk management. Priority attention is needed to ensure water safety.

WSP elementwise objective, scoring guideline and outcome status is presented below.

5.2.1 WSP Team

Objective: Assemble an appropriate team of professionals with knowledge and experience in all aspects of the water supply system and sufficient decision-making authority to develop and implement the WSP.

Question		Scoring guidance
1.1	Is there a documented WSP team and is the team list current?	Ask WSP team to make a list of current WSP team members (ideally without referring to the WSP). Compare this list with the WSP team list documented in the WSP. • Score 4 only for a perfectly up-to-date list; • Score 2 for one member out of date (new member not added or resigned member not deleted); • Score 0 for two or more team members out of date or no documented WSP team list. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations.)
1.2	Are appropriate organizations represented on the team?	Appropriate persons often include representatives of the health or environment sectors in addition to water supplier staff. Based on knowledge of optimum team composition (drawing on experience elsewhere in the country), assessor should score. • Score 4 for a fully complete team; • Score 2 for a team with one key organization missing; • Score 0 for a team with two or more key organizations missing. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations.)
1.3	Does the team include people with the authority to carry out WSP recommendations as well as	The WSP team should include those with authority in matters related to budget and operations, for example. A balanced WSP team should also include technical staff to capture inputs and ensure awareness and buy-in. • Score 4 for a well-balanced team with

Question		Scoring guidance
	technical staff?	technical and management-level staff; • Score 2 for a team with one key position/discipline missing (e.g. either no technical staff or no managers); • Score 0 for a team with two or more key positions/disciplines missing. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations.)
1.4	Is there evidence that regular team meetings held and recorded?	Is the WSP team able to furnish evidence, e.g. meeting minutes, that WSP team meetings are held at the frequency indicated in the WSP? Assessor should review these records for the audit period (or for a period of at least one year). • Score 4 only if target frequency is documented in the WSP and there is evidence that meetings are held at this frequency; • Score 2 if there is partial evidence that meetings are held at least six-monthly (or at the target frequency in WSP); • Score 0 if there is no evidence of regular WSP team meetings. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations.)

The score provided in each of the four questions were summed up and graded as below.

Total score					
16 **Excellent**	**14** **Very good**	**13** **Good**	**11 – 12** **Average**	**09 – 10** **Below average**	**≤ 08** **Priority attention needed**

5.2.2 System Description

Objective: Thoroughly describe the water supply system to demonstrate complete system understanding and inform the risk assessment.

Question		Scoring guidance
2.1	Are intended users/uses of the water supply defined?	The WSP should clearly describe the method and basis for the risk assessment, including key terminology and definitions (e.g. how likelihood and severity are defined). • Score 4 if the risk assessment methodology is clearly and thoroughly defined in the WSP; • Score 2 if partially defined (e.g. if key definitions are missing or incomplete); • Score 0 if not defined. *(Scores 1 and 3 can be assigned at assessor's discretion for in between situations.)
2.2	Are drinking-water quality standards or targets described?	Does the WSP include the nationally relevant water quality standards or targets that the water supply must meet? A general reference to WHO guidelines is not sufficient. • Score 4 if standards/targets are fully defined in the WSP (or a relevant national document is thoroughly/accurately referenced); • Score 2 if this requirement is partially addressed in the WSP; • Score 0 if there is no reference to standards in the WSP. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations, e.g. standards included but out of date.)

2.3	Are clear, accurate and up-to-date maps and/or schematics of the complete water system included?	Follow the flow of water from catchment to consumer on the schematics/maps to confirm clarity and consistency. Field verify the information provided and note any errors or inconsistencies. Also, discuss the schematic details with staff and ask them if there have been any changes. • Score 4 if maps/schematics are detailed, clear, complete, accurate and fully up to date; • Score 2 if included but not fully clear, complete, accurate or up to date; • Score 0 if not included. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations.)
2.4	Are all major steps in the water supply chain described?	Accurate information on the catchment, treatment and storage facilities, distribution system and household-level practices should be provided. • Score 4 if all steps are thoroughly and accurately described (including household practices where household storage and/or treatment are required, e.g. because of tap stand use or intermittent supply to homes); • Score 2 if one major step is missing; • Score 0 if two or more major steps are missing. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations, e.g. steps are included but inadequately or inaccurately described.)

The score provided in each of the four questions were added and graded as below.

Total score					
16 Excellent	14 Very good	13 Good	11 – 12 Average	09 – 10 Below average	≤ 08 Priority attention needed

5.2.3 Hazard Identification and Risk Assessment

Objective: Identify hazards/hazardous events and assess related risk to water safety to determine if improvements are needed.

Question		Scoring guidance
3.1	Has the risk assessment approach been clearly described?	The WSP should clearly describe the method and basis for the risk assessment, including key terminology and definitions (e.g. how likelihood and severity are defined). • Score 4 if the risk assessment methodology is clearly and thoroughly defined in the WSP; • Score 2 if partially defined (e.g. if key definitions are missing or incomplete); • Score 0 if not defined. *(Scores 1 and 3 can be assigned at assessor's discretion for in between situations.)
3.2	Have all significant hazards been identified at all major steps?	Based on discussions with the WSP team and field visits, determine if all important hazards/hazardous events have been documented. • Score 4 if all major hazards have been identified and documented for each step in the water supply chain; • Subtract one point for each significant hazard that in the assessor's estimation should have been considered/ documented and was not (down to a minimum score of 0).
3.3	Have existing	Ensure that the risk assessment considers controls

	control measures been identified and validated?	that are already in place and whether or not those existing controls are capable of mitigating the risk. ('Validation' is the process of confirming the effectiveness of existing controls and is an important step in determining if additional controls are needed.) • Score 4 if existing controls are documented and validated for all hazardous events; • Score 2 if existing controls have been documented but not validated; • Score 0 if existing controls have not been documented. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations.)
3.4	Have risks been logically and systematically assessed for all hazards identified?	Confirm that the risk assessment indicates a clear understanding of the risk assessment methodology and that the risk scoring is clear, consistently applied and logical. • Score 4 if the complete risk assessment is clear, consistent and logical; • Score 0 if the risk assessment is significantly unclear, inconsistent or illogical and/or suggests that the WSP team does not have a clear understanding of the risk assessment process. *(Scores 1, 2 and 3 can be assigned at assessor's discretion for 'in between' situations.)
3.5	Is it clear which hazards require additional control or improvement?	Confirm that the risk assessment clearly indicates which hazards require additional control (or improvements). Any additional controls needed should be clearly separated from the existing controls

		documented. • Score 4 if there are no challenges in determining which hazards require additional control; • Score 2 if it is somewhat unclear which hazards need more control (e.g. existing and proposed controls are mixed together); • Score 0 if it cannot be determined from the risk assessment which hazards require additional control. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations.)

The scoring of the five questions were summed up and graded as below.

Total score					
20 **Excellent**	**18 – 19** **Very good**	**16 – 17** **Good**	**14 – 15** **Average**	**11 – 13** **Below average**	**≤ 10** **Priority attention needed**

5.2.4 Improvement Plan

Objective: Plan improvements based on system needs and priorities identified through the risk assessment process.

Question		Scoring guidance
4.1	Has an improvement plan been developed that is clearly linked to the risk assessment process?	There should be a clear and direct link between the risk assessment and the improvement plan. All improvements identified in the plan should follow directly from the risk assessment process. • Score 4 only if the following two conditions are met: a) an improvement has been proposed for each significant risk requiring additional control, and b) each improvement

		in the plan is clearly and directly linked to the risk assessment; • Score 2 if the link between the risk assessment process and the improvement plan exists but is not fully clear and direct; • Score 0 if there is no clear link between the risk assessment and the improvement plan, or if there is no improvement plan. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations.)
4.2	Does the improvement plan describe the action, responsible party, cost, funding source and due date?	The improvement plan should be specific to facilitate action. Score one point for each of the following categories of information included in the improvement plan (provided that meaningful information has been provided for each category): 1) action to be taken; 2) responsible party; 3) cost and/or funding source; and 4) target due/completion date. • If no improvement plan, score 0.
4.3	Is the improvement plan being carried out as documented and kept up-to-date?	Look for evidence that improvements are being made as per the defined schedule. The improvement plan is of little use if it is not being implemented. Talk through the full improvement plan with the WSP team to gauge the degree of implementation. Also look for evidence that the plan is revisited and revised by the WSP team, e.g. that completed works are marked as complete or that new schedules have been defined for lapsed deadlines. • Score 4 only where all works are being implemented as described in the schedule and

		where completed work are marked as complete or removed from the improvement schedule; • Score 2 where works are generally being implemented as described but where there are a couple of lapsed deadlines or where completed works have not been marked; • Score 0 where the improvement plan is generally out of date and not being followed, or there is no improvement plan. *(Scores 1 and 3 can be assigned at assessor's discretion for "in between" situations.)

The scoring of the three questions were totaled and graded as below.

Total score					
12 **Excellent**	**11** **Very good**	**10** **Good**	**9** **Average**	**7– 8** **Below average**	**≤ 6** **Priority attention needed**

5.2.5 Operational Monitoring

Objective: Describe monitoring to be carried out by the supplier (visual inspections and water quality testing) to ensure that key water supply system components and control measures continue to work effectively.

Question		Scoring guidance
5.1	Has an operational monitoring plan been documented addressing routine water quality monitoring and	This addresses operational monitoring by the supplier to confirm control measure effectiveness, and it is distinct from compliance monitoring by health officials to confirm that health-based standards or targets are being met (which is covered in the next section 6: Verification). Ideally, the operational

	visual inspections by the supplier?	monitoring plan should cover visual inspections, e.g. checking fences, storage tanks, spring boxes, etc., as well water quality testing by the supplier. Where possible, the supplier should monitor water quality at appropriate locations to inform operational decisions, e.g. monitoring raw, settled or filtered water. This is especially critical where treatment chemicals are being used, such as alum or chlorine. • Score 0 if an operational monitoring plan has not been documented to cover water quality testing and/or visual inspections by the supplier. • Where a documented plan exists, score one point for each of the following elements: o parameters (e.g. turbidity, pH, chlorine) and/or control measures/components to be monitored (e.g. fences) o monitoring locations and frequency o responsible party o target conditions and/or critical limits and corrective actions if critical limits are breached.
5.2	Is the supplier carrying out operational monitoring as per the documented plan?	Review monitoring records, e.g. water quality logbooks and site inspection checklists for the audit period (or for a period of at least one year) to confirm that operational monitoring is being conducted by the supplier as per the plan. • Score 4 only where complete records clearly indicate full compliance with the monitoring plan; • Score 2 where available records indicate

		general compliance with the schedule but where there are gaps in records; • Score 0 where no records exist to confirm compliance with the monitoring plan or where there is no plan for operational monitoring by the supplier. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations.)

The scoring of the two questions were summed up and graded as below.

Total score					
8 Excellent	7 Very good	6 Good	5 Average	4 Below average	≤ 3 Priority attention needed

5.2.6 Verification

Objective: Confirm that drinking water quality standards are being met, consumers are satisfied and the WSP is complete and effective.

Question		Scoring guidance
6.1	Has a compliance monitoring plan been documented?	The compliance monitoring plan is generally developed as a collaboration between health officials and the water supplier. Compliance monitoring is distinct from operational monitoring by the supplier (covered in the previous section 5 - Operational monitoring). It covers the water quality monitoring required to determine compliance with health-based water quality standards or targets. • Score 0 if a compliance monitoring plan has not been documented; • Where a documented plan exists, score one point for each of the following elements:

		○ parameters monitored (e.g. *E. coli*) and relevant standard or target for each parameter ○ monitoring locations ○ monitoring frequency ○ responsible party.
6.2	Is compliance monitoring being carried out as planned?	Review water quality records for the audit period (or for a period of at least one year) to confirm that compliance monitoring is being conducted as planned. No monitoring (or no records) may indicate insufficient communication between water supplier staff and health sector members of the WSP team. • Score 4 only where complete records clearly indicate full compliance with the monitoring plan; • Score 2 where available records indicate general compliance with the schedule but where there are gaps in records; • Score 0 where no records exist to confirm compliance with the monitoring plan or where there is no plan for compliance monitoring. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations.)
6.3	Are water quality standards or targets being met?	Do compliance monitoring records indicate that water quality targets are being achieved? If not, the WSP is not achieving one of its primary objectives. The assessor should review available water quality records for the audit period (at least one year) and calculate compliance rates for key water quality indicators, e.g. faecal coliforms. • Score 4 where records indicate >95%

		compliance with standards; • Score 3 for 85–95% compliance; score 2 for 75–85%; • Score 1 for 65–75%; • Score 0 for ≤65%; (If no water quality records are available, score 0.) Where there is documented evidence of corrective action by the supplier during non-complying events, the assessor should add one point to the breakdown above (with a maximum score of 4). For instance, 70% compliance with regular, documented corrective action by the supplier during non-complying events would score 1 + 1 = 2.
6.4	Does the supplier have a documented and implemented system of regularly monitoring and recording consumer satisfaction?	The WSP should define a system for regularly monitoring consumer satisfaction, e.g. customer surveys or complaints logs, and the supplier should be able to furnish evidence that the system is implemented in practice. • Score 4 if the supplier has clearly defined and documented a system of monitoring consumer satisfaction and can furnish thorough evidence that the system is implemented; • Score 2 where the supplier has developed and regularly implements a system of consumer satisfaction monitoring but where there are some gaps in documentation and record; • Score 0 where no documentation or records of consumer satisfaction monitoring exist, or no system has been defined. *(Scores 1 and 3 can be assigned at assessor's

		discretion for 'in between' situations.)
6.5	Has a plan for internal WSP auditing been defined and is it being implemented?	The WSP should define the frequency of internal audits and the WSP team should be able to furnish evidence that internal audits are being conducted at the frequency indicated in the WSP. (The auditor should make this guidance note available to WSP teams to use for internal auditing.) • Score 4 only if target internal audit frequency is documented in the WSP and there is evidence that internal auditing is carried out at this frequency; • Score 2 if there is partial evidence that an internal audit has been conducted during the audit period; • Score 0 if there is no evidence of internal auditing. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations.)

The scoring of the five questions were summed up and graded as below.

Total score					
20	**18 – 19**	**16 – 17**	**14 – 15**	**11 – 13**	**≤ 10**
Excellent	**Very good**	**Good**	**Average**	**Below average**	**Priority attention needed**

5.2.7 Management Procedures

Objective: Define procedures to be followed during routine operations and emergency situations.

Question		Scoring guidance
7.1	Have clear SOPs been defined for	Based on the experience and site knowledge acquired during the assessment, the assessor should be able to

	major operational activities?	make a general list of key operational activities for which SOPs should be developed (e.g. filter backwashing, coagulant dosing, chorine dosing, storage tank cleaning, pipeline repair and replacement, equipment calibration, etc.). The assessor should make this list with WSP team members and review evidence that these SOPs have been developed. • Score 4 if the supplier has developed clear and detailed SOPs for the majority of the key operational activities listed by the assessor; • Score 2 where the supplier has developed SOPs for many of the activities on the list and/or where the level of detail is not sufficient to guide field staff; • Score 0 where few or no detailed SOPs exist. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations.)
7.2	Are SOPs up-to-date and accessible to field staff?	The assessor should review a sample of the supplier's SOPs in detail with the WSP team to gauge whether or not they are generally accurate and up to date. In addition, the assessor should determine whether or not the SOPs are easily accessible to field staff for their use and reference. (SOPs that exist only at the head office are of little use to field staff.) • Score 4 if all sample SOPs reviewed are up to date and easily accessible to relevant field staff; • Score 2 if there are minor issues with SOP updating/accuracy or accessibility; • Score 0 if SOPs are significantly out of date,

		inaccurate or inaccessible or if documented SOPs do not exist. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations.)
7.3	Does the WSP include a current emergency response plan?	The WSP should include a documented emergency response plan describing water quality emergencies that would trigger implementation of the plan, as well as communication protocols and up-to-date contact information. • Score 0 if an emergency response plan has not been documented. • Where a documented plan exists, score one point for each of the following elements: ○ a list of water quality incidents or emergencies that would trigger plan activation; ○ current names, positions and contact details of persons within the water supplier to be notified (no point given for outdated contact information); ○ current names, positions and contact details of health officials to be notified (no point given for outdated contact information); and ○ plan for disseminating emergency messages to consumers.

The scoring of the three questions were totaled and graded as below.

Total score					
12	**11**	**10**	**9**	**7– 8**	**≤ 6**
Excellent	**Very good**	**Good**	**Average**	**Below average**	**Priority attention needed**

5.2.8 Supporting Programmes

Objective: Identify programmes that indirectly support water safety.

Question		Scoring guidance
8.1	Have appropriate supporting programmes been clearly defined?	Based on the experience and site knowledge acquired during the assessment, the assessor should be able to make a general list of supporting programmes that should be included in the WSP, generally including operator training and consumer education as a minimum. • Score 4 if the supplier has clearly defined all relevant supporting programmes, including implementation details; • Score 2 where the supplier has vaguely defined all relevant supporting programmes or has clearly defined only some of the key supporting programmes; • Score 0 where few or no supporting programmes are defined. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations.)
8.2	Are supporting programmes being implemented as planned?	The supplier should be able to furnish evidence that supporting programmes are being implemented as described in the WSP. Review relevant records to confirm. • Score 4 where records indicate that supporting programmes are being carried out as planned; • Score 2 where available records indicate the supporting programmes are being carried out to some extent but where there are gaps in

		records or some departures from implementation plan in WSP; • Score 0 where no records exist to confirm implementation of supporting programmes. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations.)

The scoring of the two questions were summed up and graded as below.

Total score					
8 **Excellent**	**7** **Very good**	**6** **Good**	**5** **Average**	**4** **Below average**	**≤ 3** **Priority attention needed**

5.2.9 Review and Revision

Objective: Ensure that the WSP remains up-to-date and effective through regular review and revision.

Question		Scoring guidance
9.1	Is a schedule for regular review and revision of the WSP defined?	Regular review and revision of the WSP by the WSP team is essential to ensuring that the WSP remains relevant and guides day-to-day operations. WSP review following an emergency or incident is also important. • Score 4 if the WSP includes a clearly defined schedule of regular WSP review and revision; • Score 0 where a regular review schedule is not defined in the WSP. *(Scores 1, 2 and 3 can be assigned at assessor's discretion for 'in between' situations.)
9.2	Is the WSP being reviewed and	The WSP team should be able to furnish evidence that the WSP is being reviewed and revised as per the

	revised as planned?	review schedule defined in the WSP, e.g. minutes from review meetings and or old/updated WSP versions. • Score 4 only if the target frequency is documented in the WSP and there is evidence that it is being reviewed at this frequency; • Score 2 if there is partial evidence that WSP is being reviewed at least annually (or at the target frequency in the WSP); • Score 0 if there is no evidence of regular WSP review. *(Scores 1 and 3 can be assigned at assessor's discretion for 'in between' situations.)

The scoring of the two questions were summed up and graded as below.

Total score					
8 **Excellent**	**7** **Very good**	**6** **Good**	**5** **Average**	**4** **Below average**	**≤ 3** **Priority attention needed**

The QA tool was used to audit both the water supply systems as discussed in Chapter 6.

CHAPTER 6

RESULTS AND DISCUSSION

6.1 Findings

The findings of WSP impact assessment based on data of key indicators, the knowledge, attitude and practice of consumers based on household survey and WSP maturity status assessed following the WSP audit guideline and using the QA tool is presented in the following sections.

6.2 WSP impact assessment result

6.2.1 Chandpur Pourashava

Based on WSP impact assessment indicators and analysis methodologies described in Chapter 4, the findings of Chandpur Water Supply systems is presented below.

Indicators		Before WSP (2011)	After WSP (2015)
OPERATIONAL OUTCOMES			
GROUP O1: CHANGES IN SYSTEM INFRASTRUCTURE			
O1a	Infrastructure has been improved or added as a direct result of the WSP	N/A	Y[1]
GROUP O2: CHANGES IN OPERATIONS AND MANAGEMENT PROCEDURES			
O2a	Level/strength of operations and management practices evident through documentation and implementation of relevant plans and procedures (out of 40)	8	24
FINANCIAL OUTCOMES			
GROUP F1: COST SAVINGS			
F1a	Operating costs per unit of water produced over past 12 months (BDT/cubic meter)	12.95	13.13
F1b	Operating costs per consumer or per connection over past 12 months (BDT/consumer)	115.2	123.4
GROUP F2: IMPROVED COST RECOVERY			
F2a	Total revenue collected per consumer or per connection over past 12 months (BDT/consumer)	68.3	128.43

[1] WSP is being implemented to some extent like: problem in distribution line has been minimized through prompt repairing the leakage. Mayor has taken initiative to solve the leakage problem

	Indicators	Before WSP (2011)	After WSP (2015)
F2b	Total revenue as a % of total operating costs over past 12 months	89 %	104.1 %
GROUP F3: INCREASED FINANCIAL SUPPORT AND INVESTMENT			
F3a	WSP has directly led to financial support from NGOs or donors for water supply system	N/A	N
F3b	Total funds/budget received from government for current year for water supply systems operations, management and improvements	----	---
INSTITUTIONAL OUTCOMES			
GROUP I1: INCREASED COMMUNICATION AND COLLABORATION AMONG STAKEHOLDERS			
I1a	No. of documented water safety meetings within water supply organization in past 12 months	0	2
I1b	No. of documented water safety meetings between water supply organization and other relevant organizations in past 12 months, e.g. health and environment representatives, development partners	0	4 (TLCC)
I1c	No. of consumer water safety training or awareness raising events in past 12 months	0	5
GROUP I2: INCREASED STAKEHOLDER KNOWLEDGE AND UNDERSTANDING			
I2a	Understanding of water supply system	12 out of 25	19 out of 25
I2b	Understanding of the hazards and hazardous events that threaten the water supply system	7	21
EQUITY OUTCOMES			
GROUP E1: CHANGES IN CONSIDERATION OF EQUITY			
E1a	Extent to which equity is explicitly considered by the water supplier to provide safe water for all	12	12
WATER SUPPLY IMPACT			
GROUP W1: WATER SERVICE CHANGES			
W1a	Hours/day (and days/week) water is provided to customers	22/7	22/7
W1b	Service coverage	84%	89.7%
W1c	System pressure provided	Not Known	Not Known
W1d	Unaccounted for water (or % water loss)	8.39%	8.06%
GROUP W2: WATER QUALITY CHANGES			
W2a	No. of treated water samples tested for microbial indicators over past 12 months	10	10

	Indicators	Before WSP (2011)	After WSP (2015)
W2b	% of treated water samples compliant with microbial water quality targets or standards over past 12 months	80%	90%
W2c	No. of treated water samples tested for turbidity over past 12 months	0	12
W2d	% of treated water samples compliant with turbidity targets or standards over past 12 months	-	100%
W2e	No. of treated water samples tested for disinfectant residual over past 12 months	0	10
W2f	% of treated water samples compliant with disinfectant residual targets or standards over past 12 months	-	80%
W2g	OPTIONAL: % of treated water samples compliant with targets or standards for other locally-relevant parameters over past 12 months	0	100%
GROUP W3: CONSUMER SATISFACTION CHANGES			
W3a	Supplier conducts regular consumer satisfaction surveys	N	N
W3b	% of consumers indicating that they are satisfied with the service provided OR average level of consumer satisfaction	-	14% [2]
W3c	Y/N: Supplier keeps a formal record of consumer complaints	Y	Y
W3d	No. of consumer complaints recorded in the past 12 months divided by total no. of consumers	0.21%	0.32%
HEALTH IMPACT			
H1: CHANGES IN INCIDENCE OF WATER-RELATED ILLNESS			
H1a	Diarrheal incidence rate over past 12 months calculated from health center records	---	--
H1b	No. of outbreaks of water-related illness (e.g. typhoid or cholera) over past 12 months based on health center records	---	--
H1c	Diarrheal incidence rate calculated from household survey results	34%	24%

6.2.2 Chapai-Nawabganj Pourashava

Similar to Chandpur, findings of WSP impact assessment indicators for Chapai-Nawabganj Water Supply systems is presented below.

[2] Survey conducted by PMID-GBUS in Dec 2014 (reason for satisfaction was due to water availability, & good water quality)

Indicators		Before WSP (2011)	After WSP (2015)
OPERATIONAL OUTCOMES			
GROUP O1: CHANGES IN SYSTEM INFRASTRUCTURE			
O1a	Infrastructure has been improved or added as a direct result of the WSP	N/A	Y
GROUP O2: CHANGES IN OPERATIONS AND MANAGEMENT PROCEDURES			
O2a	Level/strength of operations and management practices evident through documentation and implementation of relevant plans and procedures (out of 40)	8	17
FINANCIAL OUTCOMES			
GROUP F1: COST SAVINGS			
F1a	Operating costs per unit of water produced over past 12 months (BDT/cubic meter)	3.14	3.48
F1b	Operating costs per consumer or per connection over past 12 months (BDT/connection)	1137	578
GROUP F2: IMPROVED COST RECOVERY			
F2a	Total revenue collected per consumer or per connection over past 12 months (BDT/ connection)	1692	679
F2b	Total revenue as a % of total operating costs over past 12 months	139.6 %	117 %
GROUP F3: INCREASED FINANCIAL SUPPORT AND INVESTMENT			
F3a	WSP has directly led to financial support from NGOs or donors for water supply system	N/A	Uncertain[3]
F3b	Total funds/budget received from government for current year for water supply systems operations, management and improvements (BDT)	----	6,25,000
INSTITUTIONAL OUTCOMES			
GROUP I1: INCREASED COMMUNICATION AND COLLABORATION AMONG STAKEHOLDERS			
I1a	No. of documented water safety meetings within water supply organization in past 12 months	0	2
I1b	No. of documented water safety meetings between water supply organization and other relevant organizations in past 12 months, e.g. health and environment representatives, development partners	0	0
I1c	No. of consumer water safety training or awareness raising events in past 12 months	0	6

[3] Though some fund received using which improvement was made as listed under improvement plan of WSP, fund was not requested mentioning WSP process

Indicators		Before WSP (2011)	After WSP (2015)
GROUP I2: INCREASED STAKEHOLDER KNOWLEDGE AND UNDERSTANDING			
I2a	Understanding of water supply system	5 out of 25	14 out of 25
I2b	Understanding of the hazards and hazardous events that threaten the water supply system	5	20
EQUITY OUTCOMES			
GROUP E1: CHANGES IN CONSIDERATION OF EQUITY			
E1a	Extent to which equity is explicitly considered by the water supplier to provide safe water for all	10	10
WATER SUPPLY IMPACT			
GROUP W1: WATER SERVICE CHANGES			
W1a	Hours/day (and days/week) water is provided to customers	14/7	14/7
W1b	Service coverage	38%	40%
W1c	System pressure provided	Not Known	Not Known
W1d	Unaccounted for water (or % water loss)	20%	16%
GROUP W2: WATER QUALITY CHANGES			
W2a	No. of treated water samples tested for microbial indicators over past 12 months	2	5
W2b	% of treated water samples compliant with microbial water quality targets or standards over past 12 months	50%	80%
W2c	No. of treated water samples tested for turbidity over past 12 months	0	0
W2d	% of treated water samples compliant with turbidity targets or standards over past 12 months	-	-
W2e	No. of treated water samples tested for disinfectant residual over past 12 months	0	0
W2f	% of treated water samples compliant with disinfectant residual targets or standards over past 12 months	-	-
W2g	OPTIONAL: % of treated water samples compliant with targets or standards for other locally-relevant parameters over past 12 months	-	-
GROUP W3: CONSUMER SATISFACTION CHANGES			
W3a	Supplier conducts regular consumer satisfaction surveys	N	N
W3b	% of consumers indicating that they are satisfied with the service provided OR average level of consumer satisfaction	-	47.6%
W3c	Y/N: Supplier keeps a formal record of consumer complaints	Y	Y

	Indicators	Before WSP (2011)	After WSP (2015)
W3d	No. of consumer complaints recorded in the past 12 months divided by total no. of consumers	0.17%	0.22%
HEALTH IMPACT			
H1: CHANGES IN INCIDENCE OF WATER-RELATED ILLNESS			
H1a	Diarrheal incidence rate over past 12 months calculated from health center records	---	32
H1b	No. of outbreaks of water-related illness (e.g. typhoid or cholera) over past 12 months based on health center records	---	--
H1c	Diarrheal incidence rate calculated from household survey results	37%	29.3 %

6.3 Household Survey

The major findings from the household survey on their knowledge and practice towards safe water is presented below.

The main source of drinking water in both these Pourashavas are piped water supplies (PWS). Figure 6-1 shows that around 96.1 percent people in Chandpur and 71.7 percent people in Chapai-Nawabganj Pourashava use PWS for drinking purpose.

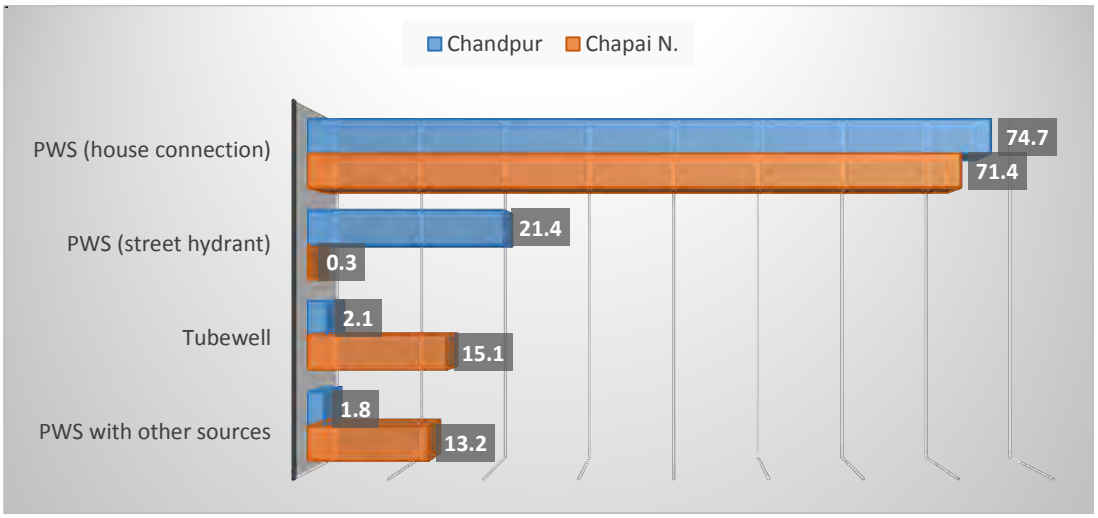


Figure 6-1: Source of drinking water

In Chandpur Pourashava 91 percent respondents believe that the supplied water is not safe; the figure is 41 percent in Chapai-Nawabganj Pourashava (Figure 6-2). Respondents, those believe that water is not safe, gave various reasons for unsafe water of which presence of iron & bad odor (as opined by 81.6% & 83.1% of respondents respectively in Chandpur and 74.3% & 18.6% of respondents respectively in Chapai-Nawabganj Pourashava) were most common. Among others microbiological contamination as opined by 35.6 percent of people in Chandpur Pourashava and presence of arsenic in water as opined by 9.7 percent of people in Chapai-Nawabganj Pourashava were significant. Figure 6-3 shows the reasons opined by respondents for unsafe water.

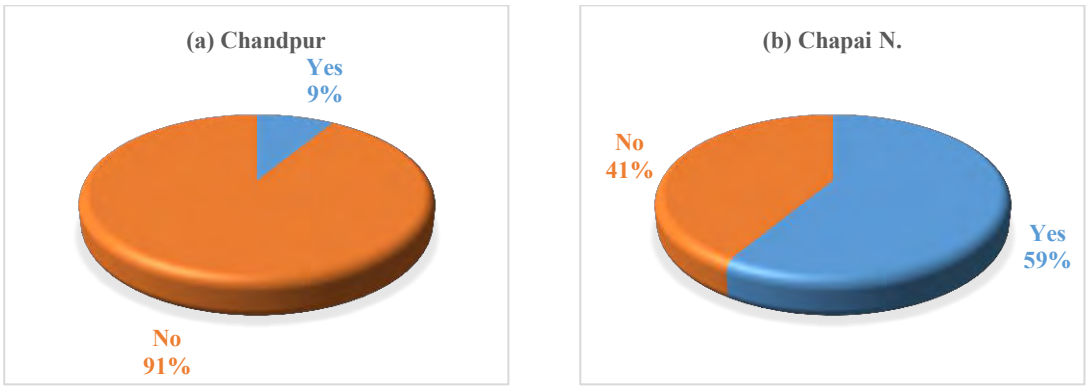


Figure 6-2: People perception on whether the supplied water is safe

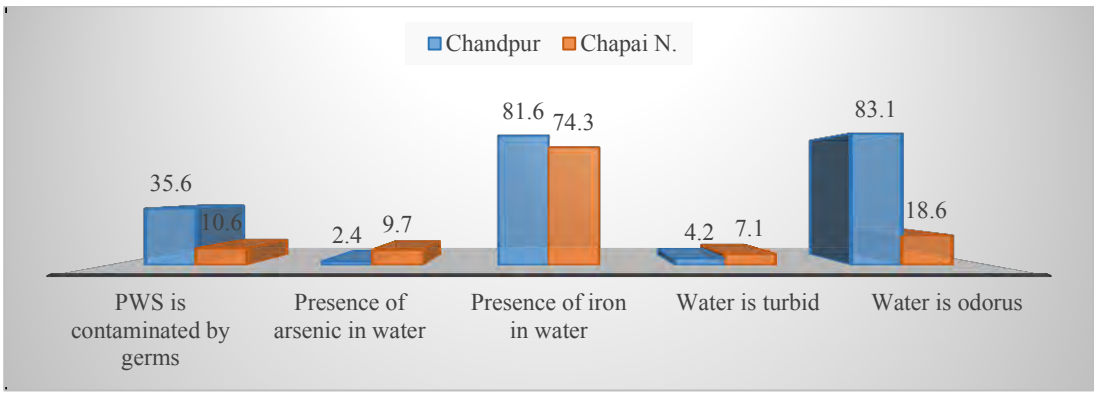


Figure 6-3: Reasons opined by percentage of people for unsafe supplied water

Figure 6-4 reveals consumers response on how the piped water become contaminated. In Chandpur 62.5 and in Chapai-Nawabganj 100 percent people believe that presence of contamination in the source water is the main reason for contamination of the supplied water. Other reasons as opined by 23.3 and 16.7 percent people in Chandpur and Chapai-Nawabganj Pourashava respectively are drain crossing of service lines and leakage in pipe network (as opined by 23.3 and 8.3 percent people respectively)

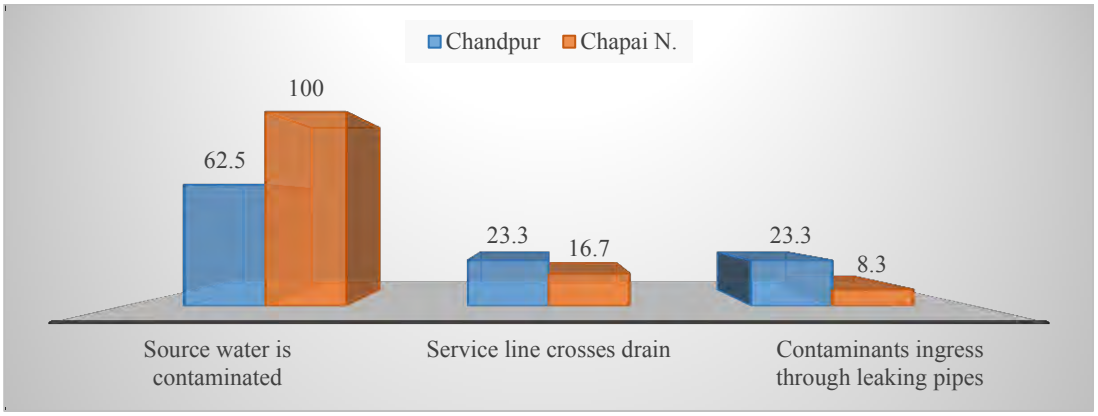


Figure 6-4: Reasons opined by percentage of people on how PWS is getting contaminated

Table 6-1 shows the underground and overhead reservoir cleaning frequency by the consumers of Chandpur and Chapai-Nawabganj Pourashava. In Chandpur most of the consumers clean their reservoirs quarterly or half-yearly whereas in Chapai-Nawabganj most of the consumers clean their reservoirs half-yearly or yearly. 54 percent consumers in Chandpur and 85 percent consumers in Chapai-Nawabganj Pourashava do not use any cleansing agent (e.g., detergent or bleaching powder) for cleaning their underground and overhead reservoirs (Figure 6-5).

Table 6-1: Reservoir cleaning practice by percentage of HH

Frequency	Underground		Overhead	
	Chandpur	Chapai N.	Chandpur	Chapai N.
Monthly	14.5	7.5	15.1	18.0
Quarterly	31.5	14.3	34.6	25.3
Half yearly	29.9	39.8	33.0	37.1

Yearly	18.3	29.3	14.0	18.5
Once in two years	1.7	0.8	1.7	0.6
Never cleaned	4.1	8.3	1.7	0.6

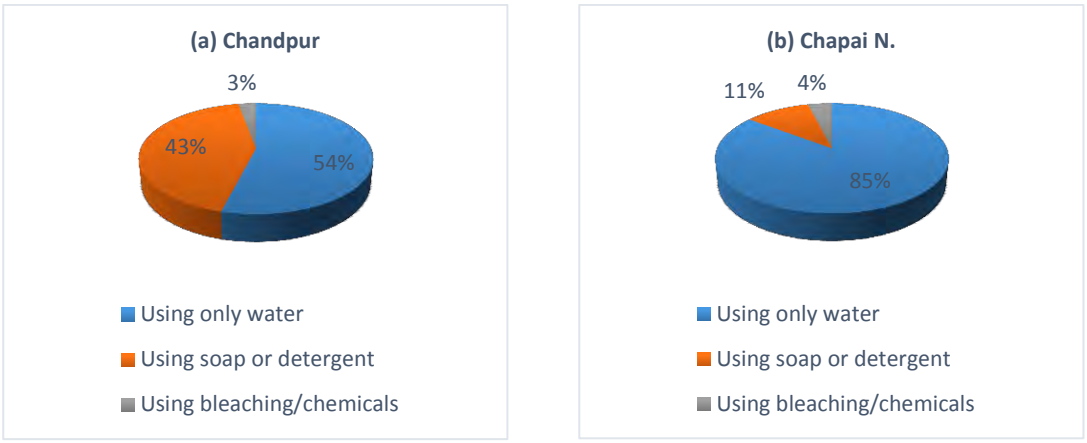


Figure 6-5: Process of cleaning reservoir

Diarrhea and dysentery were found to be the most striking waterborne diseases in both the towns. As shown in Figure 6-6 around 18.3% people in Chandpur and 36.3% people in Chapai Nawabganj Pourashava suffered from these two diseases in the last year whereas a total of 34.4% and 38.2% people suffered from various waterborne diseases respectively in these towns. Among the affected people 13.1% people in Chandpur and 23.7% people in Chapai Nawabganj Pourashava suffered more than once from the waterborne diseases in the last one year (Figure 6-7).

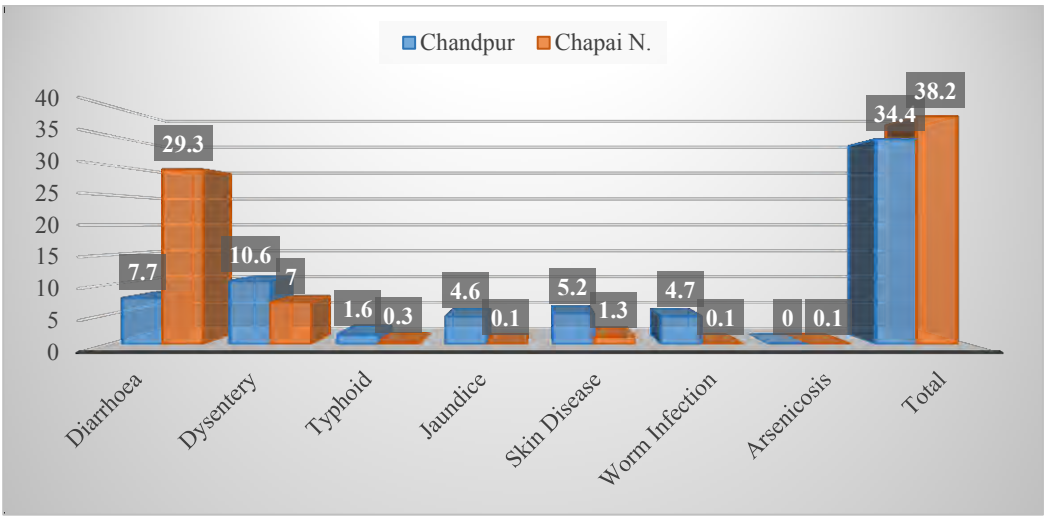


Figure 6-6: Incidence of waterborne diseases

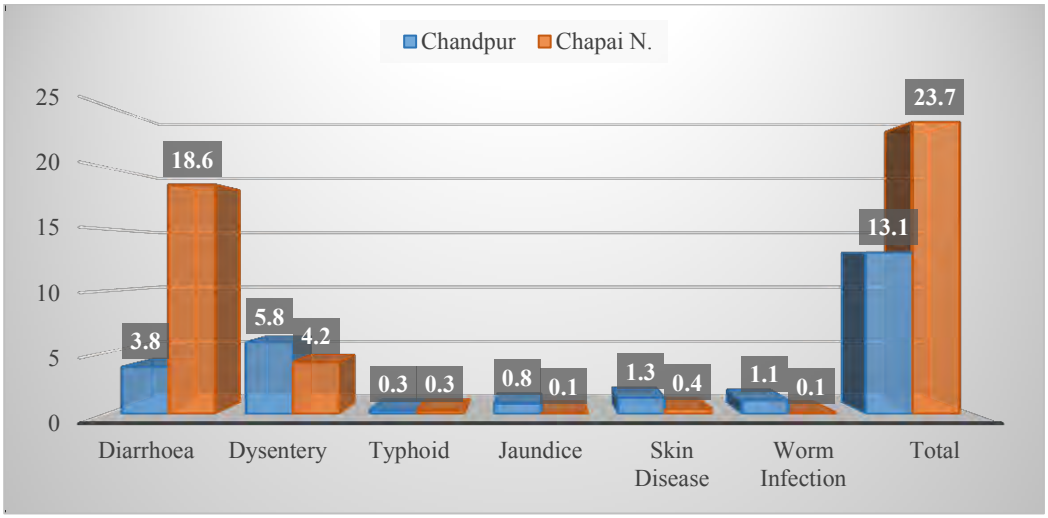


Figure 6-7: Multiple incident rate of waterborne diseases

Most of the people are getting sick twice a year from waterborne diseases. As detailed in Figure 6-9 these amounts are 43 and 57 percent of people in Chandpur and Chapai-Nawabganj Pourashava respectively. Again all ages of people are suffering almost equally in Chandpur and around 81 percent people above the age of 12 in Chapai-Nawabganj from these diseases (Figure 6-8).

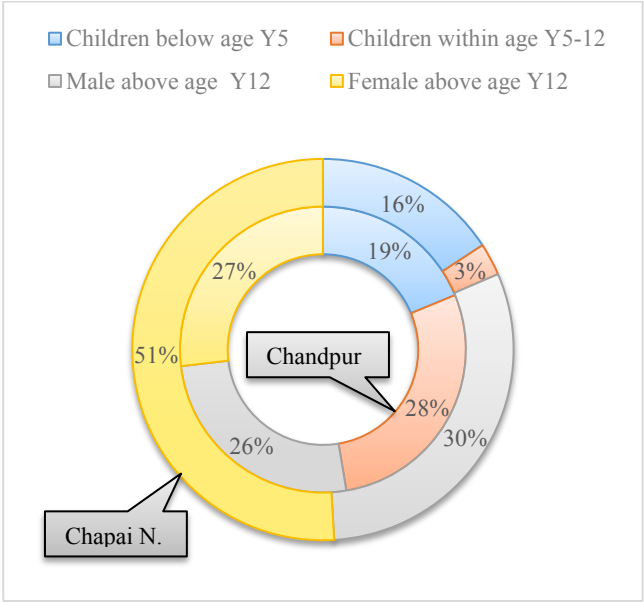


Figure 6-8: Who get sick frequently

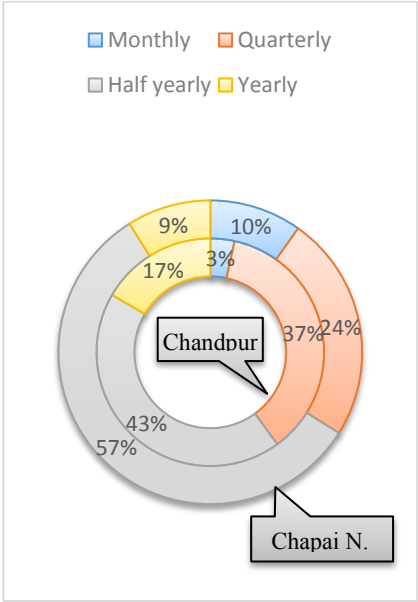


Figure 6-9: Frequency of sickness

6.4 Status of Water Quality

Four water quality parameters, (i) Thermo-Tolerant Coliform (TTC), (ii) arsenic, (iii) residual chlorine, and (iv) nitrate have been set as the first priority health based targets by the WSF in Bangladesh (Table 3-2). In addition, turbidity has also been set as first priority non-HBT. Water samples from different section of the water supply systems of the two Pourashavas were analyzed for these parameters and the result are presented in the following sections.

6.4.1 Chandpur

Table 6-2: Water quality test result of samples collected from storage tank of treatment plant

Sampling location	pH	TTC (N/100 ml)	Arsenic (mg/l)	Residual chlorine (mg/l)	Nitrate (mg/l)	Turbidity (NTU)
Pouran Bazar WTP	6.55	0	<0.01	2.2	1	7
Notun Bazar WTP1	6.85	0	<0.01	2.0	0	6
Notun Bazar WTP2	6.70	0	<0.01	2.6	0	5

Table 6-3: Water quality test result of samples collected from street tap stands and household reservoirs.

Ward	Address	pH	Residual Chlorine (mg/l)	TTC (N/100 ml)
Ward 1	Chandan Kumar Dhar, House No. #1413/1, Merkatiz Road	6.50	0.3	3
Ward 2	Lokman Khan, House No#506, Royej Road	6.85	0.3	4
Ward 3	Ranjit Devnath, House No#009, Matisalt Road	6.90	0.3	4
Ward 4	Hasina Begum, House No. #328, Purba Shreeramdi	7.00	0.3	2
Ward 5	Masud Akhand, House No. #009, Akhan Bar	7.25	0.25	3
Ward 6	Mojibur Rahman, House No. #363, Stand Road	6.85	0.25	2
Ward 7	Fazlul Patwari, House No. #703, Koralia Road	6.50	0.25	2
Ward 8	Dr. Amin Ahmed, House No. #671, Mohsin Road	6.50	0.25	2
Ward 9	Dr. Shahabuddin Khan, House	6.55	0.25	2

	No. #506, Bishnudi Road			
Ward 10	Prodeep Guho, House No. #152, Adalat Para	6.75	0.25	3
Ward 11	Md. Amanullah, House No. #395, Bagadi Road	6.50	0.20	2

6.4.2 Chapai-Nawabganj

Table 6-4: Water quality test result of samples collected from production tubewells (PTW).

Sampling location	pH	TTC (N/100 ml)	Arsenic (mg/l)	Residual chlorine (mg/l)	Nitrate (mg/l)	Turbidity (NTU)
PTW1	7.05	0	0.03	N.T.	1	3
PTW2	6.95	0	0.03	N.T.	0	1
PTW3	7.10	1	0.05	N.T.	0	2
PTW4	7.10	0	0.05	N.T.	0	1
PTW5	7.20	0	<0.01	N.T.	1	1
PTW6	7.15	0	<0.01	N.T.	0	1
PTW7	6.90	0	0.01	N.T.	1	1
PTW8	7.10	1	0.03	N.T.	0	2

Table 6-5: Water quality test result of samples collected from street tap stands and household reservoirs.

Ward	Address	pH	TTC (N/100 ml)
Ward 1	Noya Gola	6.75	0
Ward 2	Zia Nagar	6.85	2
Ward 3	Shantir More	6.70	0
Ward 4	Mohananda Bridge	7.10	0
Ward 5	Angariya Para	6.65	1
Ward 6	Jannat Para	7.05	1
Ward 7	Bindu Para	6.90	0
Ward 8	Dariyapur Gorshant	6.80	0
Ward 9	Sehala	7.15	3
Ward 10	Tula Potti	6.95	0

6.5 WSP Audit Result: Using QA Tool

The water supply systems at Chandpur and Chapai-Nawabganj Pourashava were audited using the developed QA tool and following the guidelines presented in section 5.2. Snapshot of the overall audit findings as produced by the QA tool is in Figure 6-10 and Figure 6-11. The detail result is presented in Appendix-I. Further analysis of the outcome is made in section 6.6.

Assessment area / WSP element	Current assessment score	Current Grade
1. WSP TEAM	15	Very good
2. SYSTEM DESCRIPTION	13	Good
3. HAZARD IDENTIFICATION AND RISK ASSESSMENT	15	Average
4. IMPROVEMENT PLAN	12	Excellent
5. OPERATIONAL MONITORING	6	Good
6. VERIFICATION	10	Priority attention needed
7. MANAGEMENT PROCEDURES	9	Average
8. SUPPORTING PROGRAMMES	5	Average
9. REVIEW AND REVISION	8	Excellent
GRAND TOTAL SCORE (Outof 120):	93	Good

Figure 6-10: WSP maturity status of Chandpur Pourashava

Assessment area / WSP element	Current assessment score	Current Grade
1. WSP TEAM	13	**Good**
2. SYSTEM DESCRIPTION	14	**Good**
3. HAZARD IDENTIFICATION AND RISK ASSESSMENT	18	**Very good**
4. IMPROVEMENT PLAN	9	**Average**
5. OPERATIONAL MONITORING	6	**Good**
6. VERIFICATION	14	**Average**
7. MANAGEMENT PROCEDURES	9	**Average**
8. SUPPORTING PROGRAMMES	7	**Very good**
9. REVIEW AND REVISION	8	**Excellent**
GRAND TOTAL SCORE (Outof 120):	98	**Good**

Figure 6-11: WSP maturity status of Chapai-Nawabganj Pourashava

6.6 Analytical observations on findings

The impact assessment revealed significant positive operational outcomes in both the water supply systems due to WSP implementation. Infrastructure has been added and the level of operations and management practices has been improved from 8 to 24 in Chandpur and 17 in Chapai-Nawabganj out of 40 (Figure 6-12). It is also evident from the WSP audit done using the QA tool developed. As shown in Figure 6-15, all the first five WSP elements (1. wsp team, 2. system description, 3. hazard id and risk assessment, 4. improvement plan, and 5. operational monitoring) got more than 75% score in both systems.

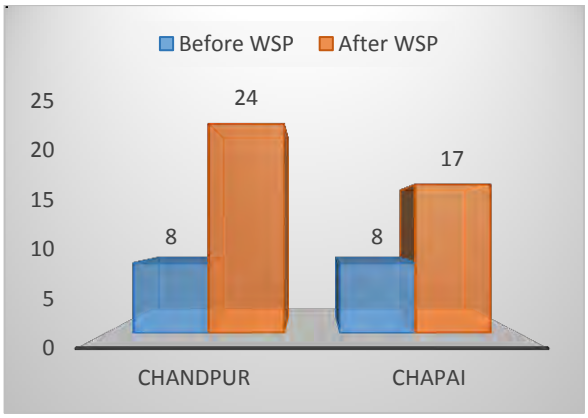
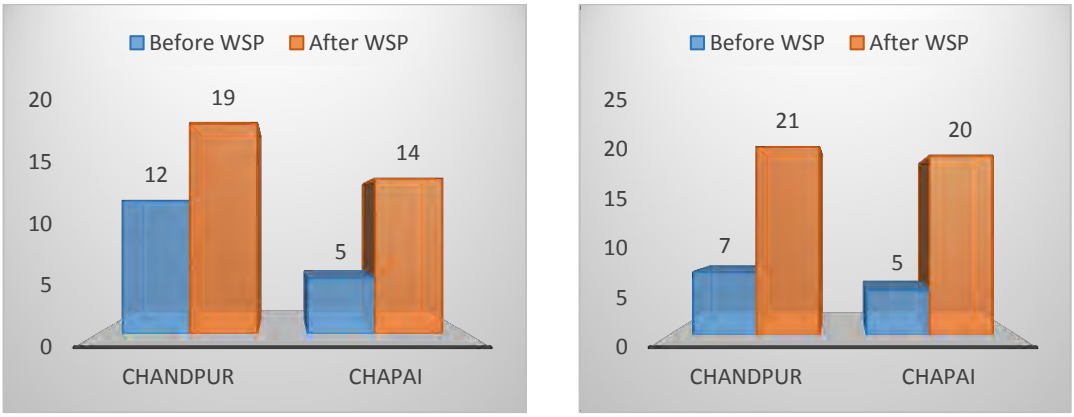


Figure 6-12: Improvement in level of operations and management practices

Diverse results have been observed in terms of financial outcomes. Operating costs per cubic meter of supplied water have been increased for both the water supplies primarily due to increase of electricity tariff. However, operating costs per consumer has been decreased in Chapai-Nawabganj and slightly increased in Chandpur. The increased price of reagents/ chemicals required to treat surface water of Chandpur water supply system is the reason of this increased operating cost.

Implementation of WSPs have resulted significant institutional outcomes in both Pourashavas. More than eight meetings, trainings and consultative sessions in last one year is an indication of increased communication and collaboration among stakeholders. Similarly, stakeholder knowledge and understanding on water supply system as well as on hazards and hazardous events that threaten the water supply

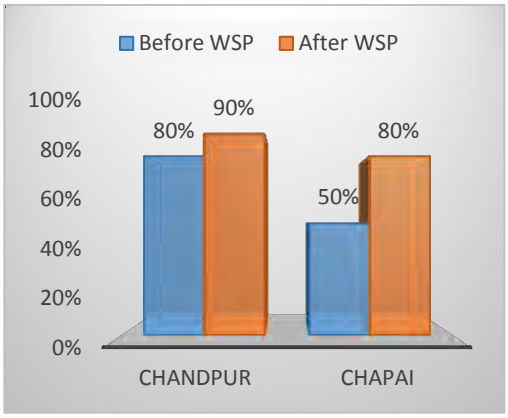
system, as shown in Figure 6-13, have been increased by many folds. However, no changes have been observed in terms of equity outcomes.



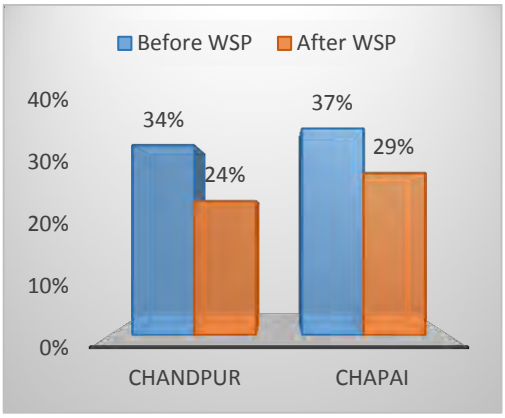
(a) water supply system (b) hazards and hazardous events

Figure 6-13: Knowledge and understanding of water supply section (on a scale of 25)

The impact on supply of water was also positive for both Pourashavas. due to implementation of WSPs. In service level the coverage area increased while the 'unaccounted for water' decreased from 8.39 to 8.06 percent and 20 to 16 percent for Chandpur and Chapai-Nawabganj respectively. Water quality has also been improved in accordance to the compliance requirement of national standard (Figure 6-14a). However, consumer satisfaction level, which need to be monitored regularly, is still not adequate. This is also analogues to the household survey findings where most of the household at Chandpur perceived that the supply water is not safe. The perception may be the resultant of turbidity in supplied water as revealed by the water quality tests performed under this research (see Table 6-2). It should also be noticed that most of the consumers only use water without any disinfectant/cleansing agent to clean their household reservoirs (Figure 6-5). Most of the household water samples had microbial contamination with low level of risks (less than 10 cfu/100 ml). The low score of WSP verification and supporting programme elements found in audit by QA tool further justifies the lacking of efforts in these areas.



(a) Treated water samples compliant with microbial water quality targets or standards over past 12 months



(b) Diarrheal incidence rate in last one year calculated from household survey results

Figure 6-14: Impact of WSP on water quality and health

The health impact assessment, presented in Figure 6-14b, revealed that the diarrheal incidence rate among the consumers of both Pourashavas has gone down. However, waterborne diseases, as revealed by household survey (Figure 6-6 and Figure 6-7), are still a concern for both the Pourashavas. The water quality test results of health based parameters also support this fact. Though the microbial contamination of treated water at Chandpur and Chapai-Nawabganj is at desired level, the turbidity of majority of samples at Chandpur is not complying the WSF targets. Also most of the water samples collected at household level are not free from microbial contamination indicating recontamination of treated water at distribution lines and/or household level. Moreover, the arsenic level is marginally within acceptable limit in two production-tube-wells of Chapai-Nawabganj.

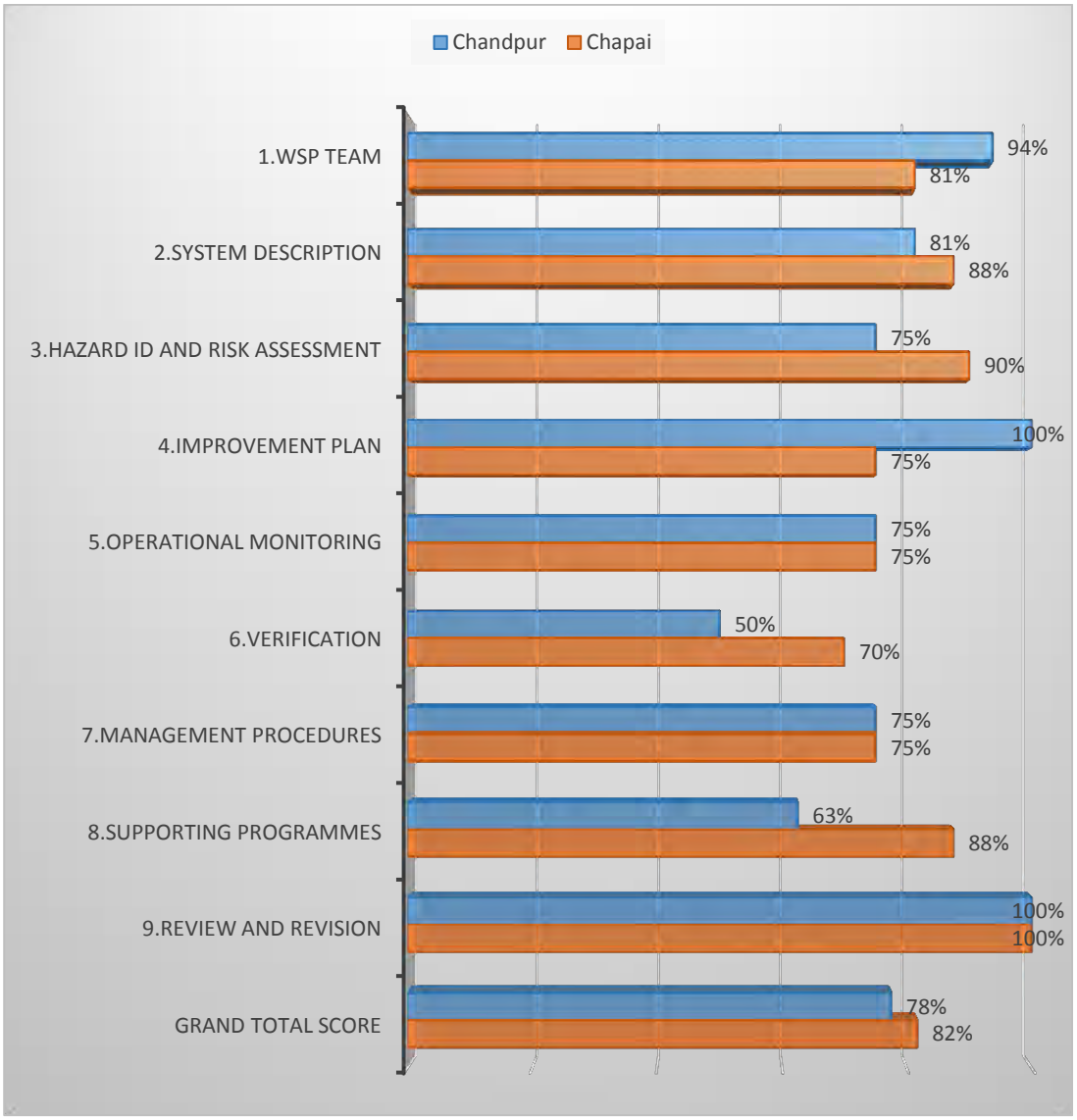


Figure 6-15: WSP elementwise audit score for Chandpur and Chapai-Nawabganj

The overall findings from WSP audit using the QA tool indicates that the WSP maturity in both the water supply systems is 'Good'. However, to reach at 'Excellent' level that will ensure the desired health benefits of the consumers, the water supply systems will need to work harder on multiple WSP elements.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

7.1 Summary

The objectives of the research were to assess the impact of WSP in municipal piped water supply systems in realizing the health-based targets; to develop a quality assurance model for carrying out WSP Audits; and to assess gaps as well as improvement opportunities of WSPs by carrying out auditing of WSPs using the developed quality assurance tool. Two municipal piped water supply systems, one at Chandpur Pourashava having surface water based system and the other at Chapai-Nawabganj Pourashava with groundwater based system, were selected as the study sites. Both the water supply systems were practicing WSPs since 2011. To assess the WSP and its impact in the water supplies data were collected against a list of indicators categorized as outcomes indicators and impact indicators. The outcome indicators were further segregated into operational, financial, Institutional and equity outcomes. Impact indicators were also sub-grouped as water supply impacts and health impacts. Following the approach, data were collected on 32 indicators with WSP and without WSP from both water supply systems and analyzed to determine the impact of WSPs.

A quality assurance (QA) tool has been developed under this study for conducting external or internal audits of WSPs of urban-piped water supply systems in order to support assessors and to ensure consistency in assessment approach, from site to site and year to year. Total 30 questions among nine WSP elements were devised to fit in the tool to have an overall as well as element wise audit score that indicates the maturity of the WSP. Microsoft excel was used to develop the tool with a simple and user-friendly interface that is easily navigable and readily provides the results.

Water samples were collected at system level and household level and tested for first priority health based water quality parameters as outlined in Water Safety Framework in Bangladesh. In addition, data from household survey at these

Pourashavas were collected and analyzed. The water quality test results and household survey results were used to validate the outcome of WSP impact assessment and WSP audit findings.

The results of the research were constructive to realize its objectives. All the results of WSP impact assessment, water quality status, household survey findings and WSP audit score complemented each other that further fortify the research outcome. The findings are further recapped in the subsequent conclusion section of this paper.

7.2 Conclusion

The research showed that WSP has positive impact at almost all level of indicators in both Chandpur and Chapai-Nawabganj water supply systems. At operational level, infrastructure has been improved and operations and management practices as well as implementation of relevant plans and procedures are progressing. Out of 40 points the enhancement was 24 and 17 in Chandpur and Chapai-Nawabganj respectively from baseline score of eight. Financial outcomes showed improvement in revenue collection by 60 BDT per consumer in Chandpur and financial support by development partners for system improvements at Chapai-Nawabganj. At both systems institutional level outcome showed increase of understanding of the hazards and hazardous events by water supply staff by three times. Water service also improved as evident from reduction in unaccounted for water by 0.33 percent at Chandpur and by 4 percent at Chapai-Nawabganj. 10 percent more water samples at Chandpur and 30 percent more water samples Chapai-Nawabganj are now compliant with microbial water quality targets. Diarrheal incidence rate decreased by 10 percent at Chandpur and by 8 percent at Chapai-Nawabganj.

The newly developed WSP QA tool was found to be highly effective in carrying out auditing of individual WSP elements and the WSP as a whole. In Chandpur the WSP elements that scored more than 80 percent were ‘WSP team’, ‘system description’, ‘improvement plan’, and ‘review and revision’. The element that needs priority attention with a score of 50 percent was ‘verification’. Strong WSP elements

with a score of more than 80 percent in Chapai-Nawabganj were ‘WSP team’, ‘system description’, ‘hazard identification’ and ‘risk assessment’, ‘supporting programmes’, and ‘review and revision’. Overall maturity of both the WSPs was ‘Good’ with a score of 78 percent and 82 percent in Chandpur and Chapai-Nawabganj respectively.

7.3 Recommendations for Future Improvement

The impact assessment process and WSP QA tool has been developed considering ideal Water Safety Plans. However, for national scale replication it should be noted that not all indicators might be applicable in all situations and that certain data may not be available. Hence, the indicators may be validated for local and specific water supply systems. Accordingly, the QA tool can be modified where certain WSP elements are irrelevant.

Considering the target user group, best efforts were made to keep the quality assurance model for WSP auditing as simple and user friendly as possible. Macros and complex user interfaces were avoided so that staff of municipal water supply section can easily use the tool for internal auditing. However, for large systems the tool can be further upgraded for better integration of multiple instances, popup assistance and online use.

REFERENCES

Barry, S.J., Atwill, E.R., Tate, K.W., Koopman, T.S., Cullor, J. and Huff, T. (1998) Developing and Implementing a HACCP-Based Programme to Control Cryptosporidium and Other Waterborne Pathogens in the Alameda Creek Watershed: Case Study. American Water Works Association Annual Conference, 21-25 June 1998, Dallas, Texas Water Resources Vol. B, 57-69.

Deere, D. and Davison, A. (1998) Safe water – are food guidelines the answer? Water, 25, 21-24.

Deere, D., Stevens, M., Davison, A., Helm, G. and Dufour, A. (2001) Management Strategies. In Water Quality: Guidelines, Standards and Health – Assessment of risk and risk management for water-related infectious disease. (eds. J. Bartram and L. Fewtrell) pp. 257-288, World Health Organization, IWA Publishing, London, UK.

Fewtrell, L. and Bartram, J. (Eds) (2001) Water Quality: Guidelines, Standards and Health – Assessment of risk and risk management for water-related infectious disease. World Health Organization, IWA Publishing, London, UK.

Gray, R. and Morain, M. (2000) HACCP Application to Brisbane Water. Water. 27, 41- 43.

LGD (2009) National Vetting Guidelines for Water Supply and Sanitation Sub-sector Bangladesh, Policy Support Unit (PSU), Local Government Division, Ministry of Local Government, Rural Development and Cooperatives.

LGD (2011) “Water Safety Framework (WSF) in Bangladesh”, Policy Support Unit (PSU), Local Government Division, Ministry of Local Government, Rural Development and Cooperatives, Government of the People's Republic of Bangladesh.

Mahmud S.G., Shamsuddin A.J., Ahmed M.F., Davison A., Deere D. (2005) Howard G., "Development and implementation of water safety plans in Bangladesh". *Journal of Water and Health*, vol. 5, no. 4, pp. 585-597.

Medema, G.J., Payment, P., Dufour, A., Robertson, W., Waite, M., Hunter, P., Kirby, R. and Andersson, Y. (2003) Safe drinking-water: an ongoing challenge. In Safer Drinking-water: Improving the Assessment of Microbial Safety. (eds. Dufour, A., Snozzi, M., Koster, W., Bartram, J., Ronchi, E. and Fewtrell, L.) pp.11-45. IWA Publishing, London.

NHPS (2012) National Hygiene Promotion Strategy for Water Supply and Sanitation Sector in Bangladesh, Local Government Division, Ministry of Local Government, Rural Development and Cooperatives, Government of the People's Republic of Bangladesh.

NSWSS (2014) National Strategy for Water Supply and Sanitation, Local Government Division, Ministry of Local Government, Rural Development and Cooperatives, Government of the People's Republic of Bangladesh, 2014

SDP (2011) Sector Development Plan (FY 2011-25), Water Supply and Sanitation Sector in Bangladesh, Local Government Division, Ministry of Local Government, Rural Development and Cooperatives, Government of the People's Republic of Bangladesh.

WHO (2009) "Water Safety Plan Manual: Step-by-step risk management for drinking-water suppliers". World Health Organization, Geneva.

WHO (2011) "Guidelines for drinking-water quality, fourth edition", World Health Organization, Geneva.

WSF (2011) Water Safety Framework in Bangladesh, Local Government Division, Ministry of Local Government, Rural Development and Cooperatives, Government of the People's Republic of Bangladesh.

APPENDIX – I

WSP Audit Findings using QA Tool

Chandpur Pourashava

GENERAL INFORMATION

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WATER SUPPLIER INFORMATION	
Water Supplier Name:	Chandpur PWSS
Town(s) Served:	Chandpur
# of People Served:	191,760
Primary Supplier Contact During Assessment:	Mr. Shahabuddin Ahmed, Water Works Superintendent Contact: 01818624406
Month/Year WSP Implementation Began:	Jun-11

EXTERNAL ASSESSOR INFORMATION	
Date:	15-Dec-15
Assessor Name(s):	Alauddin Ahmed
Assessor Organization(s):	Individual

1. WSP TEAM

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GRADE

Very good

Objective: *Assemble an appropriate team of professionals with knowledge and experience in all aspects of the water supply system and sufficient decision-making authority to develop and implement the WSP.*

Items	Score	Comments
1.1 Is there a documented WSP team and is the team list current?	4	All team members are up to date
1.2 Are appropriate organizations represented on the team?	3	The team includes representative from top management, health, engineers and councillors. However, a water quality analyst/chemist is required.
1.3 Does the team include people with the authority to carry out WSP recommendations as well as technical staff?	4	The team includes the Mayor as well the engineers.
1.4 Is there evidence that regular team meetings held and recorded?	4	Review of WSP team meeting minutes show that the team meetings are being held quarterly as reflected in the WSP.
Total Score	**15**	

2. SYSTEM DESCRIPTION

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GRADE

Good

Objective: *Thoroughly describe the water supply system to demonstrate complete system understanding and inform the risk assessment.*

Items	Score	Comments
2.1 Are intended users/uses of the water supply defined?	4	The intended users/uses of the water supply are well defined in the WSP doc
2.2 Are drinking-water quality standards or targets described?	4	Water quality is to be maintained as per the health based parameter and target
2.3 Are clear, accurate and up-to-date maps and/or schematics of the complete water system included?	2	Improvement on system flow diagram is required (For eg. The storage and flow of backwash water and sludge management, sampling locations and
2.4 Are all major steps in the water supply chain described?	3	Details on catchment and the chemical dosing processes are not described.
Total Score	**13**	

3. HAZARD IDENTIFICATION AND RISK ASSESSMENT

< CONTENTS < BACK NEXT >

GRADE

Average

Objective: *Identify hazards/hazardous events and assess related risk to water safety to determine if improvements are needed.*

Items	Score	Comments
3.1 Has the risk assessment approach been clearly described?	3	The risk assessment methodology is clearly defined. However the definition of severity is subjective. Eg. Catastrophic is defined as potentially sick/lethal
3.2 Have all significant hazards been identified at all major steps?	2	Hazards at consumer level, hazard due to improper chemical addition (alum and Chlorine) and hazard of seepage of contaminated water from the
3.3 Have existing control measures been identified and validated?	2	Existing control measures are identified and documented but are not validated
3.4 Have risks been logically and systematically assessed for all hazards identified?	4	Risk assessment is consistent, clear and logical.
3.5 Is it clear which hazards require additional control or improvement?	4	The risk assessment clearly indicates the need for additional control for the hazards identified.
Total Score	**15**	

4. IMPROVEMENT PLAN

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GRADE

Excellent

Objective: *Plan improvements based on system needs and priorities identified through the risk assessment process.*

Items	Score	Comments
4.1 Has an improvement plan been developed that is clearly linked to the risk assessment process?	4	There is a clear link between the risk assessment and the improvement plan. Reference numbers have been given for easy referencing.
4.2 Does the improvement plan describe the action, responsible party, cost, funding source and due date?	4	The improvement plan describes the action, responsible party, cost and the due date.
4.3 Is the improvement plan being carried out as documented and kept up-to-date?	4	Field inspection and review of records show that all the improvements are being implemented as planned.
Total Score	**12**	

5. OPERATIONAL MONITORING

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GRADE

Good

Objective: *Describe monitoring to be carried out by the supplier (visual inspections and water quality testing) to ensure that key water supply system components and control measures continue to work effectively.*

Items	Score	Comments
5.1 Has an operational monitoring plan been documented addressing routine water quality monitoring and visual inspections by the supplier?	4	Operational monitoring plan documented clearly indicating control measures to be monitored, monitoring locations and frequency, responsible partly
5.2 Is the supplier carrying out operational monitoring as per the documented plan?	2	Water quality records confirm that water quality monitoring is generally not done as per the plan. Eg. RCI testing in the distribution is planned to be done
Total Score	**6**	

6. VERIFICATION

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GRADE

Priority attention needed

Objective: *Confirm that drinking water quality standards are being met, consumers are satisfied and the WSP is complete and effective.*

Items	Score	Comments
6.1 Has a compliance monitoring plan been documented?	2	The compliance monitoring is planned to be carried out by the Paurashava monthly (using Potable test kit) and on a half yearly frequency at the DPHE
6.2 Is compliance monitoring being carried out as planned?	2	The compliance monitoring is planned to be carried out by the Paurashava monthly (using Potable test kit) and on a half yearly frequency at the DPHE
6.3 Are water quality standards or targets being met?	1	Faecal Coliform- DPHE lab 70% compliance against minilab's 46% compliance from August 2015 to November 2015. There is some data
6.4 Does the supplier have a documented and implemented system of regularly monitoring and recording consumer satisfaction?	3	Customer complaints are not recorded and therefore analyses of customer complaints are not being done. However a customer satisfaction survey has
6.5 Has a plan for internal WSP auditing been defined and is it being implemented?	2	Internal auditing is planned but not been done.
Total Score	**10**	

7. MANAGEMENT PROCEDURES

< CONTENTS < BACK NEXT >

GRADE

Average

Objective: *Define procedures to be followed during routine operations and emergency situations.*

Items	Score	Comments
7.1 Have clear SOPs been defined for major operational activities?	3	SOP for most of major activities available. However, SOP for Alum dosing is not available
7.2 Are SOPs up-to-date and accessible to field staff?	4	The SOPs are up to date and easily accessible to the operators.
7.3 Does the WSP include a current emergency response plan?	2	An emergency plan is documented. However, the names and contact details of persons within the Paurashava and also the health officials to be notified
Total Score	**9**	

8. SUPPORTING PROGRAMMES

< CONTENTS < BACK NEXT >

GRADE

Average

Objective: *Identify programmes that indirectly support water safety.*

Items	Score	Comments
8.1 Have appropriate supporting programmes been clearly defined?	3	Supporting programs such as consumer education and operator training are documented with responsibility, time frame and status. However the cost
8.2 Are supporting programmes being implemented as planned?	2	Consumer education has been carried out as planned but operator training has been done on WSP only and not on the O&M as documented.
Total Score	**5**	

9. REVIEW AND REVISION

< CONTENTS < BACK NEXT >

GRADE

Excellent

Objective: *Ensure that the WSP remains up-to-date and effective through regular review and revision.*

Items	Score	Comments
9.1 Is a schedule for regular review and revision of the WSP defined?	4	The review and revision of WSP is scheduled to be carried out annually as document in the WSP.
9.2 Is the WSP being reviewed and revised as planned?	4	Available records show that the review and revision has been conducted as planned.
Total Score	**8**	

AUDIT RESULT

< CONTENTS < BACK HOME >

Assessment area / WSP element	Current assessment score	Current Grade	Score from previous assessment	Previous Grade	Comment
1. WSP TEAM	15	Very good		Not graded	
2. SYSTEM DESCRIPTION	13	Good		Not graded	
3. HAZARD IDENTIFICATION AND RISK ASSESSMENT	15	Average		Not graded	
4. IMPROVEMENT PLAN	12	Excellent		Not graded	
5. OPERATIONAL MONITORING	6	Good		Not graded	
6. VERIFICATION	10	Priority attention needed		Not graded	
7. MANAGEMENT PROCEDURES	9	Average		Not graded	
8. SUPPORTING PROGRAMMES	5	Average		Not graded	
9. REVIEW AND REVISION	8	Excellent		Not graded	
GRAND TOTAL SCORE (Outof 120):	93	Good		Not graded	

Chapai-Nawabganj Pourashava

GENERAL INFORMATION

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WATER SUPPLIER INFORMATION	
Water Supplier Name:	Chapai-Nawabganj PWSS
Town(s) Served:	Chapai-Nawabganj
# of People Served:	101,809
Primary Supplier Contact During Assessment:	Mr. Md. Sadequl Islam Executive Engineer, Chapainawabgonj Pourashava
Month/Year WSP Implementation Began:	Jul-11

EXTERNAL ASSESSOR INFORMATION	
Date:	18-Dec-15
Assessor Name(s):	Alauddin Ahmed
Assessor Organization(s):	Individual

1. WSP TEAM

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GRADE

Good

Objective: *Assemble an appropriate team of professionals with knowledge and experience in all aspects of the water supply system and sufficient decision-making authority to develop and implement the WSP.*

Items	Score	Comments
1.1 Is there a documented WSP team and is the team list current?	4	The WSP Team was reformed by Mayor and is active
1.2 Are appropriate organizations represented on the team?	3	Selection from other stakeholders like DOE, Health Dept. etc can be included
1.3 Does the team include people with the authority to carry out WSP recommendations as well as technical staff?	3	Well balanced team; both technical & public representatives are present. Roles & responsibility of individual members are clearly defined
1.4 Is there evidence that regular team meetings held and recorded?	3	Meeting is being conducted from May 2015; Meeting records & attendance are preserved
Total Score	**13**	

2. SYSTEM DESCRIPTION

< CONTENTS < BACK NEXT >

GRADE

Good

Objective: *Thoroughly describe the water supply system to demonstrate complete system understanding and inform the risk assessment.*

Items	Score	Comments
2.1 Are intended users/uses of the water supply defined?	3	It would better if the use of water is clearly defined whether it can drink directly
2.2 Are drinking-water quality standards or targets described?	4	DWQS well defined
2.3 Are clear, accurate and up-to-date maps and/or schematics of the complete water system included?	4	Schematic diagram has been included, maps showing potential hazards are available
2.4 Are all major steps in the water supply chain described?	3	Description of water supply is almost clear. History of leakages & breaks absent
Total Score	**14**	

3. HAZARD IDENTIFICATION AND RISK ASSESSMENT

< CONTENTS < BACK NEXT >

GRADE

Very good

Objective: *Identify hazards/hazardous events and assess related risk to water safety to determine if improvements are needed.*

Items	Score	Comments
3.1 Has the risk assessment approach been clearly described?	4	Semi-quantitative risk assessment method was followed including assessment of raw risk or reassess risk
3.2 Have all significant hazards been identified at all major steps?	3	All major hazardous events (HE) in supply system are clearly defined, HE at consumer level is not elaborated
3.3 Have existing control measures been identified and validated?	3	Existing controls are clearly defined but validation is excluded.
3.4 Have risks been logically and systematically assessed for all hazards identified?	4	RA are clear and logical
3.5 Is it clear which hazards require additional control or improvement?	4	Additional control measure was proposed for most of all existing control having high to medium risk
Total Score	**18**	

4. IMPROVEMENT PLAN

< CONTENTS < BACK NEXT >

GRADE

Average

Objective: *Plan improvements based on system needs and priorities identified through the risk assessment process.*

Items	Score	Comments
4.1 Has an improvement plan been developed that is clearly linked to the risk assessment process?	4	Improvement plan was proposed against each high to medium risk of control and clearly linked with risk assessment
4.2 Does the improvement plan describe the action, responsible party, cost, funding source and due date?	3	1) Action to be taken is defined; 2) Responsible person is identified; 3) Estimated cost is also included; 4) Target / due date is mentioned. Funding
4.3 Is the improvement plan being carried out as documented and kept up-to-date?	2	Improvement work on short to medium term plan are being executed
Total Score	**9**	

5. OPERATIONAL MONITORING

< CONTENTS < BACK NEXT >

GRADE

Good

Objective: *Describe monitoring to be carried out by the supplier (visual inspections and water quality testing) to ensure that key water supply system components and control measures continue to work effectively.*

Items	Score	Comments
5.1 Has an operational monitoring plan been documented addressing routine water quality monitoring and visual inspections by the supplier?	4	Monitoring plan has been prepared which reflects all the indicators
5.2 Is the supplier carrying out operational monitoring as per the documented plan?	2	Monitoring records are kept on monthly basis but corrective action records are maintained as per customer complaints only (not based on the critical
Total Score	**6**	

6. VERIFICATION

< CONTENTS < BACK NEXT >

GRADE

Average

Objective: *Confirm that drinking water quality standards are being met, consumers are satisfied and the WSP is complete and effective.*

Items	Score	Comments
6.1 Has a compliance monitoring plan been documented?	4	Water quality monitoring plan is documented with relevant indicators
6.2 Is compliance monitoring being carried out as planned?	4	WQ monitoring is being executed on monthly basis
6.3 Are water quality standards or targets being met?	2	Low risk level of fecal contamination was found, presence of elevated level of arsenic in two wards
6.4 Does the supplier have a documented and implemented system of regularly monitoring and recording consumer satisfaction?	2	Consumer satisfaction survey protocol has been prepared but not yet executed. Satisfaction survey was conducted through NGO under the
6.5 Has a plan for internal WSP auditing been defined and is it being implemented?	2	Internal audit was carried out through external assistance; Should be undertaken by the utility
Total Score	**14**	

7. MANAGEMENT PROCEDURES

< CONTENTS < BACK NEXT >

GRADE

Average

Objective: *Define procedures to be followed during routine operations and emergency situations.*

Items	Score	Comments
7.1 Have clear SOPs been defined for major operational activities?	3	SOPs have been prepared and made available to the key / relevant staff
7.2 Are SOPs up-to-date and accessible to field staff?	3	Up to date and accessible to the staff
7.3 Does the WSP include a current emergency response plan?	3	Emergency plan exist but absence of information about health officials
Total Score	**9**	

8. SUPPORTING PROGRAMMES

< CONTENTS < BACK NEXT >

GRADE

Very good

Objective: *Identify programmes that indirectly support water safety.*

Items	Score	Comments
8.1 Have appropriate supporting programmes been clearly defined?	4	Supporting program are clearly defined with implementation plan
8.2 Are supporting programmes being implemented as planned?	3	Plans are executed by the NGOs under development program; Paurashava should have own program
Total Score	**7**	

9. REVIEW AND REVISION

< CONTENTS < BACK NEXT >

GRADE

Excellent

Objective: *Ensure that the WSP remains up-to-date and effective through regular review and revision.*

Items	Score	Comments
9.1 Is a schedule for regular review and revision of the WSP defined?	4	Revision date is clearly mentioned
9.2 Is the WSP being reviewed and revised as planned?	4	WSP document has been revised on the scheduled time
Total Score	**8**	

AUDIT RESULT

< CONTENTS < BACK HOME >

Assessment area / WSP element	Current assessment score	Current Grade	Score from previous assessment	Previous Grade	Comment
1. WSP TEAM	13	Good		Not graded	
2. SYSTEM DESCRIPTION	14	Good		Not graded	
3. HAZARD IDENTIFICATION AND RISK ASSESSMENT	18	Very good		Not graded	
4. IMPROVEMENT PLAN	9	Average		Not graded	
5. OPERATIONAL MONITORING	6	Good		Not graded	
6. VERIFICATION	14	Average		Not graded	
7. MANAGEMENT PROCEDURES	9	Average		Not graded	
8. SUPPORTING PROGRAMMES	7	Very good		Not graded	
9. REVIEW AND REVISION	8	Excellent		Not graded	
GRAND TOTAL SCORE (Outof 120):	98	Good		Not graded	

APPENDIX – II

WSP Documents of Chandpur and Chapai-Nawabganj Pourashava

Piped Water Supply System – Chandpur Paurashava

Water Safety Plan

Version – 2.1

November 2014

Technical Assistance by
Participatory Management Initiative for Development (PMID)

Under the program of

Establishing model WSP using piped water supply system
WHO – AusAid Water Quality Partnership Program, Phase – 2
Department of Public Health Engineering (DPHE)

Table of Contents

Chapter - 1. Water Safety Plan Local Team

1.1 Commitment from Higher Authority

The top authority of Chandpur Paurashava is committed to engage the relevant staff inside and outside of Paurashava Council and to provide continuous support in relation to implement WSP. In this respect, a statement of such commitment of the top authority has been duly signed and circulated as a separate declaration. The statement will also be included in the citizen charter of the Paurashava. The declaration is attached in **(Annex- 1)**

1.2 WSP Team

The honorable Mayor of Chandpur Paurashava assembled a multidisciplinary team of experts who have thorough understanding of the local water supply system. The WSP team will be responsible for developing, implementing and maintaining the WSP as a core part of their day-to-day roles. The WSP team has been approved in the TLCC meeting dated on Sep 2011. The approved team compositions are presented in the Table 1.1.

Table 1.1 WSP Team Capture Proforma

Name	Affiliation / Job Title	Role in WSP team	Contact Information (Phone no.)
Mr. Md. Nasiruddin Ahamed	Pourashava Mayor	Chairperson & Fund Approver	01711669309
Mr. AHM Samsuduhha	EE, Pourashava	WSP Coordinator	01715628967
Mr. Mozaffar Ahamed	EE, DPHE	Member	01711261044
Mr. H.M. Tareque	Paura Medical Officer	Member	01717014886
Mr. Ashu Toss Datta	Asst. Engineer	Member	01711395487
Mr. Md. Abdus Sattar	SAE, DPHE Sadar	Member	01711585874
Mr. Md. Rafiqul Islam	Paura Sanitary Inspector	Member	01710947408
Mr. Dr. Ruhul Amin	Paura PVT Doctor	Member	01711473898
Mr. Md. Mahafuz Bepary	Paurashava Councilor	Member	01818279423
Mr. Md. Shahab Uddin	Paurashava Water Super	Member Secretary & Document Controller	01818624406

1.3 **Roles & Responsibility of the WSP team**

The WSP team will be responsible for developing, implementing and maintaining the WSP as a core part of their day-to-day roles. The team's responsibility is to define the scope of the water safety plan that will include which part of the water supply chain is involved and the general classes of hazards to be addressed. The team include people with authority to make any required changes as well as those with the technical ability to develop and supervise the implementation of WSP. Keeping a successful implementation of WSP the regular task of the Team can be outlined as follows:

1. Regular checking the progress on the Improvement Plan
2. Regular (e.g. quarterly) checking of Operational Monitoring
3. Regular checking of WSP application and its functional integrity
4. Annual report of progress and impact of the plan

The individual roles and responsibilities of the WSP Team members are described below:

Table 1.2: Roles & Responsibility of WSP team members

Team Members	**Roles & Responsibility**
Chairman	• Circulate duly signed commitment letter to implement WSP • Chair the regular meeting of the WSP team • Make decision or approve of the relevant issues of WSP • Confirmation of financial support to implement WSP • Distribute responsibilities among the team members related to WSP
Coordinator	• Help guide and direct the team through the preparation of the water safety plan and the assessment of the system. • In consultation with Chairperson, WSP Coordinator will organize planning meeting with the WSP Team • Give necessary direction to Asst. Engineer (Water) to implement WSP • Ensure that WSP is implemented in all aspect
Member Secretary	• Maintain communication with WSP coordinator & WSP Team members for implementation of WSP • Share the WSP related information with Coordinator and WSP Team members on a regular basis • Control all types of document related to WSP • Inspect the operational monitoring log sheet regularly • Ensure that water quality monitoring is carried out regularly • Verify the effectiveness of WSP implementation through Sanitary Inspection activities • Keep all types of records specially related to operational monitoring, staff training, improvement plan etc.
Member	• Carry out the tasks related to WSP, which assigned by Chairman & Conrdinator • Communicate with all stakeholders • Communicate with Surveillance committee • Assist to collect data related to user satisfaction • Take necessary step during emergency • Support in all aspect to ensure a successful WSP implementation

1.4 Engagement of Stakeholders

There is only one external stakeholder has been identified (Ministry of Water Resources) and this agency need to be formally contacted to inform about their roles in relation to the WSP. A representative from MWR can be included in the team.

Other agencies that may be relevant for the surface water catchment include Ministry of Shipping/BIWTC (to determine the best Department to link up with), Department of Environment (agency responsible for regulating and monitoring industry discharges), and other Department of Pourashava responsible for land use (Town Planning Dept) etc.

DPHE / Water Supply is a stakeholder as regulator and advisor and Executive Engineer of DPHE Chandpur can liaison with other stakeholder and the national surveillance authority.

Chapter - 2. Description of ChandpurWater Supply System

Chandpur Pourashava is bounded by river Meghna in the west and the river Dakatia passes through dividing the Pourashava into two parts, the South and the North. South Part consists of 6 wards (ward #1 – 6) and named as Puran Bazaar area and North Part consists of 9 wards (ward #7 – 15) and named as Nutan Bazaar area. Two independent water supply systems along with separate treatment plants exist in two parts of the Pourashava. The total population of Chandpur Paurashava is approximately 250,000 in which 60,000 people live in south part.

The current system of Chandpur Paurashava piped water supply is described in the following table 2.1. The flow chart of the existing system is shown in page 9. The system descriptions mentioned in the following table was verified by the following way:

1. Confirmation by on site observation by the consultants / Assessors.
2. Review existing documents
3. Review available water quality data

In each cases, the professional staffs like Executive Engineer and Water Superintendent help to understand the systems by providing documents and evidence as and when necessary.

2.1 Description of Water Supply System

Step	Description	
Source Type – 1	Present source	Surface water from Dakatia Rriver
	Availability	Water in Dakatia river is available round the year
	Collection process	Raw water is collected from river through an intake point, which is 15 feet deep. The bottom end of the intake point is lower than the bottom level of the river, so the availability of water is ensured during dry season. But there is no provision to adjust the level from which water is withdrawn from the river. The intake point was built in 1931 using concrete and the condition is good. It was situated 20 feet away from the bank. It is effectively fenced and accessible only to the supplier and there is little other human activity in its immediate vicinity. During rainy season the intake point is submerged and hyacinth like weeds may enter inside the intake point. PWSS has own divers who sometimes go inside the intake point for cleaning purpose.
Source Type – 2	Present source	Production well from groundwater
	Total No of production well (PW)	02
	Average depth	225 Meter
	Aquifer	Confined
	Abstraction process	Sub mersible pump – 2

<table>
<tr><th>Step</th><th colspan="5">Description</th></tr>
<tr><td rowspan="14">Source water quality (surface water)</td><td>Parameter</td><td>Report – 1*
Dated:</td><td>Report– 2*
Dated:</td><td>Report– 3*
Dated:</td><td>Water Quality Target for surface water</td></tr>
<tr><td>pH</td><td></td><td></td><td></td><td>6.5 – 7.5</td></tr>
<tr><td>Turbidity (mg/L)</td><td>20 - 100</td><td></td><td></td><td>---</td></tr>
<tr><td>TDS (mg/L)</td><td></td><td></td><td></td><td>1000</td></tr>
<tr><td>Color (Pt-Co)</td><td></td><td></td><td></td><td>15</td></tr>
<tr><td>Nitrate (mg/L)</td><td></td><td></td><td></td><td>50</td></tr>
<tr><td>BOD (mg/L)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>COD (mg/L)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>DO (mg/L)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total Hardness (mg/L)</td><td></td><td></td><td></td><td>200 – 500</td></tr>
<tr><td>TSS (mg/L)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Fecal Coliform (cfu/100ml)</td><td></td><td></td><td></td><td>0</td></tr>
<tr><td>Total Coliform (cfu/100ml)</td><td></td><td></td><td></td><td>0</td></tr>
<tr><td colspan="5">*Ref of Report:</td></tr>
<tr><td rowspan="9">Source water quality (ground water)</td><td>Parameter</td><td>Report – 1*
Dated:</td><td>Report– 2*
Dated:</td><td>Report– 3*
Dated:</td><td>Water Quality Target for drinking water in Bangladesh</td></tr>
<tr><td>Arsenic (mg/L)</td><td>0</td><td></td><td></td><td>< 0.050</td></tr>
<tr><td>Iron (mg/L)</td><td>1.0 – 2.0</td><td></td><td></td><td>< 1.00</td></tr>
<tr><td>Manganese (mg/L)</td><td>---</td><td></td><td></td><td>< 0.40</td></tr>
<tr><td>Chloride (mg/L)</td><td>---</td><td></td><td></td><td></td></tr>
<tr><td>Fecal Coliform (cfu/100ml)</td><td>---</td><td></td><td></td><td>0</td></tr>
<tr><td>Total Coliform (cfu/100ml)</td><td>---</td><td></td><td></td><td>0</td></tr>
<tr><td colspan="5">*Ref of Report: report from early commissioning of the PTW</td></tr>
<tr><td>Water Treatment Process</td><td colspan="5">The untreated water from Dakatia river is stored in the pre-sedimentation ponds through three steps. Water is transmitted from the ponds to the clarifier. Alum is also added near the entrance of clarifier and the clear water (from clarifier) goes to rapid sand filter bed followed by chlorination. In the treatment unit there are simultaneous process of four stages like alum coagulation, flocculation, rapid sand filtration and chlorination.
Components of treatment unit:
Treatment unit : 2
Capacity of Treatment : 150 m^3 / day
Surface area of pre-sedimentation ponds : 8540, 14000 & 21600 sft respectively
No of clear water reservoir : 2
Volume of clear water reservoir (each) : 60 m^3
No of Turbine pump : 3 (15 – 25 HP)
Capacity of booster pump : 60 m^3 / hour</td></tr>
</table>

<table>
<tr><th>Step</th><th>Description</th></tr>
<tr><td>Water supply system (existing)</td><td>The untreated water from Dakatia River is taken to the treatment unit and the treated water is stored in an Overground Reservoir (OGR) and Overhead tank (OHT). Water is supplied to the distribution network from both OHT (gravitational force) and OGR (through pumping at a rate of 150 m3 per hour). The flow diagram of the water supply system is shown in page 10.

Groundwater is also distributed without any treatment or chlorination to the distribution line through direct pumping (using 2 submersible pump, 20HP each) in a separate zone from the two production wells.</td></tr>
<tr><td>Reservoir</td><td>
<table>
<tr><th>Reservoir type</th><th>Total no</th><th>Usable no</th><th>Capacity</th></tr>
<tr><td>Over Head Tank (OHT)</td><td>1</td><td>5
1 OHT is not using near City College</td><td>Each 1000 m^3</td></tr>
</table>
</td></tr>
<tr><td>Distribution Line</td><td>Length of distribution line : 88.5 Km
Size (Dia) : 75 to 250 mm
Materials : uPVC (--- km)
AC (--- km) (old aged asbestos pipes has frequent leakage problem)
GI (--- km)
Total Sluice Valve : --- nos
Active sluice valve : --- nos
Total wash out : --- nos
Active wash out : --- nos
Water loss : 8.06% (according to WSP-WB)</td></tr>
<tr><td>Distribution time</td><td>Distribution per day : Regular
Distribution time : average 22 hours / day
Number of Zone : ---
Supply hour in each zone : 5 Hours</td></tr>
<tr><td>Water supply connection</td><td>Residential connection : 7500 nos
Commercial connection : --- nos
Street hydrant : --- nos</td></tr>
<tr><td>Intended consumer</td><td>Residential user : Citizens of Chandpur Paurashava
Commercial user : Consumer of hotel & restaurant, people working at office and institutions etc.
Street Hydrant : lower middle class people, slum people and floating people</td></tr>
<tr><td>Intended use</td><td>The distributed water is used for drinking, cooking, personal hygiene and household washing (point of entry) purposes.</td></tr>
<tr><td>Distributed Water quality</td><td>Water should meet safety and quality (aesthetic) standards i.e. the Health Based Target, which has been set by the government (HBT – WSF 2011)
<table>
<tr><th>Parameter</th><th>Unit</th><th>Target (standard)</th><th>Report – 1* Dated: 22/09/2013</th><th>Report – 2* Dated: 22/09/2013</th><th>Report – 3* Dated: 22/09/2013</th></tr>
<tr><td>Fecal Coliform</td><td>/100 ml</td><td>0</td><td>0 – 2</td><td>--</td><td>--</td></tr>
<tr><td>Total Coliform</td><td>NTU</td><td>< 5</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>Arsenic</td><td>mg / L</td><td>< 0.05</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>Iron</td><td>mg / L</td><td>0.3 - 1.0</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>Manganese</td><td>mg / L</td><td>< 0.4</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>Free residual chlorine</td><td>mg / L</td><td>0.2</td><td>0.2</td><td>--</td><td>--</td></tr>
<tr><td colspan="6">**Ref. of Report:**</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Step</th><th colspan="4">Description</th></tr>
<tr><td></td><td colspan="4">Aesthetic requirements
• Taste not unpleasent
• Odorless</td></tr>
<tr><td rowspan="5">Sanitary Inspection Score</td><td colspan="4">Reference to the Sanitary Inspection Report 2011, conducted by the NGO, under the WSP implementation program, the risk scores of different steps of water supply system are shown below.</td></tr>
<tr><td>Steps</td><td>Risk Score</td><td>Steps</td><td>Risk Score</td></tr>
<tr><td>Treatment Unit-1</td><td>Medium Risk</td><td>Treatment Unit-2</td><td>Medium Risk</td></tr>
<tr><td>Production well</td><td>Medium Risk</td><td>Overhead Tank</td><td>Medium risk</td></tr>
<tr><td>Pump House</td><td>Medium Risk</td><td>Distribution line</td><td>High Risk</td></tr>
<tr><td>Any special controls required?</td><td colspan="4">1) Intermittent supplies require special consideration in relation to ingress during periods of low or no pressure
2) Due to presence of iron, the pipeline need to be cleaned frequently</td></tr>
</table>

2.2 Persistent problem in paurashava pipe water supply system

a. Chandpur is a commercial town and is renowned for river transportation between the Capital city and southern part of Bangladesh. It is located on the country's one of the most important river bank, where transportation of commercial vessels cause severe water pollution through oil leaking and disposing of hazardous waste materials. For this to prevent from the intake (i.e. river water), special measures need to be taken.
b. Intermittent supplies require special consideration in relation to ingress during periods of low or no pressure.
c. Chlorination is not included in the zone-B where groundwater is directly supplied in the distribution
d. Contamination of stored water at kitchen and other places must be controlled.
e. A number of users transport water in vessels that are not kept solely for drinking water use and store water in unsanitary conditions, which can lead to contamination. Controlling these risks requires hygiene education about the safe water chain and Paurashava Sanitary Inspector and health staff working at the Paurashava level.

2.3 Sanitation situation of Paurashava area

From Household survey report

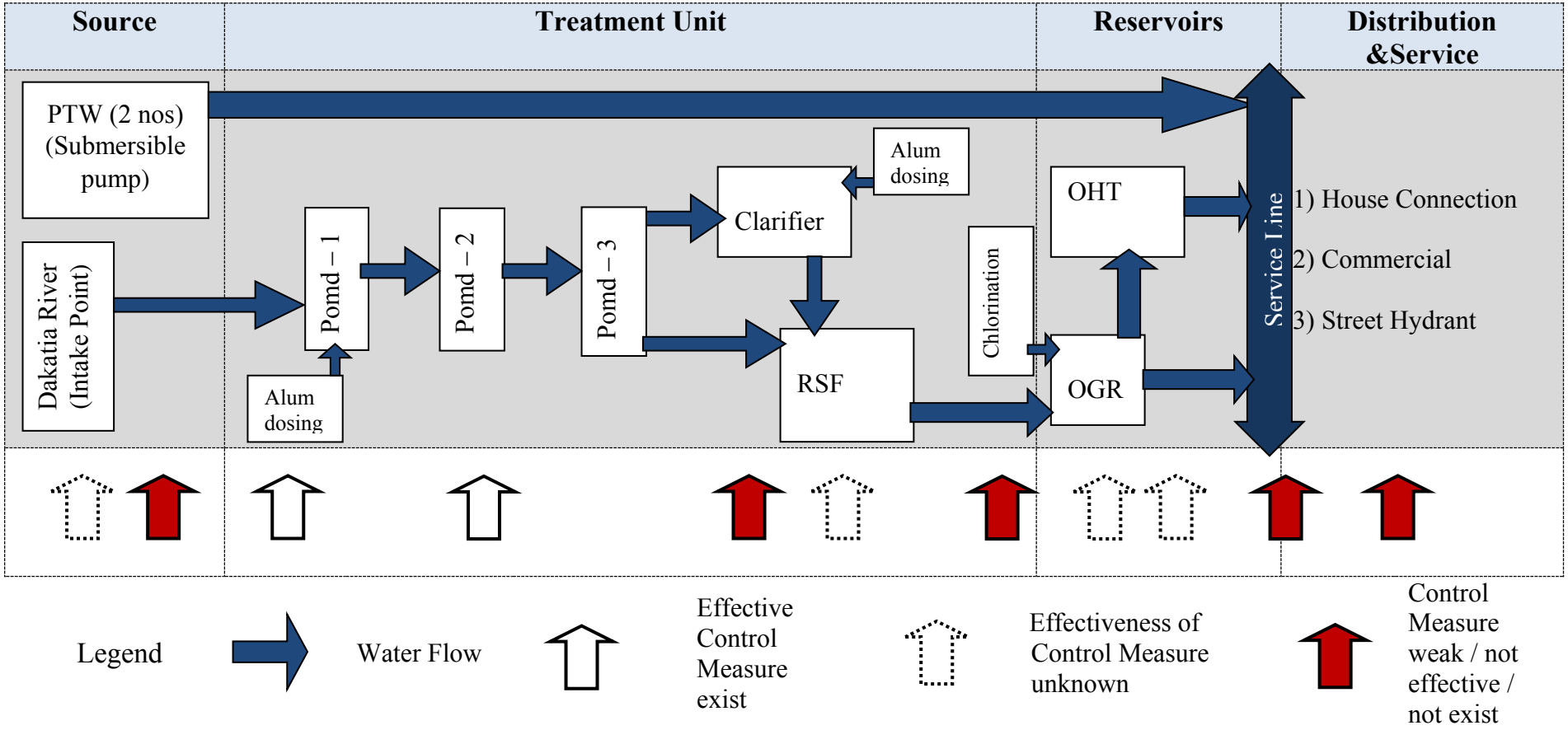
2.4 Consumers practice on water use

From Household survey report

2.5 Flow diagram of Chandpurwater supply system

The flow diagram of existing water supply system is shown in the following page.

2.1: Flow diagram of Chandpur Paurashava PWSS



Chapter- 3. Hazardous event and risk analysis

The hazardous events were identified from different component of water supply system by the WSP Team with the assistance of expert consultant. The different steps of hazard analysis are described below:

3.1 Identify the hazards and hazard events

In this document, 'Hazard' is defined as the Physical, Microbial, Chemical & Radiological agents that cause harm to public health. The 'Hazardous Event' is defined as an event that introduces hazards to, or fails to remove them from, the water supply. The process of identification of hazards and hazard events involve:

a) Visual inspection of validated water supply components and desk review of various hazard events
b) Assessment of historic information and events
c) Predictive information based on utility data and knowledge of particular aspects
d) Identification of influencing factors for the potential hazard events

3.2 Assessment of risk

The risks associated with each hazard of various components are assessed by semi-quantitative risk matrix approach which includes:

a. Identify the likelihood (L) of the occurrence (e.g. certain, likely, possible, unlikely & rare) (Table 3.1)
b. Evaluate the severity (S) of consequences if the hazard occurred (e.g. Insignificant, minor, moderate, major & catastrophic) (Table 3.1)
c. Estimate risk score (R) by multiplying individual score of likelihood and severity (Equation 3.1) and
d. Rate of risks as High (>15), Medium (6-14) and Low (<5) (Table 3.2)

Table 3.1: Definition & score of Likelihood and Severity

Likelihood		Severity	
Rank (Score)	**Definition**	**Rank (Score)**	**Definition**
Almost Certain (5)	Once per day	Catastrophic (5)	Potentially lethal to a large Population
Likely (4)	Once per week	Major (4)	Potentially lethal to a small Population
Possible (3)	Once per month	Moderate (3)	Potentially harmful to a large population but no mortality
Unlikely (2)	Once per year	Minor (2)	Potentially harmful to a small population but no mortality
Rare (1)	Once every five years	Insignificant (1)	Negligible impact in terms of severity of disease or numbers of people affected

Estimation of Risk Score = Likelihood × Severity .....(3.1)

(Understand the likelihood & severity as per definition from Table 3.1 and find out the risk score from Table 3.2)

Table – 3.2: Risk Score & Ranking

		Severity				
		Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Likelihood	Almost certain (5)	5	10	15	20	25
	Likely (4)	4	8	12	16	20
	Possible (3)	3	6	9	12	15
	Unlikely (2)	2	4	6	8	10
	Rare (1)	1	2	3	4	5

Risk Rating		
Low (**L** ≤ 5)	Medium (**M** 06-14)	High (**H** ≥ 15)

3.3 Determine and validate control measures

Control measures are preventive actions for the hazardous events of water supply components that ensure the supplied water consistently meets water quality targets. These are systematic activities, which reduce the risks associated with the hazard events. The reduction in risk achieved by each control measure is an indication of its effectiveness, which can be validated through historical record, intensive program of monitoring or technical data from scientific literature. Finally the operational monitoring (Chapter-5) activities show that the validated control continues to work effectively and provide sufficient operating data to give it confidence that further validation monitoring is not required.

3.4 Reassess & prioritize the risks and new operational control

If the existing control is found ineffective or not sufficient for long time then the risk is recalculated in terms of likelihood and consequences taking into account the effectiveness of each control. Risks are prioritized in terms of their likely impact on the capacity of the system to deliver safe water. High priority risks may require upgrade / new operational control or system modification (improvement action plan) to achieve the water quality targets. Lower priority risks can often be minimized as part of routine good practice activities.

Table 3.3 shows the hazardous event and associated risks for different components of Chandpur Paurashava water supply system. The existing control system, reassess and prioritization of risks along with proposed new control are also described in the table.

Table 3.3: Hazard Events, Risk Prioritization and Control Measures of different process step of Chaumuhoni Water Supply System

Ref No.	Steps	Hazardous Event	Hazard type	Risk without control L = likelihood S= severity R= Risk Score	Existing Control Measures / preventive action / barriers (Ref of OM plan in Chapter 4)	Risk with existing control L = likelihood S= severity R= Risk Score	Improvement Opportunity / New Operational Control) (Ref of OM plan in Chapter 5)	Improvement ActionPlan Ref. (Ch. 4)
3.1	Catchment around source	1. Increased pollution of intake /catchment due to spread of chemical and waste materials • from commercial vessels and • waste dumping on the river sides	Microbial (B,V,P) Chemical	L = 4 S = 5 R = 20 **High**	a. Raw water intake point protected with RCC well associated with filter pipe	L = 3 S = 5 R = 15 **High**	Control of raw water quality within the average level round the year (**ref 5.1**)	**Ref. 4.1**
		2. Human activity near the intake point may cause contamination of raw water	Microbial (B,V,P)	L = 4 S = 5 R = 20 **High**	a. Intake point is effectively protected and accessible only to the supplier	L = 1 S = 4 R = 4 Low		
3.2	Natural aquifer recharge/ storage	1. Stagnant polluted water in ditches around PW / crowded canal flowing beside PW contaminates raw water	Microbial (B,V,P) Nitrate Pesticides	L = 3 S = 4 R = 12 Medium	a. PTW platform is elevated compared with surrounding area, b. Fencing surround the pump house and well head & door to pump house c. Surround area of pump houses is kept clean (**ref 5.2**)	L = 1 S = 4 R = 4 Low		
		2. Open defecation, animal waste material remaining around the source contaminates raw water	Microbial (B,V,P)	L = 3 S = 4 R = 12 Medium		L = 1 S = 4 R = 4 Low		
		3. Ingress of contaminated water into borehole from surface and shallow aquifer or back-siphonage from pipeline	Microbial (B,V,P) Nitrate Pesticides	L = 3 S = 4 R = 12 Medium	a. Sealed apron around pump head b. Well head capping c. Sanitary seal exists at a depth of 5 meter d. Non-return valve installed to prevent back-siphonage **(ref 5.3)**	L = 1 S = 4 R = 4 Low		

Table 3.3: Hazard Events, Risk Prioritization and Control Measures of different process step of Chaumuhoni Water Supply System

Ref No.	Steps	Hazardous Event	Hazard type	Risk without control L = likelihood S= severity R= Risk Score	Existing Control Measures / preventive action / barriers (Ref of OM plan in Chapter 4)	Risk with existing control L = likelihood S= severity R= Risk Score	Improvement Opportunity / New Operational Control) (Ref of OM plan in Chapter 5)	Improvement ActionPlan Ref. (Ch. 4)
		4. Polluted runoff from faecal matter containing pathogens or agriculture chemicals enters the aquifer	Microbial (B,V,P) Nitrate Pesticides	L = 3 S = 4 R = 12 Medium	a. Aquifer is deep, overlain by impervious layer, is a confined aquifer with very long hydraulic travel times to aquifer	L = 1 S = 4 R = 4 Low		
		5. Groundwater delivered to customers is high in As, Fe & Mn	Chemical	L = 5 S = 5 R = 20 **High**	a. Confined aquifer does not contain Arsenic b. All water sources tested prior to commissioning and PTW is only used if meets national standards *Note: As per record there is no Arsenic but iron is 1-2 ppm*	L = 3 S = 5 R = 15 **High**	Periodically checking of water quality parameters ensure safe water to be delivered **(ref 5.4)**	**Ref. 4.2**
3.3	Treatment Plant – Surface Water	1. Ingress of contaminated water into the sedimentation ponds may increase pathogens and turbidity 2. Pond-3 is found vulnerable to runoff inflow on some part of the road side	Microbial (B,V,P) & Turbidity	L= 3 S= 5 R= 15 **High**	Pond embankments are elevated and protected from flood level (Except few parts of road side due to soil erosion) (**ref. 5.5.1**)	C= 3 S= 5 R= 15 **High**	Provided brick wall at the road side of adjacent bank of pond-3	**Ref. 4.3**
		3. Seasonal variation in river water quality may affect the performance of treatment plant	Physical (Turbidity)	L= 3 S= 4 R= 12 **Medium**	a. Regular use of alum for effective sedimentation b. Alum dosing is maintained based on the turbidity of water (**ref 5.1)**	L= 2 S= 4 R= 8 **Medium**	Optimum Turbidity of feed water need to be ensured before entering Rapid Sand Filter **(ref. 5.5.2**)	
		4. Overflowing water from underground reservoir of the treatment plant often flooding pump-house floor, which may cause water contamination	Microbial (B,V,P) Chemical	L= 3 S= 4 R= 12 **Medium**	Occasional cleaning/drying up of the floor	L= 3 S= 4 R= 12 **Medium**	Observe pumping time so that overflowing can be controlled;	**Ref. 4.3**

Table 3.3: Hazard Events, Risk Prioritization and Control Measures of different process step of Chaumuhoni Water Supply System

Ref No.	Steps	Hazardous Event	Hazard type	Risk without control L = likelihood S= severity R= Risk Score	Existing Control Measures / preventive action / barriers (Ref of OM plan in Chapter 4)	Risk with existing control L = likelihood S= severity R= Risk Score	Improvement Opportunity / New Operational Control) (Ref of OM plan in Chapter 5)	Improvement ActionPlan Ref. (Ch. 4)
		5. Insufficient/inappropriate chlorine dosing may cause water to be remained unsafe	Microbial (B,V,P) Chemicals	L = 5 S = 5 R = 25 **High**	a. Regular chlorination procedure is maintained as per SOP; b. Monthly test of residual chlorine in supply water	L = 4 S = 5 R = 20 **High**	c. Appropriate chlorine dosing must be ensured; d. Regular test of residual chlorine (**ref 5.5.3**)	
		6. Power Failure stops the pump of treatment plant cause increase of chlorine concentration (due to manual feeding) in clear water reservoir	Chemical	L = 4 S = 5 R = 20 **High**	Switch off the flow rate control valve of the chlorine dosing mixing tank as soon as power failure occur (**ref 5.5.3**)	L = 1 S = 5 R = 5 Low		
		7. Backwash sludge washes out from sludge pond to the river upstream may increase turbidity during rainy season	Physical (Turbidity)	L= 3 S= 4 R= 12 **Medium**	See ref 4.3.3 for control measure	L = 1 S = 5 R = 5 Low		
3.4	Reservoir / Storage (OHT)	1. Water of reservoirs and OHT is contaminated by birds and lizards	Microbial (B,V,P)	L= 3 S= 4 R= 12 Medium	a. Always covered the manhole of the CWR & OHT (**ref 5.6**)	L= 3 S= 4 R= 12 Medium	b. Netting to restrict entrance of birds and lizards inside the treatment plant	
		2. Contamination of water from bio-film and sediment	Aesthetic	L= 1 S= 4 R= 4 Low	Tank is kept clean periodically; Chlorination is performed regularly (**ref 5.5.3 & 5.6**)			
		3. Storage tank allows mosquito breeding	Biological	L= 1 S= 4 R= 4 Low	Regular draw down, then refill of tank to create turnover of water (**ref 5.6**)			
3.6	Distribution and service	1. Distribution Main pipe line, old aged, occur damage or leak, causes ingress of contaminants into the pipe network	Microbial (B,V,P) Turbidity	L= 4 S= 5 R= 20 **High**	Leaks repaired when reported (**ref. 5.7.1**)	L= 4 S= 5 R= 20 **High**	Improvement Plan is needed for replacing the old aged pipeline	**Ref. 4.4**

Table 3.3: Hazard Events, Risk Prioritization and Control Measures of different process step of Chaumuhoni Water Supply System

Ref No.	Steps	Hazardous Event	Hazard type	Risk without control L = likelihood S= severity R= Risk Score	Existing Control Measures / preventive action / barriers (Ref of OM plan in Chapter 4)	Risk with existing control L = likelihood S= severity R= Risk Score	Improvement Opportunity / New Operational Control) (Ref of OM plan in Chapter 5)	Improvement ActionPlan Ref. (Ch. 4)
		2. Ingress of contaminated water through • pipe or joint leakage • sluice valve leakage • unhygienic condition of valve chamber • leaking or broken service line • leaking house connection and drain cross	Microbial (B,V,P)	L= 5 S= 5 R= 25 **High**	a. Quickly repair of any leaks reported or identified b. Quality of materials is controlled during construction c. Ensured that sluice valve chambers are always covered by slab; d. Sand/gravel filling of the valve chambers; e. Use cover pipe when pile crosses drains; **(ref. 5.7.2 & 5.7.3)**	L= 3 S= 5 R= 15 **High**	f. Undertake regular leak detection and repair programme g. Separate house connection and wash out drains	**Ref. 4.5**
		3. ingress contaminant through leaking pipe joints during periods of low or no pressure due to Intermittent supplies	Microbial (B,V,P) Turbidity	L= 3 S= 3 R= 9 **Medium**	No control exists	L= 3 S= 3 R= 9 **Medium**	Improvement action plan is needed	**Ref. 4.6**
		4. In Zone-B, Iron in water builds up in pipes causes excessively dirty water, leading to rejection of water by customers	Aesthetic & Turbidity	L= 5 S= 4 R= 20 **High**	a. Occasional scouring by cutting pipe and flushing and repairing pipe and use of SVs to manage flows b. Occasional supply from surface water zone to clear water	L= 3 S= 4 R= 12 **Medium**	a. Structured/regular flushing program b. In problem areas, install cross connections or flushing point	**Ref. 4.7**
		5. Chlorination is not included in the zone-B where groundwater is directly supplied in the distribution causes contamination	Microbial (B,V,P)	L= 5 S= 5 R= 25 **High**	No control exists	L= 5 S= 5 R= 25 **High**	Improvement plan is needed because direct chlorination in distribution line will not feasible due to high iron content	**Ref. 4.2**
		6. Some street hydrant are kept open (no tap) that cause wastage and entering wastewater into the pipe	Microbial (B,V,P)	L= 3 S= 5 R= 15 **High**	a. Set new taps in the stand-posts; (**ref 5.7.4**)	L= 2 S= 5 R= 10 **Medium**	b. Undertake user awareness program about misuse of stand post water;	**Ref. 4.8**

Table 3.3: Hazard Events, Risk Prioritization and Control Measures of different process step of Chaumuhoni Water Supply System

Ref No.	Steps	Hazardous Event	Hazard type	Risk without control L = likelihood S= severity R= Risk Score	Existing Control Measures / preventive action / barriers (Ref of OM plan in Chapter 4)	Risk with existing control L = likelihood S= severity R= Risk Score	Improvement Opportunity / New Operational Control) (Ref of OM plan in Chapter 5)	Improvement ActionPlan Ref. (Ch. 4)
		7. Installation of street hydrant in dirty places (i.e. near drain and toilet) and broken platform cause contamination of supplied water	Microbial (B,V,P)	L= 5 S= 5 R= 25 **High**	No Control exists	L= 5 S= 5 R= 25 **High**	a. Re-install street hydrants at clean and safe distance from drain/toilets; b. Re-construct plarform c. Install toilets at least 10m far from the water points. (**ref 5.7.4**)	**Ref. 4.8**

Chapter - 4. Improvement Action Plan

If Table 3.3 identifies significant risks to the safety of water and demonstrates that required existing controls are not effective or are absent, or the reassessment of respective hazardous events are under High or medium risk then an improvement opportunity or new operational control is proposed. Every High or unacceptable re-assessed risk needs some action to reduce the risk to an acceptable level, assuming that the improvement is effective.

Based on the proposed new control measure or improvement opportunity the timeline for implementing improvement action plans can be classified as follows:

1) Short term action plan – this type of improvement action plan can be implemented within maximum three months and a minimum budget is required to accomplish such activity, which is under control by the respective staff and does not need consent from top authority.
2) Medium term action plan – This type of action plan can be implemented within maximum six months for which a minimum amount of budget is required from the authority and the authority has ability to provide such amount. In this case the section chief or utility authority is sufficient to approve the budget.
3) Long term action plan – This type of action plan can be implemented within six month to two years, which required top authority approval and seeking of donor fund / loan.

Table 4.1 shows the proposed improvement action plan based on the hazard and risk analysis in Table 3.3 for different components of Chandpurwater supply system. Successful implementation of this action plan will ensure the utility to provide safe water to the consumer. The action plan also mention about the person who is responsible for the associated task and a tentative timeline.

Table – 4.1: Improvement Action Plan (Short to long term)

Ref:	Activities	Description	Responsibility	Time frame	Status
4.1	Improve management of river catchment	Liaison with different stakeholders (sec 2.4) of river catchment need to be maintain for effective management of river water near intake point	WSP Team members (assigned)	--	Not started
4.2	Reducing risks due to high iron in groundwater	feasibility study is needed to find • other safe sources and /or • new iron removal plant	Pourashava Executive Engineer	One year	Not started
4.3	Improve management of surface (river) water treatment plant	• Renovate remaining road side brick wall to protect embankment of Pond-3; • Provide training to the PWSS staff on surface water treatment process and integrity of treatment plants and regular cleaning and maintenance of SWTP & storages.	Pourashava Executive Engineer and WSP Team Member	--	Not Started

Table – 4.1: Improvement Action Plan (Short to long term)

Ref:	Activities	Description	Responsibility	Time frame	Status
	Develop operator (including private plumber) training programme	Training is required for technical staff, private plumbers and should cover the following aspects of WS system: • Wellhead protection from external contaminants and area drainage • Wellhead protection from floods • Critical source area for wellhead and aquifer recharge area • Wellhead sanitary seal • Chlorine dosing system and testing for free chlorine levels in dosed water • Bleaching powder storage and shelf life • Exclusion of vermin from tanks using meshing and lids • Valve box drainage and sand/gravel filling • Reticulation system supports • Integrity of pipes and joints and filling and covering • Tap stand condition and drainage	Pourashava Executive Engineer keeps continuing the programme	--	Not Started
4.4	Replacing of old aged asbestos made distribution main	Around **three Kilometre** long asbestos distribution main line need to be replaced due to frequent leaking problem.	Executive Engineer	One Year	Not started
4.5	1. Improve sanitary protection and water conservation through improved distribution system management	Provide increased protection of distribution system by: • Improving jointing and sealing of connections, replacements and extensions • Sand/gravel filling of and improve drainage from sluice valve chambers • Develop legal obligation on consumers to repair any defective service lines	Pourashava Executive Engineer	Six Month	On going

Table – 4.1: Improvement Action Plan (Short to long term)

Ref:	Activities	Description	Responsibility	Time frame	Status
4.6	Maximise duration and extent of pressurised system through an improvement programme	The more extensively and consistently positive hydraulic pressure should be maintained in the piped system, the lower the risk of backflow events of all kinds. Means for achieving this, actions include: • Increase pumping hours • Increase period during which the overhead tanks pressurise the system • Create distinct supply zones of similar pressure, and use non-return valves and shut valves	Pourashava Executive Engineer	--	On Going / Not Started
4.7	Addition of some new flushing points	• Regular flushing the pipe line will not cause clog or builds up excessively dirty water	Pourashava Executive Engineer	--	Not Started
4.8	Protection of street hydrant from re-contamination	• Need renovation of all broken platform of street hydrant • Keep the stand post at least 10 meter away from public toilet, drains or ditches • Undertake awareness program for the user about misuse of water and provide good quality taps	Water Superintendent	Six Month	On Going / Not Started

Table – 4.1: Improvement Action Plan (Short to long term)

Ref:	Activities	Description	Responsibility	Time frame	Status
4.9	Develop consumer education programme	Consumer education should be undertaken to explain and motivate on how to safely abstract, store and use water. This should cover concepts including: • Avoidance of pumping outside of supply times when the system is not pressurised • Keeping storage tanks covered and cleaned • Raising storage tanks above flood level • Avoiding use of water from tanks if inundated until it is properly sanitised • Avoiding contaminating water in pitchers with hands or other intrusions • Preventing backflow of contaminated stored water into system though air gaps and non-return valves • Using only clean pitchers/pots for storing and transporting water • Avoiding re-contaminating water in pitchers/pots with dirty hands or utensils • Keeping insects and vermin out of pitchers/pots and water tanks • Preventing mosquito breeding in storage tanks • Using clean receptacles such as cups for drinking • Periodical testing of microbial and chemical water quality	Pourashava Executive Engineer (through local NGOs, civil societies and community volunteers or Donor Agency)	--	Not Started
4.10	Marking contaminated tubewells through an improvement programme	Once contamination (specially arsenic) is identified a tubewell should be reliably marked so that it is very clear that the well should not be used for drinking water supply purposes Paurashava can seek Donor Funding	Pourashava Executive Engineer	--	Not Started

Chapter - 5. Operational Monitoring of Water Safety Plan

A systematic monitoring plan is needed to convey the authority that the control system or new control system for different components of water supply system that identified in table 3.3 are working properly. During monitoring if it is found that the control measure of a certain component exceeds beyond the control limit i.e. not working properly to prevent hazardous event, then the operational staff will take necessary and appropriate corrective action to mitigate the problem. The monitoring plan should also guides such corrective action plan corresponding to the control limit of respective monitoring indicators. Altogether this is mentioning here as Operational Monitoring Plan.

Table 5.1 shows the operational monitoring plan for Chandpur Paurashava Water Supply System in which the following issues are considered for the monitoring plan:

1) What will be monitored?
2) How it will be monitored?
3) Where it will be monitored?
4) Who monitores it?
5) When it is monitored?

Moreover, the critical control limit for each control system is defined in the table. Accordingly, the corrective action procedure is described in the plan if the control system fails to meet the critical control limit. The responsible staff for the monitoring activities will note the monitoring information using a log sheet as is mentioned in Annex-2.

In Table 3.3 a reference number is mentioned for operational monitoring against each existing or new control measure and the same sequence is followed to describe the overall monitoring plan in Table 5.1.

Table: 5.1: Operational Monitoring Plan

Ref No.	Component	Operational Control (Performance Indicator)	Monitoring of operational control		Control Limit	Corrective Action
5.1	Source – River Water	Control of raw water quality within the average level round the year	What	Raw water quality like pH, Turbidity, TDS & FC	River water quality should be within the following limit • pH 6.5 – 8.5 • Turbidity <100 NTU • TDS <500 mg/L • FC <500 count/100 ml **[need to be reviewed the limit based on treatment capacity]**	• Necessary steps are taken to reduce turbidity at treatment plant (like increase alum dosing etc.) • Suddenly shut down the raw water transmission line if TDS is found high and investigation is to be carried out if any harmful chemical comes in or allow sufficient time to reduce chemical hazard by river flowing • communicate with the authorities to control the incidents (from river vessels or other source)
			How	• Visual inspection of turbidity and any incident (ref 4.1.1) • Test Using pH meter, Turbidity tube, TDS meter, MF technique • Record keeping		
			When:	• Weekly test of using equipments and keep record; • Daily visual inspection; • If any rapid changes in turbidity is observed or any incidents is notified then WQ is to be verified by test & keep record		
			Where:	Near the intake point		
			Who:	WQ analyst (assigned by Water Super) & Sanitary Inspection Officer		
5.2	Source – Ground water	Land Use and activity in critical source areas	What	• Land use & activity around PTW & pump house • Fencing around pump house • Keep pump-house and well sites clean	• No latrines, animal pens, waste dumps within 10 meter of PTW • Fencing Surrounding the pump house and restriction of human activities inside	• Sanitary Inspection Officer immediate takes necessary action providing information to the respective authority • Record keeping is necessary to notify and take into action.
			How	Physical inspection & record keeping		
			When:	Monthly		
			Where:	Each well site and surrounding of critical source area		
			Who:	Sanitary Inspection Officer		
5.3		integrity of pumps	What	• Checking apron, capping and platform of well head • Inspect and check functionality of non return valve	• No cracks or undercutting of apron or platform • Capping of well head in place and intact	• Pump Operator takes immediate action for repairing the non-integrity or notify to the respective authority if beyond his capacity
			How	Physical inspection & record keeping		
			When:	Weekly		
			Where:	Each well site and surrounding of critical source area		
			Who:	Pump Operator		
5.4	Source – Ground Water	Periodically checking of water quality parameters ensures safe water is to delivered	What	• First priority WQ parameters: As, NO_3 • Second priority WQ parameters: Mn, B, Ba • Non health based parameter: Fe, Cl	WQ parameters critical limit as per WSF 2011: Arsenic (As) < 0.05 mg/L Iron (Fe) < 1.00 mg/L	• Decommission contaminated tubewell or • add treatment facilities as per improvement plan (**ref 6.2**)
			How	Sample is taken as per protocol and send to designated lab for testing		

Table: 5.1: Operational Monitoring Plan

Ref No.	Component	Operational Control (Performance Indicator)	Monitoring of operational control		Control Limit	Corrective Action
			When:	• Every Six Month for As, Fe, NO_3, Cl • Mn, B & Ba were not tested earlier, so need the testing once	Manganese (Mn) < 0.40 mg/L Boron (B) < 1.00 mg/L Barium (Ba) < 0.70 mg/L Chloride (Cl) < 600 mg/L Nitrate (NO_3) < 50 mg/L	
			Where:	DPHE Zonal Lab, Comilla		
			Who:	Water Superintendent		
5.5	Treatment Plant	1. Pond embankments are elevated and protected from flood level	What	• Checking of any erosion of ponds embankment • Cleaning of surrounding environment of ponds	• Protected embankment of all sedimentation ponds • Cleaning of surrounding environment of ponds	Necessary fund requisition need to be processed for renovation or repairing
			How	Physical Inspection		
			When:	Monthly		
			Where:	Sedimentation ponds (Treatment plant)		
			Who:	Sanitary Inspection Officer		
		2. Optimum Turbidity of feed water need to be ensured before entering Rapid Sand Filter	What	• Alum dosing in both Pond-1 & circular clarifier • Checking feed water turbidity	Quality of feed water: Turbidity <20 NTU	Revise alum dose during adverse situation
			How	Using Turbidity Tube		
			When:	Weekly / adverse situation		
			Where:	Feed water at RSF unit		
			Who:	WQ Analyst / Pump Operator		
		3. Appropriate Chlorination is to be performed	What	• Quality of bleaching Powder • Effective dose apply and keeping record daily • Test of residual chlorine at clear water reservoir • Test of residual chlorine at farthest end user • Stop chlorination when electricity goes off	**Dose of bleaching powder:** • 9 kg bleaching powder having 30% strength in 300 liter mixing tank **Conc. of residual chlorine:** • 1.6 mg/L Cl_2 at clear water reservoir (CWR) • 0.2 mg/L Cl_2 at farthest end user point	• If the strength of bleaching powder is decreased then accordingly the dose need to be increased, which can be confirmed by testing residual chlorine at CWR that meets the critical limit
			How	• Chlorine test kit is used for chlorine dose adjustment and residual chlorine test		
			When:	• Residual Cl2 test for CWR at weekly basis • Dose adjustment – when strength of bleaching decreased • Switch off manual flow controller of chlorine mixing tank during power failure		
			Where:	At entry point to distribution system (farthest)		
			Who:	WQ Analyst / Pump Operator		
5.6	Reservoir/ Storage	Regular maintenance for integrity of reservoir &	What	Integrity of reservoirs & OHT	Reservoir & tank lid must be closed and intact	Maintenance, repair or replace vents and lid as required
			How	Visual inspection and record keeping		

Table: 5.1: Operational Monitoring Plan

Ref No.	Component	Operational Control (Performance Indicator)	Monitoring of operational control		Control Limit	Corrective Action
		storage	When:	Monthly	Tank vents to be sealed against entry of vermin	
			Where:	Top of OHT & reservoir promises		
			Who:	Pump Operator		
5.7	Distribution Network	1.Repair / Replace old aged distribution main line made of asbestos	What	Condition of asbestos pipe	No leakage in asbestos pipe	Immediate action need to be under consideration to avoid high level contamination.
			How	Repair when it becomes leak Replace as per improvement plan in 6.4		
			When:	leakage or damage		
			Where:	Paurashava main pipe line		
			Who:	Water Super / Executive Engineer		
		2. Sanitary condition and integrity of pipes and joints, sluice valve, wash out	What	Condition of pipe and joints Condition of sluice valve / wash out	No leaks in pipes or joints, no missing coverings or fill around pipes or joints No stagnant dirty water in sluice valve and wash out chamber	Repair pipes of joints, replace or coverings Sand filling of sluice valve and wash out chamber
			How	Sanitary inspection		
			When:	Half yearly for accessible portions of system		
			Where:	Throughout accessible distribution line		
			Who:	Lineman		
		3. Structural integrity of crossing supports	What	Support of pipes at crossing	Pipe support must be in place Use good quality fittings	Provide support to pipes; Use recommended support practice
			How	Sanitary inspection		
			When:	Annually for accessible portions of system		
			Where:	At all accessible crossings		
			Who:	Lineman		
		4. Sanitary condition and integrity of street hydrants	What	Tap is under operating condition Cleaning environment surrounding stand post Good condition of platform	• Tap exists with street hydrant • Platform exists • Safe distance of drain and toilet	• Replace non-functional taps • Re-construct broken platforms • Keep safe distance of street hydrant from drain / toilet
			How	Sanitary Inspection		
			When:	Monthly		
			Where:	All stand post		
			Who:	Sanitary Inspection officer Lineman		
5.8	Consumer Premises	Consumer awareness program on personal hygiene	What	• Hygiene practices • Condition of storage tanks, drainage and cleanliness • Occurrence of water borne disease	• Good hygiene practice • Clean & tidy of water storage system	• Involve all stakeholders for actively participate in mass awareness program

Table: 5.1: Operational Monitoring Plan

Ref No.	Component	Operational Control (Performance Indicator)	Monitoring of operational control		Control Limit	Corrective Action
			How	• Consumers survey program • Sanitary Inspection	• Reduce disease burden	• Information dissemination through poster, leaflet, billboard etc.
			When:	Annually		
			Where:	Household & Consumers		
			Who:	Paurashava Sanitary Inspection office / NGO		

Chapter - 6. Verification of the effectiveness of WSP

A verification procedure is needed to build evidence that overall system design and operation is capable of consistently delivering water of the specified quality to meet health-based targets. Table 6.1 shows such verification schedule for Chandpur Paurashava water supply system. It involves three following activities:

1) Delivered water quality monitoring – It indicates that the delivered water is safe
2) Internal and external auditing of WSP operational activities – It helps to assess the WSP activities and verify the status of proper implementation process
3) Consumer satisfaction – checking that consumers are satisfied with the supplied water

Table 6.1: Verification schedule

Activities	Description	Frequency	Responsibility	Record
6.1 Water quality monitoring of supplied water	1. At least 3 samples per Ward will be collected for testing thermotolerant coliform (TTC) & E.Coli at consumer level. The sample will be collected directly from service connection at household level. (Using Pota test kit at utility)	Once per month 27 samples per month	Asst. Engineer (Water), Chandpur Paurashava	Office of the Asst. Engineer (Water)
	2. At least one sample per Ward is collected for testing thermotolerant coliform & E.Coli at DPHE zonal lab Comilla. The sample will be collected and will be sent to DPHE lab under supervision of Asst. Engineer (Water).	Half yearly 9 samples	Asst. Engineer (Water), Chandpur Paurashava	Office of the Asst. Engineer (Water)
6.2 Internal Audit for WSP related actitvities	1) Sanitary inspection will be carried out by Asst. Engineer (Water) or by his representative in all components of water supply system to verify the effectiveness of WSP (Sanitary Inspection Form for all components are attached in Annex 3)	Quarterly	Asst. Engineer (Water), Chandpur Paurashava	Office of Asst. Engineer (Water)
	2) The records of operational monitoring and water quality monitoring will be audited / verified. This will ensure that the lineman, pump operator or the other responsible person do their respective duty as per operational monitoring plan and record the corrective action activities as and when necessary.	Half Yearly	Executive Engineer, Chandpur Paurashava	Office of Executive Engineer
6.3 External Audit for WSP related actitvities (Surveillance)	1) Under supervision of Executive Engineer, DPHE Chandpur, water sample will be collected and sent to DPHE zonal lab for testing of TTC & E, Coli 2) Inspect all components of water supply system, auditing of all types of records of operational monitoring and water quality monitoring 3) Prepare a report based on the information gathered	Yearly Min 9 samples to be tested	Executive Engineer, DPHE, Chaumuhoni	Office of the EE, DPHE, Chandpurand copy to EE, Chandpur Paurashava
6.4 Verify consumer satisfaction	1) Consumer satisfaction survey about water quality and use through questionnaire. 2) Analyse the customer complains	Yearly	Executive Engineer, Chandpur Paurashava	Office of Executive Engineer

Chapter - 7. Management & Communication

7.1 Management Procedure of Water Safety Plan

It is essential to keep written documents for different steps of WSP related activities. On the other hand, all sort of records related to WSP activities need to be collected in a prescribed format or log sheet. Such written documents and keeping records in log sheets are part of management procedure that ensures the safe operation of WSP activities. Such management procedures can be divided into following three parts:

1) General Procedures
   All of the actions need to be documented to maintain, normal operating conditions for the production of safe drinking water. This includes procedures of all treatment processes, distribution system operations and maintenance of the system. These are called Standard Operating Procedure (SOP). Moreover, all types of records from different components need to be kept in the log sheets.
2) Procedures for corrective action
   Procedures are in place for incident situations (situations outside of normal operating conditions), describing corrective actions necessary to maintain safe water and protect consumers. All information related to the incident and associated corrective measure need to be recorded.
3) Procedures for emergency
   There should be management procedures setting out a communication plan to alert and inform consumers and other stakeholders when there is a problem with the safety of water supply

Control of Document and Records

All documents and records related to management procedures will be controlled by Asst. Engineer (Water) of PWSS section of Chandpur Paurashava. Asst. Engineer (Water) is responsible to circulate the necessary documents and records to the concern person in PWSS and WSP Team members. Table 7.1 shows the list of management procedures of Chandpur Paurashava PWSS section which already exist and which will be prepared.

Table 7.1: List of Management Procedures

Serial No	Management procedures	Controlled by and used by	Status of document preparation
1	Citizen Charter	Executive Engineer	Completed; Preserved in Utility
2	Water Safety Planning	Executive Engineer, Asst. Engineer (Water)	Draft; Version-2a, Nov 2014
3	Protocol for protection of source and catchment	Executive Engineer, Asst. Engineer (Water)	Not completed
4	Protocol for maintenance of booster & turbine pump	Asst. Engineer (Water) & Pump Operator	Not completed
5	Cleaning procedure of overhead tank	Asst. Engineer (Water) & Pump Operator	Not completed
6	Cleaning procedure of distribution and servce line	Asst. Engineer (Water) & Line Mechanic	Not completed
7	Chlorination process in supplied water	Asst. Engineer (Water) & Line Mechanic	Not Completed

8	Operational Monitoring Log Sheet	Asst. Engineer (Water) & concern staff	Completed; Annex-2
9	Accomplishment Corrective Action Log Sheet	Asst. Engineer (Water) & concern staff	Completed; Annex-2
10	Sanitary Inspection Form	Asst. Engineer (Water) & concern staff	Completed; Annex-3
11	Customer Complain Register / Log Sheet	Asst. Engineer (Water) & concern staff	Completed, Preserved in Utility
12	Management Procedure for Emergency	Asst. Engineer (Water)	Completed; Annex-4
13	Asset management of PWSS	Asst. Engineer (Water)	Completed; Annex-5
14	Consumer satisfaction survey form	Asst. Engineer (Water) & concern staff	Not completed
15	Communication strategy relevant to water quality	Executive Engineer, Asst. Engineer (Water)	Descrived in sec 7.2 of WSP Document

7.2 Communication Procedure of Water Quality related information

It is essential to communicate water quality and safety related information to the consumer. The communication strategy is outlined in Table 7.2

Table 7.2: Communication strategy for water quality issues

Issue	Information	Media
procedures for promptly advising of any significant incidents with the drinking water supply	- To drink boiled water - To clean reservoir	- Through miking - Leaflet distribution
summary information to be made available to consumers	- Water quality of supplied water	- Annual Report - Internet - Notice Board
establishment of mechanisms to receive and actively address community complaints in a timely fashion	- Customer complain - Procedure of corrective action and notify to customer	- Customer complain register (log) book - Approval from customer prior to take corrective action

Chapter - 8. Supporting Programs

Supporting programs are the group of activities need to be carried out to supplement the outcome of WSP implementation. Supporting programs are enrolled under the Improvement Action Plan of the WSP. The supporting programs to be developed for ChandpurPourashava water supply system include:

- Consumers education supporting program;
- Operator training supporting program; and
- Environmental sanitation improvement program.

PWSS super is responsible for developing, coordinating and maintaining the Support Program. Consumer's education support program will be implemented by the local NGOs with involvement of local WSP team. The other programs are to be carried out by the PWSS and Chandpur Pourashava.

Activities	Description	Responsibility	Timeframe	Status
1. Develop Consumers education supporting program	Consumers' education is planned to explain how to safely collect, store and use water. This covers issues including: • Keeping storage tanks covered and cleaned • Raising storage tanks above flood level • Avoiding use of water from tanks if inundated until tanks have been drained and disinfected • Avoiding contaminating water in kolshis / pitcher with hands or other intrusions. • Preventing backflow of contaminated stored water into system though air gaps and non-return valves • Using only clean kolshis / pots / jars for storing and transporting water • Keeping insect and vermin out of kolshis / pots and water tanks • Preventing mosquito breeding in storage tanks • Using clean holder such as cups for drinking	NGO/Pourashava Health Section	Not determined	
2. Develop operator training supporting program	Training is required for technical staff and should cover at least the following water supply and sanitation aspects:	DPHE Local Office, Pourashava Asst. Engineer (Water)	Not determined	

	• Wellhead protection including external contaminates, flooding, and drainage • Critical source area for Wellhead and aquifer recharge area • Wellhead sanitary seal • Pump House Maintenance • Maintenance of IRP • Chlorine dosing system • Testing of water quality parameters i/c free chlorine levels in dosed water • Strength of bleaching powder • Bleaching powder storage and shelf life • Exclusion of vermin from tanks using meshing and lids • Valve box drainage and sand fill • Operation of sluice valve and gland packing of sluice valve • Reticulation system supports • Integrity of pipes and joints, fill and covering and crossing • Tap stand condition and drainage	in long-term		
3. Improve environmental sanitation through undertaking sanitation improvement program	The existing environmental sanitation condition of the town is a threat to ensure safe water and for overall improvement of the environmental sanitation the following activities are to be undertaken: • Educate people on better management of onsite sanitation facilities; • Arrangement of solid waste collection and sanitary landfill;	Pourashava Health Section / NGO	Not determined	

Chapter - 9. WSP Review Procedure

Purpose of WSP review

It is essential to review Water Safety Planing activities periodically to ensure that WSP is up to date and continuous to be appropriate to the needs of the utility and by which it is possible to overcome any unavoidable circumstances. On the otherhand, it is necessary to review WSP if there are any changes in water supply management in terms of technical or improvement of water quality. In this regard, WSP Team should agree to meet regularly to review all aspects of the WSP.

Review Procedures & Elements

WSP Team will meet at least once in a year to review all aspects of water safety planning. It will be helpful for the review procedure to gather information or records from operational monitoring and verification monitoring. The progress of improvement action plan can also be discussed in the review meeting. Moreover the following issues can be consideration for discussion in the review meeting:

- Changes to membership of the WSP team and allocation of responsibility among team members
- Changes or modifies water supply management system in catchment, treatment or distribution
- Outcome of internal and external audit
- Staff changes in water supply section
- Keeping and archiving all types of documents and records and easily identifiable to the concern
- Direction of necessary action and responsibility of the concern during emergency

Upgradation process of WSP documents

The WSP document is subject to continuous improvement. As new knowledge or information becomes available about water supply, and as the system improves, the WSP is to be updated to reflect the changes. The WSP Document Controller is responsible for keeping an up to date version of the WSP and for circulation of the updated version to other WSP team members and interested parties.

Chapter - 10. WSP Related Activities – At a glance

Improvement Action Plan

Ref	Description of Activities	Responsibility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4.1	Protection and maintenance of PTW and pump house	EE & WS												
4.2	Protection of aquifer	WS												
4.3	Maintenance of pump house	EE & WS												
4.4	Renovation work of overhead tank	EE & WS												
4.5	Repair sluice valve chambers	WS												
4.6	Maximise duration and extent of pressurised system	EE, WS	NOT	DETER	MINEND									
4.7	Improve sanitary protection and water conservation through improved distribution system asset management	EE, WS	NOT	DETER	MINEND									
4.8	Distribution and service Pipeline cleaning activity	EE, WS												
4.9	Integrity and cleanliness of stand pipes	EE, WS												
4.10	Develop asset maintenance and calibration supporting program	EE, WS	NOT	DETER	MINEND									

Operational Monitoring

Ref	Monitoring Activities	Responsibility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.1	Land use and activities	Sanitary Insp												
5.2.1	Sanitary seal and casing of well head	Pump Op												
5.2.2	Leakage of sluice valve and cleanliness	Pump Op												
5.2.3	Status of air release valve and non-return valve	Pump Op												
5.2.4	Fencing & cleanliness around PT	Pump Op												
5.2.5	Presence of As, Fe, Mn, Cl & NO3 in PTW water sample	W Super												
5.3.1	Cleaning of pump house													
5.4.1	Status of wire mesh or netting	Plant Op												
5.4.2	Cleanliness of inside OHT	Plant Op												

Ref	Monitoring Activities	Responsibility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.5.1	Cleanliness of valve chamber	Lineman												
5.5.2	Condition of pipe and joints	Lineman												
5.5.3	Support of pipes at crossing	Lineman												
5.5.4	Pipeline washing & chlorination	Lineman												
5.5.5	Integrity of stand post	Mechanics												

Verification Monitoring

Ref	Description of Activities	Responsibility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6.1.1	Testing of TTC & E.Coli, sampling from consumer level in mini lab	Asst. Engineer (Water)												
6.1.2	Testing of TTC & E.Coli, sampling from consumer level in DPHE lab	Asst. Engineer (Water)												
6.2.1	Internal audit through sanitary inspection	Asst. Engineer (Water)												
6.2.2	Internal audit – Records of operational and WQ monitoring	Executive Engineer												
6.3.1	Testing TTC & EColi at DPHE lab	EE, DPHE												
6.3.2	Inspection of System & records	EE, DPHE												
6.4.1	Verify Consumer satisfaction	EE, Paura												

Annex - 1: Declaration of Management Commitment

Providing safe water to the citizen is one of the services of Chandpur Paurashava. For this, water is supplied to the citizen through pipeline and tarrif is taken from them. Since the water is considered as life saving product, hence the Paurashava authority is committed to ensure safe water service to the consumer.

Paurashava authority has taken an initiative to implement 'Water Safety Plan (WSP)' as recommended by World Health Organisation (WHO) for ensuring safe water service. Following WSP the supplied water is considered safe due to apply control measure (prevent) in each component of water supply system i.e. from source to consumer end. The Paurashava authority will publish the water quality report time to time to achive customer satisfaction about the service.

The Paurashava authority is ensuring the citizen that the supplied water is safe for drinking puropose.

Signature

Mayor

Chandpur Paurashava

Annex - 2: Sample of Monitoring & Corrective action log sheet

Following the next page:

Water Safety Plan (WSP) Monitoring Log Sheet, Chandpur Paurashava

Monitoring Date	Monitoring Point	Problem identified (Yes/No)	Description of identified problem	Necessary corrective measure	Name & Signature of Inspector	Date of notice to Asst. Engineer (Water)	Date of completion of corrective action	Signature who has taken corrective action	Signature of Asst. Engineer (Water)

Monitoring Point: 1) Production well 2) Pump & Pump house 3) Transmission Line 4) Overground Reservoir 5) Overhead Tank 6) Sluice Valve Chamber 7) Distribution/ Service Line 8) Stand Post

Log Sheet for Completion of Corrective Action, Chandpur Paurashava

Ref No:	
Monitoring Point:	
Identified problem	
Necessary Corrective Action	
Estimated Cost:	

Person		☐ **Monitoring Inspector**	☐ **Asst. Engineer (Water)**	☐ **Executive Engineer**	☐ **Mayor Paurashava**
Signature					
Date	Receive				
	Sent				
Activity / Decision / Comment					

Annex - 3: Sanitary Inspection Form

The following sanitary Inspection Forms have been attached in the following pages:

SI Form – 1: Well Field / Well Site
SI Form – 2: Pump House
SI Form – 3: Reservoir
SI Form – 4: Transmission & Distribution Mains
SI Form – 5: Valve Chamber / Washout Chamber
SI Form – 6: Stand Pipe / House Connections
SI Form – 7: Road, Drain & Ditch Crossing

Sanitary Inspection Form-1

Type of facility **WELL FIELD /WELL SITE**

1. General information: Area/Location:……..
2. Code number:…….
3. Date of visit:……..
4. Water samples taken? Y/N Sample No……..……

Specific diagnostic information for assessment

(**Please indicate at which sites the risk was identified**) **Risk Sample No.**

1. Is there any sanitary landfill/cesspool/ditch within 30m or zone of influence of well? Y/N
2. Is there any evidence of human faeces in vicinity of well field/site? Y/N
3. Are there animal faeces in the vicinity of the well field/site? Y/N
4. Is there any evidence of solid waste in the vicinity of the well field/site? Y/N
5. Is there any evidence of excessive algal growth in proximity of the well field/site? Y/N
6. Can stagnant or dirty water collect in well head chamber? Y/N
7. Is the well field/site unfenced or insecure? Y/N
8. Is not there a non-return valve with the transmission main? Y/N

Risk score: 7-8= Very High, 5-6 = High, 3-4 = Medium, 0-3 = Low

Results and recommendations

The following important points of risk were noted: (list Nos: 1-8)

Signature of PWSS Super/assistant:

Comments:

Sanitary Inspection Form- 2

Type of facility **PUMP HOUSE**

1. General information: Area/Location:……..

2. Code number:……..

3. Date of visit:……

4. Water samples taken? Y/N Sample No.

Specific diagnostic information for assessment

(Please indicate at which sites the risk was identified) **Risk Sample No.**

1. Is not the pump house provided with standby/alternative source of power? Y/N

2. Is any observable part of the inside of the pump house corroded or damaged? Y/N

(Including ladders, roof struts, walls)

3. Is there evidence of leakage/cracks in the pump house? Y/N

(Check the inside of the pump house to look for faults)

4. Can run-off form stagnant pools close to the pump house? Y/N

5. Can stagnant or dirty water collect inside pump house? Y/N

6. Is the pump house unfenced or insecure? Y/N

7. Is there evidence of faecal material surrounding the pump house? Y/N

8. Has the pump house not been cleaned within one month? Y/N

9. Is the valve in the powerhouse leaking? Y/N

10. Are the fuses by passed? Y/N

Risk score: 9-10 = Very High; 7-8 = High; 4-6 = Medium; 0-3 = Low

Results and recommendations

The following important points of risk were noted: (list Nos: 1-10)

Signature of PWSS Super/Inspector:

Comments:

Sanitary Inspection Form- 3

Type of facility **Treatment Plant**

1. General information: Area/Location:……..

2. Code number:……..

3. Date of visit:……

4. Water samples taken? Y/N Sample No.

Specific diagnostic information for assessment

(Please indicate at which sites the risk was identified) **Risk Sample No.**

1. Is there any free access of outside people in the treatment plant area? Y/N
2. Is there any situation observed for inadequate air circulation in the aeration chamber? Y/N
3. Is there any barrier not exist to protect free movement of birds in the plants? Y/N
4. Is there any bird faeces observed in the protected area of the treatment plant? Y/N
5. Does the aeration chamber find unhygienic? Y/N
6. Does the filter bed finds unhygienic or dirty? Y/N
7. Was clay ball or crack found in the filter? Y/N
8. Does the clear water reservoir of the treatment system find without cover and unprotected from insects? Y/N
9. Does the clear water reservoir of the treatment system find unhygienic or dirty? Y/N
10. Is there any possibility to reenter the waste water from the treatment plant into the filter bed? Y/N
11. Does the aeration chamber find inactive? Y/N
12. Was the updated information not recorded? Y/N

Risk score: 10-12 = Very High; 7-9 = High; 4-6 = Medium; 0-3 = Low

Results and recommendations
The following important points of risk were noted: (list Nos: 1-12)

Signature of PWSS Super/Inspector:
Comments:

Sanitary Inspection Form- 4

Type of facility **Chlorine Dosing system**

1. General information: Area/Location: ……..

2. Code number: ……..

3. Date of visit: ……

4. Water samples taken? Y/N Sample No.

Specific diagnostic information for assessment

(**Please indicate at which sites the risk was identified**) **Risk Sample No.**

1. Does any symptom observed for effectiveness of Bleaching Powder solution? Y/N

2 Is there any leakage in mixing tank? Y/N

3. does the condition of Mixing tank unhygienic ? Y/N

4. Does any chemical use which date is expired? Y/N

5. Is the used chemical manufactured from renowned company? Y/N

6. Is Cl concentration used sufficient for expected result? Y/N

7. Was any cross connection between Solution and treated water observed? Y/N

8. Is there any evidence for inadequate use of bleaching powder? Y/N

9. Is concentration of residual chlorine being monitored? Y/N

Risk score: 8-9= Very High, 6-7 = High, 3-5 = Medium, 0-2 = Low

Results and recommendations

The following important points of risk were noted: (list Nos: 1-9)

Signature of PWSS Super/assistant:

Comments:

Sanitary Inspection Form-5

Type of facility **RESERVOIR**

1. General information: Area/Location: ……..

2. Code number: ……..

3. Date of visit: ……

4. Water samples taken? Y/N Sample No.

Specific diagnostic information for assessment

(**Please indicate at which sites the risk was identified**) **Risk Sample No.**

1. Are vents of reservoir not covered? (Could vermin get into the reservoir) Y/N
2. Is the inspection cover or concrete around the cover corroded or damaged Y/N
3. Is the inspection cover not in place when inspected? Y/N
4. Is any observable part of the inside of the tank damaged or dirt? Y/N
5. Is there evidence of leakage/cracks in the reservoir? Y/N
6. Can rain water collect in the reservoir? Y/N
7. Can stagnant or dirty water collect in the reservoir? Y/N
8. Is the reservoir unfenced or insecure? Y/N
9. Is there evidence of faecal material surrounding the roof tank? Y/N
10. Has the tank not been cleaned within one month? Y/N
11. Does observe the presence of larvae or insects in the tank? Y/N

Risk score: 10-11= Very High, 7-9 = High, 4-6 = Medium, 0-3 = Low

Results and recommendations

The following important points of risk were noted: (list Nos: 1-11)

Signature of PWSS Super/assistant:

Comments:

Sanitary Inspection Form-6

Type of facility **TRANSMISSION MAINS/DISTRIBUTION MAINS/RETICULATION SYSTEM**

1. General information: Area/Location: ……..

2. Code number: ……..

3. Date of visit: ……

4. Water samples taken? Y/N Sample No.

Specific diagnostic information for assessment

(**Please indicate at which sites the risk was identified**) **Risk Sample No.**

1. Is there any evidence of leakage? Y/N
2. Is there any evidence of human faeces in vicinity of pipe? Y/N
3. Are there animal faeces in the vicinity of the pipe? Y/N
4. Does the primary main pass through stagnant water? Y/N
5. Is there any evidence of solid waste in the vicinity of the pipe? Y/N
6. Is there any evidence of excessive algal growth in proximity of the pipe? Y/N
7. Is there any evidence of a primary line crossing culvert? Y/N
8. Are there not any air valves connected to the elevated pipe? Y/N
9. Are there any exposed pipe or any portion of it? Y/N
10. Is the pipe line prone to flooding? Y/N
11. Is the supply through this main intermittent? Y/N

Risk score: 9-11= Very High, 6-8 = High, 3-5 = Medium, 0-3 = Low

Results and recommendations

The following important points of risk were noted: (list Nos: 1-11)

Signature of PWSS Super/assistant:

Comments:

Sanitary Inspection Form-7

Type of facility **VALVE CHAMBER/WASHOUT CHAMBER**

1. General information: Area/Location: ……..

2. Code number: ……..

3. Date of visit: …….

4. Water samples taken? Y/N Sample No.

Specific diagnostic information for assessment

(Please indicate at which sites the risk was identified)	**Risk Sample No.**
1. Is the valve not operational?	Y/N
2. Was the cover missing or kept away when visited?	Y/N
3. Is the valve box cover cracked/rusted?	Y/N
4. Is the valve corroded?	Y/N
5. Does the valve leak?	Y/N
6. Is there heap of solid waste around the valve chamber?	Y/N
7. Is there debris or faecal matter in the valve box?	Y/N
8. Is not the valve installed properly?	Y/N
9. Is there stagnant water in valve box?	Y/N
10. Are there evident standpipes connected to the valve?	Y/N

Risk score: 8-10 = Very High, 6-7 = High, 4-5 = Medium, 0-3 = Low

Results and recommendations

The following important points of risk were noted: (list Nos: 1-10)

Signature of inspectors/assistant:

Comments:

Sanitary Inspection Form-8

Type of facility **STAND PIPES /HOUSE CONNECTIONS**

1. General information: Area/Location: ……..

2. Code number: ……

3. Date of visit: ……..

4. Water samples taken? Y/N Sample No.

Specific diagnostic information for assessment

(Please indicate at which sites the risk was identified) **Risk Sample No.**

1. Does the standpipe/house connection leak? Y/N
2. Does surface water collect around the standpipe/house connection? Y/N
3. Is there animal faeces in the vicinity of the standpipe/house connection? Y/N
4. Are pipes exposed close to the standpipe/house connection? Y/N
5. Is human excreta on the ground within 10m of the standpipe/house connection? Y/N
6. Is the main pipe submerged in stagnant water? Y/N
7. Are there solid waste dumps 10m from the standpipe/house connection? Y/N
8. Are there stagnant pools of water close to the house connection pipe? Y/N
9. Does the house connection pipe pass through sewage/pit latrines/septic tank foul water bodies? Y/N
10. Does the house connection pipe cross a drain/ditch? Y/N

Risk score: 8-10 = Very High, 5-7 = High, 3-4 = Medium, 0-3 = Low

Results and recommendations

The following important points of risk were noted: (list Nos: 1-10)

Signature of health inspectors/assistant:

Comments:

Sanitary Inspection Form-9

Type of facility **ROAD, DRAIN AND DITCH CROSSINGS**

1. General information: Area/Location:. …….

2. Code number: ……

3. Date of visit: ……..

4. Water samples taken? Y/N Sample No.

Specific diagnostic information for assessment

(Please indicate at which sites the risk was identified) **Risk Sample No.**

1. Is there a valve box within 1m of road crossing? Y/N
2. Is the supply pipe exposed close to the road crossing? Y/N
3. Is there evidence of ingress into the pipe from stagnant water? Y/N
4. Is there evidence of cattle faeces in the area surrounding of the pipe? Y/N
5. Is there evidence of leakage around the pipe? Y/N
6. Does pipe cross open ditch/trench? Y/N
7. Is there evidence of faeces in trench/ditch? Y/N
8. Is there waste material around the pipe? Y/N
9. Is the pipe submerged in stagnant water? Y/N
10. Is the pipe damaged/cracked/leaking/pitted? Y/N

Risk score: 9-10 = Very High; 6-8 = High; 3-5 = Medium; 0-3 = Low

Results and recommendations

The following important points of risk were noted: (list Nos. 1-10)

Signature of PWSS Super/Assistant:

Comments:

Sanitary Inspection Form-10

Type of facility **UNDERGROUND HOUSEHOLD RESERVE TANK**

1. General information: Area/Location: …….

2. Code number: …….

3. Date of visit: …….

4. Water samples taken? Y/N Sample No.

Specific diagnostic information for assessment
(Please indicate at which sites the risk was identified) **Risk Sample No.**

1. Are vents not covered? (Could vermin get into the reservoir?) Y/N

2. Is the inspection cover or concrete around cover damaged or corroded? Y/N

3. Is the inspection cover not in place when inspected? Y/N

4. Is any observable part of the inside of the tank corroded or damaged? Y/N

5. Is there evidence of leakage/cracks in the reservoir? Y/N
(check the outside of the tank to look for faults)

6. Can run-off form stagnant pools close to the reservoir? Y/N

7. Can stagnant or dirty water collect in the reservoir? Y/N

8. Is the reservoir unfenced or insecure? Y/N

9. Is there evidence of faecal material surrounding the valve box? Y/N

10. Has the tank not been cleaned within one month? Y/N

11. Is there flow control valve in the reservoir? Y/N
12. is the area prone to flooding/ Y/N
Risk score: 10-12 = Very high; 7-9 = High; 4-6 = Medium; 0-3 = Low

Results and recommendations
The following important points of risk were noted: (list Nos: 1-12)

Signature of Inspector:

Annex - 4: WSP Related Message and Management System for Emergency

Water Supply Section. Chandpur Paurashava

Sl. No	Type of Emergency	Messages to be sent to Consumer	Measures to be taken	Responsible person	Types of methods to be used	Comments
01	Flood and Post flood period	• Don't defecate scatteredly • Purify water of flood affected tube well with bleaching powder • Repair latrines	• Supply of water purifying tablets • Rehabilitation of damaged pipe line • Supply of water through mobile tanker	• Asst. Engineer (Water) • Pipe line Mechanic • Staffs of Water Section	• Leaflet distribution • Awareness building through meeting • Miking	
02	Post Cyclone period	• Preservation of safe water • Repair affected latrines • Repair HTWs and stand pipe	• Formation of relief team and inspection of affected area • Supply of water purifying tablets and bleaching powers in the affected areas	• Officers and staffs of Water Section	• Community meeting • Awareness campaign	
03.	Electricity disturbance due to cyclone and flood	• Collect safe water from alternative source	• Supply of water in the affected areas through mobile tankers or other means	• Asst. Engineer (Water) • Staffs of Water Section	• Mobile water tanker • Miking • Community meeting	

Prepared by: Pourashava Water Supply Section, ChandpurPourashava, District: Chandpur

Annex - 5: Inventory of Assets of PWSS, Chandpur

List of assets of Paurashava PWSS

Name of Pourashava:	**Chandpur**			
Name of Asst. Engineer (Water):				
Location of PWSS:				
No. of Employees:				

Sl. No	**Asset**	**Quantity**			**Remarks**
		Unit	**Field**	**Office /Store**	
1	Maitanance Tools set	Set.			
2	Production TubeWells / Well Fields	No.			
3	Spare Sub -mersible pumps	No.			
4	Spare /Standby Motors	No.			
5	Other Spare parts (for PTWs):				
	A	No.			
	B	No.			
	C	No.			
	D	No.			
	E	No.			
6	Pump Houses	No.			
7	Rig Machine (if available)	No.			
8	Chain Pully (if available)	No.			
9	Tripod (if available)	No.			
10	Ditribution Pipe (maintanance purpose)				
	50mm	m			
	75mm	m			
	100mm	m			
	150mm	m			
	200mm	m			
	250mm	m			
	>250mm	m			
11	House connection (Spare parts)				
	a. MS Clamp of different dia	No.			
	b. GI Elbow	No.			
	c. Gate Valve of different dia	No.			
	d. Short Nipple	No.			
	e. Connecting Pipe	m			
12	Hand tube well (Pourashava,)	No.			
13	Other Assets (OHT)	No.			

14	Land for Pump Houses & OHTs	Decimal			

Piped Water Supply System
Chapainawabgonj Paurashava

Water Safety Plan

Version – 2

November 2014

Technical Assistance by
Participatory Management Initiative for Development (PMID)

Under the program of

Establishing model WSP using piped water supply system
WHO – AusAid Water Quality Partnership Program, Phase – 2
Department of Public Health Engineering (DPHE)

Table of Contents

Chapter - 1. Water Safety Plan Local Team

1.1 Commitment from Higher Authority

The top authority of Chapainawabgonj Paurashava is committed to engage the relevant staff inside and outside of Paurashava Council and to provide continuous support in relation to implement WSP. In this respect, a statement of such commitment of the top authority has been duly signed and circulated as a separate declaration. The statement will also be included in the citizen charter of the Paurashava. The declaration is attached in **(Annex- 1)**

1.2 WSP Team

The honorable Mayor of Chapainawabgonj Paurashava assembled the WSP team, having eleven members, for the first time through Paurashava Council meeting held in April 2011. In last Nov 2014 it was proposed to reform the team having multidisciplinary representatives, who can contribute an effective water safety planning for the Chapainawabgonj Paurashava water supply system. The proposed team compositions are presented in the Table 1.1.

Table 1.1 WSP Team Capture Proforma

Name	Affiliation / Job Title	Role in WSP team	Contact Information (Phone no.)
1. Alhaj Mowlana Abdul Matin	Mayor, Chapainawabgonj Pourashava	Chairman	
2 Mr. Sadequl Islam,	EE, Chaumuhani Paurashava	WSP Coordinator	01558323598
3. Md. Rokonuzzaman	Asst. Engineer (Water) Chapainawabgonj Paurashava	Member Secretary	
4. Md. Imran Hossain	Town Planner, Chapainawabgonj Paurashava,	Member	
5. Md. Abdul Barek	Councillor, Ward-6 Chapainawabgonj Paurashava,	Member	
6. Md. Shakhayet Hossain	Councillor, Ward-15 Chapainawabgonj Paurashava,	Member	
7. Most Moslema Begum	Councillor, Ward-1 Chapainawabgonj Paurashava,	Member	
8. Md. Shahnewaj Khan	Water Committee, Chapainawabgonj Paurashava	Member	
9. Md. Amirul Islam	Member TLCC, Chapainawabgonj Paurashava	Member	
10. Md.	Asst. Engineer (Water), DPHE, Chapainawabgonj	Member	

1.3 **Roles & Responsibility of the WSP team**

The WSP team will be responsible for developing, implementing and maintaining the WSP as a core part of their day-to-day roles. The team's responsibility is to define the scope of the water safety plan that will include which part of the water supply chain is involved and the general classes of hazards to be addressed. The team include people with authority to make any required changes as well as those with the technical ability to develop and supervise the implementation of WSP. Keeping a successful implementation of WSP the regular task of the Team can be outlined as follows:

1. Regular checking the progress on the Improvement Plan
2. Regular (e.g. quarterly) checking of Operational Monitoring
3. Regular checking of WSP application and its functional integrity
4. Annual report of progress and impact of the plan

The individual roles and responsibilities of the WSP Team members are described below:

Table 1.2: Roles & Responsibility of WSP team members

Team Members	**Roles & Responsibility**
Chairman	• Circulate duly signed commitment letter to implement WSP • Chair the regular meeting of the WSP team • Make decision or approve of the relevant issues of WSP • Confirmation of financial support to implement WSP • Distribute responsibilities among the team members related to WSP
Coordinator	• Help guide and direct the team through the preparation of the water safety plan and the assessment of the system. • In consultation with Chairperson, WSP Coordinator will organize planning meeting with the WSP Team • Give necessary direction to Asst. Engineer (Water) to implement WSP • Ensure that WSP is implemented in all aspect
Member Secretary	• Maintain communication with WSP coordinator & WSP Team members for implementation of WSP • Share the WSP related information with Coordinator and WSP Team members on a regular basis • Control all types of document related to WSP • Inspect the operational monitoring log sheet regularly • Ensure that water quality monitoring is carried out regularly • Verify the effectiveness of WSP implementation through Sanitary Inspection activities • Keep all types of records specially related to operational monitoring, staff training, improvement plan etc.
Member	• Carry out the tasks related to WSP, which assigned by Chairman & Conrdinator • Communicate with all stakeholders • Communicate with Surveillance committee • Assist to collect data related to user satisfaction • Take necessary step during emergency • Support in all aspect to ensure a successful WSP implementation

1.4 Engagement of Stakeholders

Department of Public Health Engineering (DPHE) is considered the main stakeholder of the Chapainawabgonj Paurashava piped water supply system. DPHE professionals have advisory roles to provide all sort of technical support to implement WSP. In addition, the Executive Engineer, DPHE Chapainawabgonj, will coordinate to communicate among different stakeholders and national surveillance committee.

Chapter - 2. Description of Chapainawabgonj Water Supply System

The documentation of this system description was prepared in Nov 2013 through physical observation, sanitary inspection, and household survey for initial data collection by the PWSS staff, DPHE and NGO representatives. Finally, a workshop was held in presence of PWSS staff, DPHE and NGO staff, which was facilitated by a consultant. In this current revision, the information has been revised through a consultation meeting with PWSS staff.
The current system of Chapainawabgonj Paurashava piped water supply is described in the following table 2.1. The flow chart of the existing system is shown in page 9.

2.1 Description of Water Supply System

<table>
<tr><th>Step</th><th colspan="4">Description</th></tr>
<tr><td rowspan="7">Source of water</td><td colspan="2">Present source</td><td colspan="2">Production well from groundwater</td></tr>
<tr><td colspan="2">Total No of production well (PW)</td><td colspan="2">32</td></tr>
<tr><td colspan="2">Working condition of PW at present</td><td colspan="2">14</td></tr>
<tr><td colspan="2">Average depth</td><td colspan="2">32 Meter (average)</td></tr>
<tr><td colspan="2">Aquifer</td><td colspan="2">Unconfined</td></tr>
<tr><td colspan="2">Abstraction process</td><td colspan="2">Sub mersible pump</td></tr>
<tr><td colspan="2">Water Demand Current
Future</td><td colspan="2">Not known</td></tr>
<tr><td rowspan="8">Source water quality (ground water)</td><td>Parameter</td><td>Report – 1*</td><td colspan="2">Water Quality Target for drinking water in Bangladesh</td></tr>
<tr><td>Arsenic (mg/L)</td><td></td><td colspan="2">< 0.050</td></tr>
<tr><td>Iron (mg/L)</td><td></td><td colspan="2">< 1.00</td></tr>
<tr><td>Manganese (mg/L)</td><td></td><td colspan="2">< 0.40</td></tr>
<tr><td>Fecal Coliform (cfu/100ml)</td><td></td><td colspan="2">0</td></tr>
<tr><td>Total Coliform (cfu/100ml)</td><td></td><td colspan="2">0</td></tr>
<tr><td colspan="4">*Ref of Report: Jhenidah Zonal Lab, DPHE Report 2013 under the implementation of WSP, 2013
Note: No written water quality data was found. The supply water contains significant amount of iron and consumers are not satisfied with the water quality. Sample of the tubewells were sent to DPHE lab and the test reports were shared verbally. It is necessary to document the water quality test results</td></tr>
<tr><td>Water Treatment Process</td><td colspan="4">The groundwater is abstracted from the production wells and directly supplied to the consumers without any treatment. No chlorination process is followed before water supply.
A new surface water treatment plant has been planned, which source water is Mahanada River. This will help to reduce the water quality problem related to groundwater in the piped water supply system.</td></tr>
<tr><td>Water supply system (existing)</td><td colspan="4">Ground water is abstracted by sub mersible pumps from 14 production tube wells (PTW) and supplied to the distribution network. There is one overhead tank (OHT) which is not currently used. The flow diagram of water supply system is shown in page 9.</td></tr>
<tr><td rowspan="2">Reservoir</td><td>Reservoir type</td><td>Total no</td><td>Usable no</td><td>Capacity</td></tr>
<tr><td>Over Head Tank (OHT)</td><td>1</td><td>0</td><td>Each 1000 m^3</td></tr>
</table>

<table>
<tr><th>Step</th><th>Description</th></tr>
<tr><td>Distribution Line</td><td>Length of distribution line : 117 Km
Size (Dia) : 100 to 200 mm
Materials : PVC
Total Sluice Valve : Not known
Active sluice valve : 41 nos
Total wash out : Not known
Active wash out : 12 nos
Water loss : Not known</td></tr>
<tr><td>Distribution time</td><td>Distribution per day : Twice in a day
Distribution time : average 14 hours / day</td></tr>
<tr><td>Water supply connection</td><td>Residential connection : 9215 nos
Commercial connection : 179 nos
Street hydrant : 450 nos</td></tr>
<tr><td>Intended consumer</td><td>Residential user : Citizens of Chapainawabgonj Paurashava
Commercial user : Consumer of hotel & restaurant, people working at office and institutions etc.
Street Hydrant : lower middle class people, slum people and floating people</td></tr>
<tr><td>Intended use</td><td>The distributed water is used for drinking, cooking, personal hygiene and household washing (point of entry) purposes.</td></tr>
<tr><td>Distributed Water quality</td><td>Water should meet safety and quality (aesthetic) standards i.e. the Health Based Target, which has been set by the government (HBT – WSF 2011)
<table>
<tr><th>Parameter</th><th>Unit</th><th>Target (standard)</th><th></th><th></th><th></th></tr>
<tr><td>Fecal Coliform</td><td>/100 ml</td><td>0</td><td></td><td></td><td></td></tr>
<tr><td>Total Coliform</td><td>NTU</td><td>< 5</td><td></td><td></td><td></td></tr>
<tr><td>Arsenic</td><td>mg / L</td><td>< 0.05</td><td></td><td></td><td></td></tr>
<tr><td>Iron</td><td>mg / L</td><td>0.3 - 1.0</td><td></td><td></td><td></td></tr>
<tr><td>Manganese</td><td>mg / L</td><td>< 0.4</td><td></td><td></td><td></td></tr>
<tr><td>Free residual chlorine</td><td>mg / L</td><td>0.2</td><td></td><td></td><td></td></tr>
</table>
*Ref. of Report:

Aesthetic requirements
• Taste not unpleasent
• Odorless</td></tr>
<tr><td>Sanitary Inspection Score</td><td>Reference to the Sanitary Inspection Report 2013, conducted by the NGO, under the WSP implementation program, the risk scores of different steps of water supply system are shown below.
<table>
<tr><th>Steps</th><th>Risk Score</th><th>Steps</th><th>Risk Score</th></tr>
<tr><td>Production well</td><td></td><td>Overhead Tank</td><td></td></tr>
<tr><td>Pump House</td><td></td><td>Distribution line</td><td></td></tr>
</table></td></tr>
<tr><td>Any special controls required?</td><td>1) Need cleaning of the distribution line at a regular interval
2) Introduce chlorination process</td></tr>
</table>

2.2 Persistent problem in paurashava pipe water supply system

The following persistent problem has been identified in the Chapainawabgonj water supply system

1) Dirty materials and stagnant waste water exist into the sluice valve chamber and the covers are almost broken

2) Due to presence of iron, hard scale has been deposited inside the pipeline and the flow of water become slow.

3) The pipelines do not clean for a long time because most of the wash-out points are under earth and cannot be identified.

4) The platforms of street hydrants are broken and there are no taps exitst.

2.3 Sanitation situation of Paurashava area

The baseline survey by the NGO shows that most of the households of Chapainawabgonj Paurashava have sanitary latrine with septic tank. Few household specially in slum area there are few unhygienic latrine. There are few public latrines in the Paurashava area. (will revise from baseline survey)

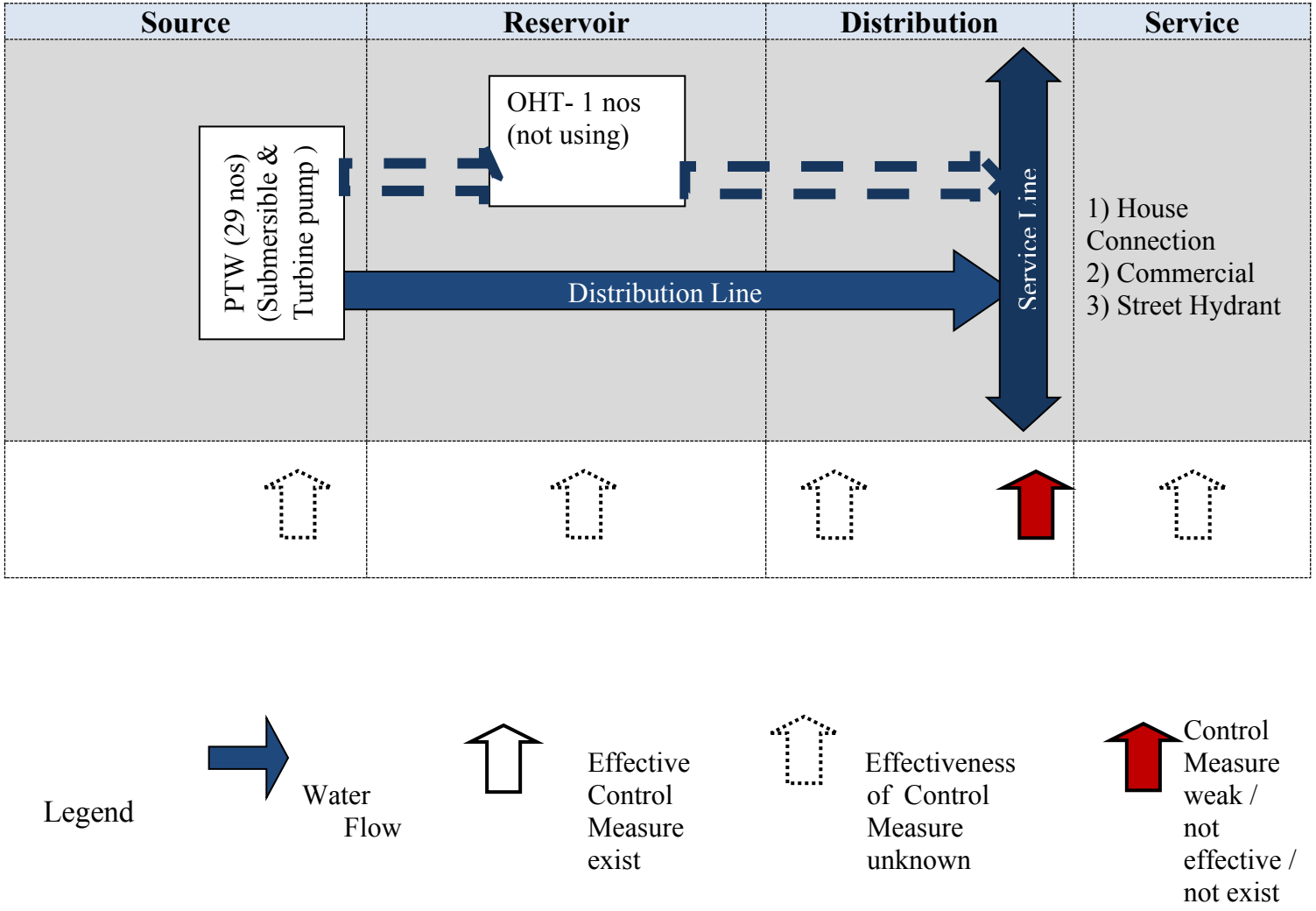
2.4 Consumers practice on water use

The consumers get water from the distribution system through house connections. In some households have underground reservoir whereas there are 30% households who store there water at roof tanks. Most of these tanks are not tidy. Few households collect water from tap stand. Usually water is collected from taps with a kolshi / bucket and transferred to another kolshi for storage in the kitchen area. Storage kolshis are generally kept above the floor but are not covered all the time. *(will revise from baseline survey)*

2.5 Flow diagram of Chapainawabgonjwater supply system

The flow diagram of existing water supply system is shown in the following page.

2.1: Flow diagram of Chapainawabgonj Paurashava PWSS



Chapter- 3. Hazardous event and risk analysis

The hazardous events were identified from different component of water supply system by the WSP Team with the assistance of expert consultant. The different steps of hazard analysis are described below:

3.1 Identify the hazards and hazard events

In this document, 'Hazard' is defined as the Physical, Microbial, Chemical & Radiological agents that cause harm to public health. The 'Hazardous Event' is defined as an event that introduces hazards to, or fails to remove them from, the water supply. The process of identification of hazards and hazard events involve:

1) Visual inspection of validated water supply components by together with PWSS staff, DPHE and NGO representatives
2) Sanitary inspection was carried out by the PWSS staff and NGO staff
3) Finally, a workshop was held in presence of PWSS staff, DPHE and NGO staff, which was facilitated by a consultant and the hazards and hazardous events were documented.

3.2 Assessment of risk

The risks associated with each hazard of various components are assessed by semi-quantitative risk matrix approach which includes:

a. Identify the likelihood (L) of the occurrence (e.g. certain, likely, possible, unlikely & rare) (Table 3.1)
b. Evaluate the severity (S) of consequences if the hazard occurred (e.g. Insignificant, minor, moderate, major & catastrophic) (Table 3.1)
c. Estimate risk score (R) by multiplying individual score of likelihood and severity (Equation 3.1) and
d. Rate of risks as High (>15), Medium (6-14) and Low (<5) (Table 3.2)

Table 3.1: Definition & score of Likelihood and Severity

Likelihood		Severity	
Rank (Score)	**Definition**	**Rank (Score)**	**Definition**
Almost Certain (5)	Once per day	Catastrophic (5)	Potentially lethal to a large Population
Likely (4)	Once per week	Major (4)	Potentially lethal to a small Population
Possible (3)	Once per month	Moderate (3)	Potentially harmful to a large population but no mortality
Unlikely (2)	Once per year	Minor (2)	Potentially harmful to a small population but no mortality
Rare (1)	Once every five years	Insignificant (1)	Negligible impact in terms of severity of disease or numbers of people affected

Estimation of Risk Score = Likelihood × Severity .....(3.1)

(Understand the likelihood & severity as per definition from Table 3.1 and find out the risk score from Table 3.2)

Table – 3.2: Risk Score & Ranking

		Severity				
		Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Likelihood	Almost certain (5)	5	10	15	20	25
	Likely (4)	4	8	12	16	20
	Possible (3)	3	6	9	12	15
	Unlikely (2)	2	4	6	8	10
	Rare (1)	1	2	3	4	5

Risk Rating		
Low (**L** ≤ 5)	Medium (**M** 06-14)	High (**H** ≥ 15)

3.3 Determine and validate control measures

Control measures are preventive actions for the hazardous events of water supply components that ensure the supplied water consistently meets water quality targets. These are systematic activities, which reduce the risks associated with the hazard events. The reduction in risk achieved by each control measure is an indication of its effectiveness, which can be validated through historical record, intensive program of monitoring or technical data from scientific literature. Finally the operational monitoring (Chapter-5) activities show that the validated control continues to work effectively and provide sufficient operating data to give it confidence that further validation monitoring is not required.

3.4 Reassess & prioritize the risks and new operational control

If the existing control is found ineffective or not sufficient for long time then the risk is recalculated in terms of likelihood and consequences taking into account the effectiveness of each control. Risks are prioritized in terms of their likely impact on the capacity of the system to deliver safe water. High priority risks may require upgrade / new operational control or system modification (improvement action plan) to achieve the water quality targets. Lower priority risks can often be minimized as part of routine good practice activities.

Table 3.3 shows the hazardous event and associated risks for different components of Chapainawabgonj Paurashava water supply system. The existing control system, reassess and prioritization of risks along with proposed new control are also described in the table.

Table 3.3: Hazard Events, Risk Prioritization and Control Measures of different process step of Chapainawabgonj Water Supply System

Ref No.	Steps	Hazardous Event	Hazard type	Risk without control L = likelihood S= severity R= Risk Score	Existing Control Measures / preventive action / barriers (Ref of OM plan in Chapter 4)	Risk with existing control L = likelihood S= severity R= Risk Score	Improvement Opportunity / New Operational Control) (Ref of OM plan in Chapter 5)	Improvement ActionPlan Ref. (Ch. 4)
3.1	Catchment around source	1 Increased pollutant loads due to collection of stagnant water in landfill or chemicals from agro-practice within 10 meter or zone of influence of well around the catchment	Microbial Chemical	L: 2 S: 4 R: 8 **Medium**	Production tubewell is placed at elevated level within 10 meter of stagnant swampy water	L: 2 S: 4 R: 8 **Medium**	Regular monitoring of land use & activities Ref 5.1.1	
		2. Presence of human and animal faeces in the vicinity of well site causes faecal contamination through subsurface leaching to the well water	Microbial	L: 2 S: 4 R: 8 **Medium**	Pump house is protected by boundary wall with fencing	L: 2 S: 4 R: 8 **Medium**	Inspection of catchment regularly No animal grazing allowed within 10m of well No open defecation allowed by community within 10m of well Ref: 5.1.1; Ref 5.2.4	Ref 4.1
3.2	Natural aquifer recharge/ storage	1. Not cleaning of inside the pump house regularly allows stagnant of dirty water which enter to the well through crakes develop in the floor slab of pump house	Microbial	L: 2 S: 4 R: 8 **Medium**	Well head raised above flood level Well head and joint sealed	L: 2 S: 4 R: 8 **Medium**	The well head casing should be placed and sealed properly Integrity of pump house near the PTW should be maintained Inside the pump house is to be cleaned regularly. Ref: 5.2.1 Ref: 5.3.1	Ref 4.2.1 Ref 4.3.1
		2. There are algae or flora grows on the surface of sluice valve due to leakage of gland pack	Microbial	L: 3 S: 3 R: 9 **High**	° Replace gland packing of sluice valve regularly ° No algae or flora present on the surface of the sluice valve Ref:5.2.2	L: 1 S: 3 R: 3 **Low**		

Table 3.3: Hazard Events, Risk Prioritization and Control Measures of different process step of Chapainawabgonj Water Supply System

Ref No.	Steps	Hazardous Event	Hazard type	Risk without control L = likelihood S= severity R= Risk Score	Existing Control Measures / preventive action / barriers (Ref of OM plan in Chapter 4)	Risk with existing control L = likelihood S= severity R= Risk Score	Improvement Opportunity / New Operational Control) (Ref of OM plan in Chapter 5)	Improvement ActionPlan Ref. (Ch. 4)
		3. Ingress of contaminated water into borehole from surface and shallow aquifer through the leakage of outside wall of production well pipes	Microbial	L: 4 S: 4 R: 16 **HIGH**	° Concrete block is built under the discharge head around the well head ° Well head was raised above the flood level ° Well head and joint were sealed upto 5 meter above ° Non return valve is effective ° The strainer of PTW is placed properly Ref:5.2.1; Ref:5.2.3	L: 1 S: 4 R: 4 **Low**		
		4. Presence of harmfull chemicals	Arsenic, Manganese Iron	L: 3 S: 4 R: 4 **High**	All water quality parameter of source are being monitored regularly ° Ref 5.2.5	L: 1 S: 4 R: 4 **Low**		
3.3	Pump house	Due to lacking of roof grating / plaster, the rain water is leached through the roof to inside of pump house, causes incident like electrocuting in the panel board	Physical	L: 2 S: 4 R: 8 **Medium**		L: 2 S: 4 R: 8 **Medium**	Ensure to repair the roof grating / plaster of pump houses Ref: 5.3.1	Ref 4.3.2

Table 3.3: Hazard Events, Risk Prioritization and Control Measures of different process step of Chapainawabgonj Water Supply System

Ref No.	Steps	Hazardous Event	Hazard type	Risk without control L = likelihood S= severity R= Risk Score	Existing Control Measures / preventive action / barriers (Ref of OM plan in Chapter 4)	Risk with existing control L = likelihood S= severity R= Risk Score	Improvement Opportunity / New Operational Control) (Ref of OM plan in Chapter 5)	Improvement ActionPlan Ref. (Ch. 4)
3.4	Overhead tank	Access of birds and small animals into the OHT through the ventilation chamber that placed underneath of the roof of OHT, leads to contaminate OHT water	Microbial	L: 5 S: 4 R: 20 **HIGH**	The chamber was covered by net / wiremesh but it was torned	L: 4 S: 4 R: 20 **HIGH**	Ensure firm and sustainable netting to protect the access of birds and animals inside the aeration chamber Ensure cleaning of inside portion of OHT Ref 5.4.1 Ref 5.4.2	Ref 4.4.1
		2. Stagnant water is observed into the transmission line chamber placed under the OHT which leads to contaminate the pipeline water	Microbial , Chemical	L: 3 S: 3 R: 9 **Medium**	The control measure is weak	L: 3 S: 3 R: 9 **Medium**	° Ensure that no water is stored into the transmission line chamber	Ref 4.4.2
3.7	Distribution and service line	1. The stagnant dirty water of sluice valve chamber enters into the pipeline through gland pack leakage of sluice valve during low pressure in the pipeline, which contaminate distributed water	Microbial	L: 4 S: 4 R: 16 **High**	° Installed the sluice valve by skilled plumber and followed standard procedure. ° gland packing of valve is changed time to time	L: 3 S: 3 R: 9 **Medium**	Ensure regular cleaning practice at sluice valve chamber Ensure the replacement or reparing of gland packing by skilled plumber Ref: 5.5.1	Ref 4.5 Ref 4.11
		2. Damage to pipeline due to exposed pipe that close to the road crossing leading to ingress of contaminated water into the pipeline	Microbial	L: 3 S: 2 R: 6 **Medium**	Pipeline is protected through securing with thrust block where necessary. Provided support and /or cover of GI pipe at all crossing. Ref: 5.5.3	L: 2 S: 2 R: 4 **Low**		

Table 3.3: Hazard Events, Risk Prioritization and Control Measures of different process step of Chapainawabgonj Water Supply System

Ref No.	Steps	Hazardous Event	Hazard type	Risk without control L = likelihood S= severity R= Risk Score	Existing Control Measures / preventive action / barriers (Ref of OM plan in Chapter 4)	Risk with existing control L = likelihood S= severity R= Risk Score	Improvement Opportunity / New Operational Control) (Ref of OM plan in Chapter 5)	Improvement ActionPlan Ref. (Ch. 4)
		3. Ingress of contaminated water in distribution due to pipe joint leakages and reduced pressure of inside pipeline	Microbial	L: 3 S: 4 R: 12 **Medium**	- Ensured pipe jointing through appropriate protocol during installation - Repair the pipe leak or joint leak promptly if noticed	L: 2 S: 3 R: 6 **Medium**	Ensure reparing the leak or crack promptly if noticed Regular inspection of pipeline Ensure through inspection to prohibit the direct pumping from the pipeline Use of quality materials during repair of disputed house connection, consumer awareness program etc. Ref: 5.5.2	Ref 4.6 Ref 4.7 Ref 4.10
		4. Iron from source water and dirt particulates from different sources are accumulated inside the pipe wall, leading to ingress contaminant into the water of service line	Microbial	L: 4 S: 4 R: 16 **HIGH**	Wash out valve and valve box were installed but now all are inactive and buried in the earth.	L: 3 S: 4 R: 12 **Medium**	- Activate all wash out valve - Regular cleaning of pipeline (once in a month) through chlorination process Ref: 5.5.4	Ref 4.8 Ref 4.11
		5. Ingress of contaminated water through leaking of service line at junction of riser / stand pipe due to the presence of stagnant water polluted by animal faeces	Microbial	L: 3 S: 3 R: 9 **Medium**	Leak is repaired promptly if noticed	L: 2 S: 3 R: 6 **Medium**	- All stand pipes of street hydrant or house connection should be fixed with RCC block and RCC platform - Bib cock (tap) need to be fitted for all stand pipes of street hydrants and house connection - Ensure the adequate drainage system around the platform Ref: 5.5.6	Ref 4.9 Ref 4.11

Chapter - 4. Improvement Action Plan

If Table 3.3 identifies significant risks to the safety of water and demonstrates that required existing controls are not effective or are absent, or the reassessment of respective hazardous events are under High or medium risk then an improvement opportunity or new operational control is proposed. Every High or unacceptable re-assessed risk needs some action to reduce the risk to an acceptable level, assuming that the improvement is effective.

Based on the proposed new control measure or improvement opportunity the timeline for implementing improvement action plans can be classified as follows:

1) Short term action plan – this type of improvement action plan can be implemented within maximum three months and a minimum budget is required to accomplish such activity, which is under control by the respective staff and does not need consent from top authority.
2) Medium term action plan – This type of action plan can be implemented within maximum six months for which a minimum amount of budget is required from the authority and the authority has ability to provide such amount. In this case the section chief or utility authority is sufficient to approve the budget.
3) Long term action plan – This type of action plan can be implemented within six month to two years, which required top authority approval and seeking of donor fund / loan.

Table 4.1 shows the proposed improvement action plan based on the hazard and risk analysis in Table 3.3 for different components of Chapainawabgonjwater supply system. Successful implementation of this action plan will ensure the utility to provide safe water to the consumer. The action plan also mention about the person who is responsible for the associated task and a tentative timeline.

Table – 4.1: Improvement Action Plan (Short to long term)

Ref:	Activities	Description	Responsibility	Time frame	Status
4.1	Protection and maintenance of production well and pump house	1. Build protected fence or boundary wall surrounding the PTW / pump house, where no security protection exists around the 10 meter distance of PTW.	Executive Engineer, Chapainawabgonj Paurashava Asst. Engineer (Water), Chapainawabgonj Paurashava	April 2015	Not started
4.2	Protection of aquifer	1. Place and seal the cover of well head casing for all PTWs to protect easy entrance of insects and small animals	Asst. Engineer (Water), Chapainawabgonj Paurashava	February 2015	Not started
4.3	Maintenance of pump house	1. Repair the cracking of floor and surrounding aproan of pump house promptly 2. Develop drainage system in and out side of pump house so that no stagnant water is observed inside the pump house or the surrounding the PTW. 3. Repair the grating / plaster of the roof of the pump house	Executive Engineer, Chapainawabgonj Paurashava Asst. Engineer (Water), Chapainawabgonj Paurashava	March 2015	Not started
4.4	Renovation work of overhead tank	1. Replace torn wire mesh of air flowing chamber by new wire mesh with firm and sustainable materials	Executive Engineer, Chapainawabgonj Paurashava	February 2015	Not started
		2. Sand filling at transmission line chamber at the underneath of OHT and transfer the sluice valve, flow meter, butterfly etc to the outside of the chamber	Asst. Engineer (Water), Chapainawabgonj Paurashava	February 2015	Not started

Table – 4.1: Improvement Action Plan (Short to long term)

Ref:	Activities	Description	Responsibility	Time frame	Status
4.5	Repair sluice valve chamber of distribution and service line	1. Remove the dirt materials from all the chambers and fill with coarse sand or gravel chips except the portion of spindle separated by small pipe with 6 inch diameter. Or improve a drainage system from the chamber so that no water is stagnant inside the chamber. 2. All slabs of sluice valve need to be replaced or repaired 3. Seal all the sluice valve chamber which are inactive and are not useful	Asst. Engineer (Water), Chapainawabgonj Paurashava	April 2015	Not started
4.6	Maximise duration and extent of pressurised system in distribution and service line	The more extensively and consistently positive hydraulic pressure can be maintained in the piped system, the lower the risk of backflow events of all kinds. Means for achieving these actions are as follows. • Increasing pumping hour • Increasing the period during which the overhead tank is pressuring the system • Change schedule of pumping to avoid power failure • Keep the distribution network with full of water pressure Moreover, the improvement action plan based on section 4.12 can be considered.	Executive Engineer, Chapainawabgonj Paurashava Asst. Engineer (Water), Chapainawabgonj Paurashava	Not determined (long term)	

Table – 4.1: Improvement Action Plan (Short to long term)

Ref:	Activities	Description	Responsibility	Time frame	Status
4.7	Improve sanitary protection and water conservation through improved distribution system asset management	Provide increased protection to distribution system by: • Improving jointing and sealing practices when making connections, replacements and extensions • Develop legal obligation on consumers to repair any defective service lines using standard materials	Executive Engineer, Chapainawabgonj Paurashava Asst. Engineer (Water), Chapainawabgonj Paurashava	Not determined (long term)	
4.8	Distribution and service Pipeline cleaning activity	Identify and activate all wash out valve and renovate the wash out chamber Introduce cleaning procedure of pipeline through chlorination process	Executive Engineer, Chapainawabgonj Paurashava Asst. Engineer (Water), Chapainawabgonj Paurashava	June 2015	Not started
4.9	Integrity and cleanliness of stand pipes	Renovate or rebuild RCC platform for all street hydrants and to hold the stand pipes with RCC block. Provide beep cocks for all stand pipes to protect wastage of water. Build a drainage system around the platform. Same integrity need to be applied for the household stand pipes and the conditions should be strictly followed	Executive Engineer, Chapainawabgonj Paurashava Asst. Engineer (Water), Chapainawabgonj Paurashava	June 2015	Not started

Table – 4.1: Improvement Action Plan (Short to long term)

Ref:	Activities	Description	Responsibility	Time frame	Status
4.10	Develop asset maintenance and calibration supporting program	Monitoring equipment and important system need to be maintained, cleaned and calibrated at programmed intervals to reduce the risk of asset failure. This schedule should cover the following assets : • Wellheads & non return valve • Pumps • Pipes and valves • Monitoring equipment	Executive Engineer, Chapainawabgonj Paurashava Asst. Engineer (Water), Chapainawabgonj Paurashava	Not determined (long term)	
4.11	Prepare distribution network map	The distribution network map will help to identify the location of sluice vulve chambers and wash out chambers within the distribution pipeline network. It is essential for tracking vulnerable points to be monitored as well as to locate the areas where persistent problem occurs	Asst. Engineer (Water), Chapainawabgonj Paurashava	March 2015	Not started

Chapter - 5. Operational Monitoring of Water Safety Plan

A systematic monitoring plan is needed to convey the authority that the control system or new control system for different components of water supply system that identified in table 3.3 are working properly. During monitoring if it is found that the control measure of a certain component exceeds beyond the control limit i.e. not working properly to prevent hazardous event, then the operational staff will take necessary and appropriate corrective action to mitigate the problem. The monitoring plan should also guides such corrective action plan corresponding to the control limit of respective monitoring indicators. Altogether this is mentioning here as Operational Monitoring Plan.

Table 5.1 shows the operational monitoring plan for Chapainawabgonj Paurashava Water Supply System in which the following issues are considered for the monitoring plan:

1) What will be monitored?
2) How it will be monitored?
3) Where it will be monitored?
4) Who monitores it?
5) When it is monitored?

Moreover, the critical control limit for each control system is defined in the table. Accordingly, the corrective action procedure is described in the plan if the control system fails to meet the critical control limit. The responsible staff for the monitoring activities will note the monitoring information using a log sheet as is mentioned in Annex-2.

In Table 3.3 a reference number is mentioned for operational monitoring against each existing or new control measure and the same sequence is followed to describe the overall monitoring plan in Table 5.1.

Table: 5.1: Operational Monitoring Plan

Ref. No	Component	Operational Control (Performance Indicator)	Monitoring of operational control		Control Limit	Corrective Action
5.1	Catchment area of source	1. Land use and activities near source	What	Land use and activities	- Control use of pesticides and fertilizer in cropping system near the source - No latrines, open defecation, animal pens, waste dumps within 10 meter of PTW	Move latrine, animal pens and dumping site from the critical areas. Aquaculture through naturally in the swamps
			How	Inspect source area		
			When	Once in a month		
			Where	Surrounding source		
			How	Sanitary Inspector		
5.2	Groundwater aquifer	1. Integrity of sanitary seal and the cover of PTW casing	What	Sanitary seal and casing of well head	- Sanitary seal around well head having 5 meter depth and 1 meter dia - cover should be sealed with casing of well head	- Repair sanitary seal as soon as possible any crack observed - Seal the cover if it is open or cracked
			How	Physical inspection		
			When	Once in a year in dry season		
			Where	All production wells		
			Who	Pump Operator		
		2. Integrity of sluice valve	What	Leakage of sluice valve and cleanliness	- no leakage of sluice valve - no sludge / algae on the surface of sluice valve	Change gland packing on a regular basis
			How	Inspection		
			When	Weekly		
			Where	Each production well site		
			Who	Pump Operator		
		3. Functionality of air release valve and non - return valve	What	Status of air release valve and non-return valve	- Air release valve should be functional and the spout of it should be cleaned - The non-return valve should be functional all the time	- As necessary, the air release valve is cleaned / repaired / replaced - Replace the non-return valve when it is found non-functional
			How	Physical inspection		
			When	Everyday during turn off of all pumps		
			Where	All production well		
			Who	Pump Operator		
		4. Integrity of protection of PTW	What	Fencing & cleanliness around PTW	- No space in the safety protection or fencing - Always clean the surrounding environment of the well site	- Repair or change the fencing system - Clean the surrounding environment as and when observe dirty
			How	Sanitary inspection		
			When	Once in a month at accessible point		
			Where	in each well site		
			Who	Pump Operator		
		5. Ground water quality	What	Presence of Arsenic, Iron, Manganese and nitrate in the water sample from PTW	Arsenic : < 0.05 mg/L Iron : < 1 mg/L Manganese : < 0.4 mg/L	If the test results are found greater than the acceptable limit then Improvement
			How	Chemical test using Test Kits		

Table: 5.1: Operational Monitoring Plan

Ref. No	Component	Operational Control (Performance Indicator)	Monitoring of operational control		Control Limit	Corrective Action
			When	Twice in a year (dry & wet season)	Nitrate : < 50 mg/L	action plan need to be taken, to be seeked alternate point source or a provision of treatment plant.
			Where	PWSS office		
			Who	Asst. Engineer (Water) (Water), Chapainawabgonj Paurashava		
5.3	Pump House	1. Cleanliness of pump house	What	Cleaning of pump house	No dirt materials in and outside of the pump house No stagnant water exists	Clean the waste and dirty promptly Detection of source of stagnant water and take remedial measure
			How	Inspection		
			When	Weekly		
			Where	Inside and surrounding environment of pump house		
			Who	Pump operator		
5.4	Overhead tank (OHT)	1. Integrity of air flowing cell	What	Status of wire mesh or netting	No torn wire mesh is present	If the torn wire mesh is observed then arrange protection system as early as possible and if possible, repair or change the wiremesh
			How	Inspection		
			When	Quarterly		
			Where	Over head tank		
			Who	Pipeline Mechanics		
		2. Environmental cleaning management	What	Cleanliness of inside OHT	- No dirt debris exist inside wall and bottom of OHT - No floating materials on the water surface of OHT	Clean dirt or debris observed then as soon as it is observed or increase the frequency of cleanliness.
			How	Inspection		
			When	Monthly		
			Where	Inside OHT		
			Who	Pipeline Mechanics		
5.5	Distribution and service line	1. Cleaning of sluice valve chamber	What	Cleanliness of valve chamber	- Valve chamber should be clear and free from debris or waster water - No cracking of inside wall or slab of the valve box to allow waste or dirt water inside the chamber	- Ensure that the slab is covered the valve chamber properly - Ensure regular cleaning of surrounding the chamber - Valve box filled with coarse sand
			How	Inspection of effectiveness		
			When	Once in a month in each valve		
			Where	Whole distribution system		
			Who	Pipeline Mechanics		
		2. Sanitary condition and	What	Condition of pipe and joints	No leaks in pipes or joints, no	- Repair leakage in pipes, at

Table: 5.1: Operational Monitoring Plan

Ref. No	Component	Operational Control (Performance Indicator)	Monitoring of operational control		Control Limit	Corrective Action
		integrity of pipes and joints	How	Effectiveness and sanitary inspection	missing coverings or fill earth around pipes or joints	joints, replace or covering the exposed pipe - Maintain quality of workmanship and materials and appropriate process
			When	Quarterly for accessible portions of system		
			Where	Throughout accessible distribution system		
			Who	Pipeline Mechanics		
		3. Structural integrity of crossing supports	What	Support of pipes at crossing	- Crosing pipe should not be exposed - Pipe support / cover must be in place	- Provide support to pipes - Use recommended support practice - Cover/bury the pipes using earth
			How	Inspection of structural integrity		
			When	Quarterly for accessible portions of system		
			Where	At all accessible crossings		
			Who	Pipeline Mechanics		
		4. Cleaning of distribution and service line	What	Pipeline washing & chlorination	No iron sludge or debris in wash out chamber & point	If any sludge observed at wash out point then increase washing frequency.
			How	Inspection of pipeline and records		
			When	Quarterly		
			Where	Wash out chambers		
			Who	Pipeline Mechanics		
		5. Distributed water quality	What	Presence of Iron and nitrate in the distributed water	Iron : < 1 mg/L Nitrate : < 50 mg/L	If the test results are found greater than the acceptable limit then pipeline cleaning activities need to be taken promptly.
			How	In situ test of min 3 samples per ward using Test Kits		
			When	Twice in a year (dry & wet season)		
			Where	In each ward		
			Who	Pipeline Mechanics		
		6. Integrity and maintenance of stand post (street hydrant / household connection)	What	Integrity of platform, RCC block, beep cock, drainage, leakage of pipes.	- All stand pipes must be fixed with RCC block & platform - Effective beep cock - Available drainage system - No leakage problem	- repair or solve problem as and when necessary - close all disputed street hydrant - In case of household connection, the criteria of integrity of standpost should be strictly mainatained.
			How	Physical inspection		
			When	Quarterly		
			Where	Sample basis Stand Post (street hydrant / household connection)		
			Who	Lineman / Mechanics		

Chapter - 6. Verification of the effectiveness of WSP

A verification procedure is needed to build evidence that overall system design and operation is capable of consistently delivering water of the specified quality to meet health-based targets. Table 6.1 shows such verification schedule for Chapainawabgonj Paurashava water supply system. It involves three following activities:

1) Delivered water quality monitoring – It indicates that the delivered water is safe
2) Internal and external auditing of WSP operational activities – It helps to assess the WSP activities and verify the status of proper implementation process
3) Consumer satisfaction – checking that consumers are satisfied with the supplied water

Table 6.1: Verification schedule

Activities	Description	Frequency	Responsibility	Record
6.1 Water quality monitoring of supplied water	1. At least 3 samples per Ward will be collected for testing thermotolerant coliform (TTC) & E.Coli at consumer level. The sample will be collected directly from service connection at household level. (Using Pota test kit at utility)	Once per month 27 samples per month	Asst. Engineer (Water), Chapainawabgonj Paurashava	Office of the Asst. Engineer (Water)
	2. At least one sample per Ward is collected for testing thermotolerant coliform & E.Coli at DPHE zonal lab Jhenidah. The sample will be collected and will be sent to DPHE lab under supervision of Asst. Engineer (Water).	Half yearly 9 samples	Asst. Engineer (Water), Chapainawabgonj Paurashava	Office of the Asst. Engineer (Water)
6.2 Internal Audit for WSP related actitvities	1) Sanitary inspection will be carried out by Asst. Engineer (Water) or by his representative in all components of water supply system to verify the effectiveness of WSP (Sanitary Inspection Form for all components are attached in Annex 3)	Quarterly	Asst. Engineer (Water), Chapainawabgonj Paurashava	Office of Asst. Engineer (Water)
	2) The records of operational monitoring and water quality monitoring will be audited / verified. This will ensure that the lineman, pump operator or the other responsible person do their respective duty as per operational monitoring plan and record the corrective action activities as and when necessary.	Half Yearly	Executive Engineer, Chapainawabgonj Paurashava	Office of Executive Engineer
6.3 External Audit for WSP related actitvities (Surveillance)	1) Under supervision of Executive Engineer, DPHE Chapainawabgonj, water sample will be collected and sent to DPHE zonal lab for testing of TTC & E, Coli 2) Inspect all components of water supply system, auditing of all types of records of operational monitoring and water quality monitoring 3) Prepare a report based on the information gathered	Yearly Min 9 samples to be tested	Executive Engineer, DPHE, Chapainawabgonj	Office of the EE, DPHE, Chapainawabgonjand copy to EE, Chapainawabgonj Paurashava
6.4 Verify consumer satisfaction	1) Consumer satisfaction survey about water quality and use through questionnaire. 2) Analyse the customer complains	Yearly	Executive Engineer, Chapainawabgonj Paurashava	Office of Executive Engineer

Chapter - 7. Management & Communication

7.1 Management Procedure of Water Safety Plan

It is essential to keep written documents for different steps of WSP related activities. On the other hand, all sort of records related to WSP activities need to be collected in a prescribed format or log sheet. Such written documents and keeping records in log sheets are part of management procedure that ensures the safe operation of WSP activities. Such management procedures can be divided into following three parts:

1) General Procedures
   All of the actions need to be documented to maintain, normal operating conditions for the production of safe drinking water. This includes procedures of all treatment processes, distribution system operations and maintenance of the system. These are called Standard Operating Procedure (SOP). Moreover, all types of records from different components need to be kept in the log sheets.
2) Procedures for corrective action
   Procedures are in place for incident situations (situations outside of normal operating conditions), describing corrective actions necessary to maintain safe water and protect consumers. All information related to the incident and associated corrective measure need to be recorded.
3) Procedures for emergency
   There should be management procedures setting out a communication plan to alert and inform consumers and other stakeholders when there is a problem with the safety of water supply

Control of Document and Records

All documents and records related to management procedures will be controlled by Asst. Engineer (Water) of PWSS section of Chapainawabgonj Paurashava. Asst. Engineer (Water) is responsible to circulate the necessary documents and records to the concern person in PWSS and WSP Team members. Table 7.1 shows the list of management procedures of Chapainawabgonj Paurashava PWSS section which already exist and which will be prepared.

Table 7.1: List of Management Procedures

Serial No	Management procedures	Controlled by and used by	Status of document preparation
1	Citizen Charter	Executive Engineer	Completed; Preserved in Utility
2	Water Safety Planning	Executive Engineer, Asst. Engineer (Water)	Draft; Version-2a, 2014
3	Protocol for protection of source and catchment	Executive Engineer, Asst. Engineer (Water)	Not completed
4	Protocol for maintenance of booster & turbine pump	Asst. Engineer (Water) & Pump Operator	Not completed
5	Cleaning procedure of overhead tank	Asst. Engineer (Water) & Pump Operator	Not completed
6	Cleaning procedure of distribution and servce line	Asst. Engineer (Water) & Line Mechanic	Not completed
7	Chlorination process in supplied water	Asst. Engineer (Water) & Line Mechanic	Not Completed

8	Operational Monitoring Log Sheet	Asst. Engineer (Water) & concern staff	Completed; Annex-2
9	Accomplishment Corrective Action Log Sheet	Asst. Engineer (Water) & concern staff	Completed; Annex-2
10	Sanitary Inspection Form	Asst. Engineer (Water) & concern staff	Completed; Annex-3
11	Customer Complain Register / Log Sheet	Asst. Engineer (Water) & concern staff	Completed, Preserved in Utility
12	Management Procedure for Emergency	Asst. Engineer (Water)	Completed; Annex-4
13	Asset management of PWSS	Asst. Engineer (Water)	Completed; Annex-5
14	Consumer satisfaction survey form	Asst. Engineer (Water) & concern staff	Not completed
15	Communication strategy relevant to water quality	Executive Engineer, Asst. Engineer (Water)	Descrived in sec 7.2 of WSP Document

7.2 Communication Procedure of Water Quality related information

It is essential to communicate water quality and safety related information to the consumer. The communication strategy is outlined in Table 7.2

Table 7.2: Communication strategy for water quality issues

Issue	Information	Media
procedures for promptly advising of any significant incidents with the drinking water supply	- To drink boiled water - To clean reservoir	- Through miking - Leaflet distribution
summary information to be made available to consumers	- Water quality of supplied water	- Annual Report - Internet - Notice Board
establishment of mechanisms to receive and actively address community complaints in a timely fashion	- Customer complain - Procedure of corrective action and notify to customer	- Customer complain register (log) book - Approval from customer prior to take corrective action

Chapter - 8. Supporting Programs

Supporting programs are the group of activities need to be carried out to supplement the outcome of WSP implementation. Supporting programs are enrolled under the Improvement Action Plan of the WSP. The supporting programs to be developed for ChapainawabgonjPourashava water supply system include:

- Consumers education supporting program;
- Operator training supporting program; and
- Environmental sanitation improvement program.

PWSS super is responsible for developing, coordinating and maintaining the Support Program. Consumer's education support program will be implemented by the local NGOs with involvement of local WSP team. The other programs are to be carried out by the PWSS and Chapainawabgonj Pourashava.

Activities	Description	Responsibility	Timeframe	Status
1. Develop Consumers education supporting program	Consumers' education is planned to explain how to safely collect, store and use water. This covers issues including: • Keeping storage tanks covered and cleaned • Raising storage tanks above flood level • Avoiding use of water from tanks if inundated until tanks have been drained and disinfected • Avoiding contaminating water in kolshis / pitcher with hands or other intrusions. • Preventing backflow of contaminated stored water into system though air gaps and non-return valves • Using only clean kolshis / pots / jars for storing and transporting water • Keeping insect and vermin out of kolshis / pots and water tanks • Preventing mosquito breeding in storage tanks • Using clean holder such as cups for drinking	NGO/Pourashava Health Section	Not determined	
2. Develop operator training supporting program	Training is required for technical staff and should cover at least the following water supply and sanitation aspects:	DPHE Local Office, Pourashava Asst. Engineer (Water)	Not determined	

	• Wellhead protection including external contaminates, flooding, and drainage • Critical source area for Wellhead and aquifer recharge area • Wellhead sanitary seal • Pump House Maintenance • Maintenance of IRP • Chlorine dosing system • Testing of water quality parameters i/c free chlorine levels in dosed water • Strength of bleaching powder • Bleaching powder storage and shelf life • Exclusion of vermin from tanks using meshing and lids • Valve box drainage and sand fill • Operation of sluice valve and gland packing of sluice valve • Reticulation system supports • Integrity of pipes and joints, fill and covering and crossing • Tap stand condition and drainage	in long-term		
3. Improve environmental sanitation through undertaking sanitation improvement program	The existing environmental sanitation condition of the town is a threat to ensure safe water and for overall improvement of the environmental sanitation the following activities are to be undertaken: • Educate people on better management of onsite sanitation facilities; • Arrangement of solid waste collection and sanitary landfill;	Pourashava Health Section / NGO	Not determined	

Chapter - 9. WSP Review Procedure

Purpose of WSP review

It is essential to review Water Safety Planing activities periodically to ensure that WSP is up to date and continuous to be appropriate to the needs of the utility and by which it is possible to overcome any unavoidable circumstances. On the otherhand, it is necessary to review WSP if there are any changes in water supply management in terms of technical or improvement of water quality. In this regard, WSP Team should agree to meet regularly to review all aspects of the WSP.

Review Procedures & Elements

WSP Team will meet at least once in a year to review all aspects of water safety planning. It will be helpful for the review procedure to gather information or records from operational monitoring and verification monitoring. The progress of improvement action plan can also be discussed in the review meeting. Moreover the following issues can be consideration for discussion in the review meeting:

- Changes to membership of the WSP team and allocation of responsibility among team members
- Changes or modifies water supply management system in catchment, treatment or distribution
- Outcome of internal and external audit
- Staff changes in water supply section
- Keeping and archiving all types of documents and records and easily identifiable to the concern
- Direction of necessary action and responsibility of the concern during emergency

Upgradation process of WSP documents

The WSP document is subject to continuous improvement. As new knowledge or information becomes available about water supply, and as the system improves, the WSP is to be updated to reflect the changes. The WSP Document Controller is responsible for keeping an up to date version of the WSP and for circulation of the updated version to other WSP team members and interested parties.

Chapter - 10. WSP Related Activities – At a glance

Improvement Action Plan

Ref	Description of Activities	Responsibility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4.1	Protection and maintenance of PTW and pump house	EE & WS												
4.2	Protection of aquifer	WS												
4.3	Maintenance of pump house	EE & WS												
4.4	Renovation work of overhead tank	EE & WS												
4.5	Repair sluice valve chambers	WS												
4.6	Maximise duration and extent of pressurised system	EE, WS	NOT	DETER	MIND									
4.7	Improve sanitary protection and water conservation through improved distribution system asset management	EE, WS	NOT	DETER	MIND									
4.8	Distribution and service Pipeline cleaning activity	EE, WS												
4.9	Integrity and cleanliness of stand pipes	EE, WS												
4.10	Develop asset maintenance and calibration supporting program	EE, WS	NOT	DETER	MIND									

Operational Monitoring

Ref	Monitoring Activities	Responsibility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.1	Land use and activities	Sanitary Insp												
5.2.1	Sanitary seal and casing of well head	Pump Op												
5.2.2	Leakage of sluice valve and cleanliness	Pump Op												
5.2.3	Status of air release valve and non-return valve	Pump Op												
5.2.4	Fencing & cleanliness around PT	Pump Op												
5.2.5	Presence of As, Fe, Mn, Cl & NO3 in PTW water sample	W Super												
5.3.1	Cleaning of pump house													
5.4.1	Status of wire mesh or netting	Plant Op												
5.4.2	Cleanliness of inside OHT	Plant Op												

Ref	Monitoring Activities	Responsibility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.5.1	Cleanliness of valve chamber	Lineman												
5.5.2	Condition of pipe and joints	Lineman												
5.5.3	Support of pipes at crossing	Lineman												
5.5.4	Pipeline washing & chlorination	Lineman												
5.5.5	Integrity of stand post	Mechanics												

Verification Monitoring

Ref	Description of Activities	Responsibility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6.1.1	Testing of TTC & E.Coli, sampling from consumer level in mini lab	Asst. Engineer (Water)												
6.1.2	Testing of TTC & E.Coli, sampling from consumer level in DPHE lab	Asst. Engineer (Water)												
6.2.1	Internal audit through sanitary inspection	Asst. Engineer (Water)												
6.2.2	Internal audit – Records of operational and WQ monitoring	Executive Engineer												
6.3.1	Testing TTC & EColi at DPHE lab	EE, DPHE												
6.3.2	Inspection of System & records	EE, DPHE												
6.4.1	Verify Consumer satisfaction	EE, Paura												

Annex - 1: Declaration of Management Commitment

Providing safe water to the citizen is one of the services of Chapainawabgonj Paurashava. For this, water is supplied to the citizen through pipeline and tarrif is taken from them. Since the water is considered as life saving product, hence the Paurashava authority is committed to ensure safe water service to the consumer.

Paurashava authority has taken an initiative to implement 'Water Safety Plan (WSP)' as recommended by World Health Organisation (WHO) for ensuring safe water service. Following WSP the supplied water is considered safe due to apply control measure (prevent) in each component of water supply system i.e. from source to consumer end. The Paurashava authority will publish the water quality report time to time to achive customer satisfaction about the service.

The Paurashava authority is ensuring the citizen that the supplied water is safe for drinking puropose without any treatment.

Signature

Mayor

Chapainawabgonj Paurashava

Annex - 2: Sample of Monitoring & Corrective action log sheet

Following the next page:

Water Safety Plan (WSP) Monitoring Log Sheet, Chapainawabgonj Paurashava

Monitoring Date	Monitoring Point	Problem identified (Yes/No)	Description of identified problem	Necessary corrective measure	Name & Signature of Inspector	Date of notice to Asst. Engineer (Water)	Date of completion of corrective action	Signature who has taken corrective action	Signature of Asst. Engineer (Water)

Monitoring Point: 1) Production well 2) Pump & Pump house 3) Transmission Line 4) Overground Reservoir 5) Overhead Tank 6) Sluice Valve Chamber 7) Distribution/ Service Line 8) Stand Post

Log Sheet for Completion of Corrective Action, Chapainawabgonj Paurashava

Ref No:	
Monitoring Point:	
Identified problem	
Necessary Corrective Action	
Estimated Cost:	

Person		☐ **Monitoring Inspector**	☐ **Asst. Engineer (Water)**	☐ **Executive Engineer**	☐ **Mayor Paurashava**
Signature					
Date	Receive				
	Sent				
Activity / Decision / Comment					

Annex - 3: Sanitary Inspection Form

The following sanitary Inspection Forms have been attached in the following pages:

SI Form – 1: Well Field / Well Site
SI Form – 2: Pump House
SI Form – 3: Reservoir
SI Form – 4: Transmission & Distribution Mains
SI Form – 5: Valve Chamber / Washout Chamber
SI Form – 6: Stand Pipe / House Connections
SI Form – 7: Road, Drain & Ditch Crossing

Sanitary Inspection Form-1

Type of facility **WELL FIELD /WELL SITE**

1. General information: Area/Location:……..
2. Code number:…….
3. Date of visit:……..
4. Water samples taken? Y/N Sample No……..……

Specific diagnostic information for assessment

(**Please indicate at which sites the risk was identified**) **Risk Sample No.**

1. Is there any sanitary landfill/cesspool/ditch within 30m or zone of influence of well? Y/N
2. Is there any evidence of human faeces in vicinity of well field/site? Y/N
3. Are there animal faeces in the vicinity of the well field/site? Y/N
4. Is there any evidence of solid waste in the vicinity of the well field/site? Y/N
5. Is there any evidence of excessive algal growth in proximity of the well field/site? Y/N
6. Can stagnant or dirty water collect in well head chamber? Y/N
7. Is the well field/site unfenced or insecure? Y/N
8. Is not there a non-return valve with the transmission main? Y/N

Risk score: 7-8= Very High, 5-6 = High, 3-4 = Medium, 0-3 = Low

Results and recommendations

The following important points of risk were noted: (list Nos: 1-8)

Signature of PWSS Super/assistant:

Comments:

Sanitary Inspection Form- 2

Type of facility **PUMP HOUSE**

1. General information: Area/Location:……..

2. Code number:……..

3. Date of visit:……

4. Water samples taken? Y/N Sample No.

Specific diagnostic information for assessment

(Please indicate at which sites the risk was identified) **Risk Sample No.**

1. Is not the pump house provided with standby/alternative source of power? Y/N

2. Is any observable part of the inside of the pump house corroded or damaged? Y/N

(Including ladders, roof struts, walls)

3. Is there evidence of leakage/cracks in the pump house? Y/N

(Check the inside of the pump house to look for faults)

4. Can run-off form stagnant pools close to the pump house? Y/N

5. Can stagnant or dirty water collect inside pump house? Y/N

6. Is the pump house unfenced or insecure? Y/N

7. Is there evidence of faecal material surrounding the pump house? Y/N

8. Has the pump house not been cleaned within one month? Y/N

9. Is the valve in the powerhouse leaking? Y/N

10. Are the fuses by passed? Y/N

Risk score: 9-10 = Very High; 7-8 = High; 4-6 = Medium; 0-3 = Low

Results and recommendations

The following important points of risk were noted: (list Nos: 1-10)

Signature of PWSS Super/Inspector:

Comments:

Sanitary Inspection Form-3

Type of facility **RESERVOIR**

1. General information: Area/Location: ……..

2. Code number: ……..

3. Date of visit: ……

4. Water samples taken? Y/N Sample No.

Specific diagnostic information for assessment

(**Please indicate at which sites the risk was identified**) **Risk Sample No.**

1. Are vents of reservoir not covered? (Could vermin get into the reservoir) Y/N
2. Is the inspection cover or concrete around the cover corroded or damaged Y/N
3. Is the inspection cover not in place when inspected? Y/N
4. Is any observable part of the inside of the tank damaged or dirt? Y/N
5. Is there evidence of leakage/cracks in the reservoir? Y/N
6. Can rain water collect in the reservoir? Y/N
7. Can stagnant or dirty water collect in the reservoir? Y/N
8. Is the reservoir unfenced or insecure? Y/N
9. Is there evidence of faecal material surrounding the roof tank? Y/N
10. Has the tank not been cleaned within one month? Y/N
11. Does observe the presence of larvae or insects in the tank? Y/N

Risk score: 10-11= Very High, 7-9 = High, 4-6 = Medium, 0-3 = Low

Results and recommendations

The following important points of risk were noted: (list Nos: 1-11)

Signature of PWSS Super/assistant:

Comments:

Sanitary Inspection Form-4

Type of facility **TRANSMISSION MAINS/DISTRIBUTION MAINS/RETICULATION SYSTEM**

1. General information: Area/Location: ……..

2. Code number: ……..

3. Date of visit: ……

4. Water samples taken? Y/N Sample No.

Specific diagnostic information for assessment

(**Please indicate at which sites the risk was identified**) **Risk Sample No.**

1. Is there any evidence of leakage? Y/N
2. Is there any evidence of human faeces in vicinity of pipe? Y/N
3. Are there animal faeces in the vicinity of the pipe? Y/N
4. Does the primary main pass through stagnant water? Y/N
5. Is there any evidence of solid waste in the vicinity of the pipe? Y/N
6. Is there any evidence of excessive algal growth in proximity of the pipe? Y/N
7. Is there any evidence of a primary line crossing culvert? Y/N
8. Are there not any air valves connected to the elevated pipe? Y/N
9. Are there any exposed pipe or any portion of it? Y/N
10. Is the pipe line prone to flooding? Y/N
11. Is the supply through this main intermittent? Y/N

Risk score: 9-11= Very High, 6-8 = High, 3-5 = Medium, 0-3 = Low

Results and recommendations

The following important points of risk were noted: (list Nos: 1-11)

Signature of PWSS Super/assistant:

Comments:

Sanitary Inspection Form-5

Type of facility **VALVE CHAMBER/WASHOUT CHAMBER**

1. General information: Area/Location: ……..

2. Code number: ……..

3. Date of visit: …….

4. Water samples taken? Y/N Sample No.

Specific diagnostic information for assessment

(Please indicate at which sites the risk was identified)	**Risk Sample No.**
1. Is the valve not operational?	Y/N
2. Was the cover missing or kept away when visited?	Y/N
3. Is the valve box cover cracked/rusted?	Y/N
4. Is the valve corroded?	Y/N
5. Does the valve leak?	Y/N
6. Is there heap of solid waste around the valve chamber?	Y/N
7. Is there debris or faecal matter in the valve box?	Y/N
8. Is not the valve installed properly?	Y/N
9. Is there stagnant water in valve box?	Y/N
10. Are there evident standpipes connected to the valve?	Y/N

Risk score: 8-10 = Very High, 6-7 = High, 4-5 = Medium, 0-3 = Low

Results and recommendations

The following important points of risk were noted: (list Nos: 1-10)

Signature of inspectors/assistant:

Comments:

Sanitary Inspection Form-6

Type of facility **STAND PIPES /HOUSE CONNECTIONS**

1. General information: Area/Location: ……..

2. Code number: ……

3. Date of visit: ……..

4. Water samples taken? Y/N Sample No.

Specific diagnostic information for assessment

(Please indicate at which sites the risk was identified) **Risk Sample No.**

1. Does the standpipe/house connection leak? Y/N

2. Does surface water collect around the standpipe/house connection? Y/N

3. Is there animal faeces in the vicinity of the standpipe/house connection? Y/N

4. Are pipes exposed close to the standpipe/house connection? Y/N

5. Is human excreta on the ground within 10m of the standpipe/house connection? Y/N

6. Is the main pipe submerged in stagnant water? Y/N

7. Are there solid waste dumps 10m from the standpipe/house connection? Y/N

8. Are there stagnant pools of water close to the house connection pipe? Y/N

9. Does the house connection pipe pass through sewage/pit latrines/septic tank foul water bodies? Y/N

10.Does the house connection pipe cross a drain/ditch? Y/N

Risk score: 8-10 = Very High, 5-7 = High, 3-4 = Medium, 0-3 = Low

Results and recommendations

The following important points of risk were noted: (list Nos: 1-10)

Signature of health inspectors/assistant:

Comments:

Sanitary Inspection Form-7

Type of facility **ROAD, DRAIN AND DITCH CROSSINGS**

1. General information: Area/Location:. …….

2. Code number: ……

3. Date of visit: ……..

4. Water samples taken? Y/N Sample No.

Specific diagnostic information for assessment

(Please indicate at which sites the risk was identified) **Risk Sample No.**

1. Is there a valve box within 1m of road crossing? Y/N
2. Is the supply pipe exposed close to the road crossing? Y/N
3. Is there evidence of ingress into the pipe from stagnant water? Y/N
4. Is there evidence of cattle faeces in the area surrounding of the pipe? Y/N
5. Is there evidence of leakage around the pipe? Y/N
6. Does pipe cross open ditch/trench? Y/N
7. Is there evidence of faeces in trench/ditch? Y/N
8. Is there waste material around the pipe? Y/N
9. Is the pipe submerged in stagnant water? Y/N
10. Is the pipe damaged/cracked/leaking/pitted? Y/N

Risk score: 9-10 = Very High; 6-8 = High; 3-5 = Medium; 0-3 = Low

Results and recommendations

The following important points of risk were noted: (list Nos. 1-10)

Signature of PWSS Super/Assistant:

Comments:

Sanitary Inspection Form-8

Type of facility **UNDERGROUND HOUSEHOLD RESERVE TANK**

1. General information: Area/Location: …….

2. Code number: …….

3. Date of visit: …….

4. Water samples taken? Y/N Sample No.

Specific diagnostic information for assessment
(Please indicate at which sites the risk was identified) **Risk Sample No.**

1. Are vents not covered? (Could vermin get into the reservoir?) Y/N

2. Is the inspection cover or concrete around cover damaged or corroded? Y/N

3. Is the inspection cover not in place when inspected? Y/N

4. Is any observable part of the inside of the tank corroded or damaged? Y/N

5. Is there evidence of leakage/cracks in the reservoir? Y/N
(check the outside of the tank to look for faults)

6. Can run-off form stagnant pools close to the reservoir? Y/N

7. Can stagnant or dirty water collect in the reservoir? Y/N

8. Is the reservoir unfenced or insecure? Y/N

9. Is there evidence of faecal material surrounding the valve box? Y/N

10. Has the tank not been cleaned within one month? Y/N

11. Is there flow control valve in the reservoir? Y/N
12. is the area prone to flooding/ Y/N
Risk score: 10-12 = Very high; 7-9 = High; 4-6 = Medium; 0-3 = Low

Results and recommendations
The following important points of risk were noted: (list Nos: 1-12)

Signature of Inspector:

Annex - 4: WSP Related Message and Management System for Emergency

Water Supply Section. Chapainawabgonj Paurashava

Sl. No	Type of Emergency	Messages to be sent to Consumer	Measures to be taken	Responsible person	Types of methods to be used	Comments
01	Flood and Post flood period	• Don't defecate scatteredly • Purify water of flood affected tube well with bleaching powder • Repair latrines	• Supply of water purifying tablets • Rehabilitation of damaged pipe line • Supply of water through mobile tanker	• Asst. Engineer (Water) • Pipe line Mechanic • Staffs of Water Section	• Leaflet distribution • Awareness building through meeting • Miking	
02	Post Cyclone period	• Preservation of safe water • Repair affected latrines • Repair HTWs and stand pipe	• Formation of relief team and inspection of affected area • Supply of water purifying tablets and bleaching powers in the affected areas	• Officers and staffs of Water Section	• Community meeting • Awareness campaign	
03.	Electricity disturbance due to cyclone and flood	• Collect safe water from alternative source	• Supply of water in the affected areas through mobile tankers or other means	• Asst. Engineer (Water) • Staffs of Water Section	• Mobile water tanker • Miking • Community meeting	

Prepared by: Pourashava Water Supply Section, ChapainawabgonjPourashava, District: Chapainawabgonj

Annex - 5: Inventory of Assets of PWSS, Chapainawabgonj

List of assets of Paurashava PWSS

Name of Pourashava:	**Chapainawabgonj**			
Name of Asst. Engineer (Water):	Md. Rokonuzzaman			
Location of PWSS:	Paurashava Bhaban			
No. of Employees:				
Sl. No	**Asset**	**Quantity**		**Remarks**
		Unit	**Field**	**Office/Store**
1	Maitanance Tools set	Set.		
2	Production TubeWells / Well Fields	No.		
3	Spare Sub -mersible pumps	No.		
4	Spare /Standby Motors	No.		
5	Other Spare parts (for PTWs):			
	a	No.		
	b	No.		
	c	No.		
	d	No.		
	e	No.		
6	Pump Houses	No.		
7	Rig Machine (if available)	No.		
8	Chain Pully (if available)	No.		
9	Tripod (if available)	No.		
10	Ditribution Pipe (maintanance purpose)			
	50mm	m		No Spare pipes for maintenance purpose
	75mm	m		
	100mm	m		
	150mm	m		
	200mm	m		
	250mm	m		
	>250mm	m		
11	House connection (Spare parts)			
	a. MS Clamp of different dia	No.		No Spare parts for house connection in PWSS store
	b. GI Elbow	No.		
	c. Gate Valve of different dia	No.		
	d. Short Nipple	No.		
	e. Connecting Pipe	m		
12	Hand tube well (Pourashava,)	No.		2500 nos -Shallow TW 50 nos.-Tara Pump
13	Other Assets (OHT)	No.		Capacity 1000 m^3

					each
14	Land for Pump Houses & OHTs	Decimal			