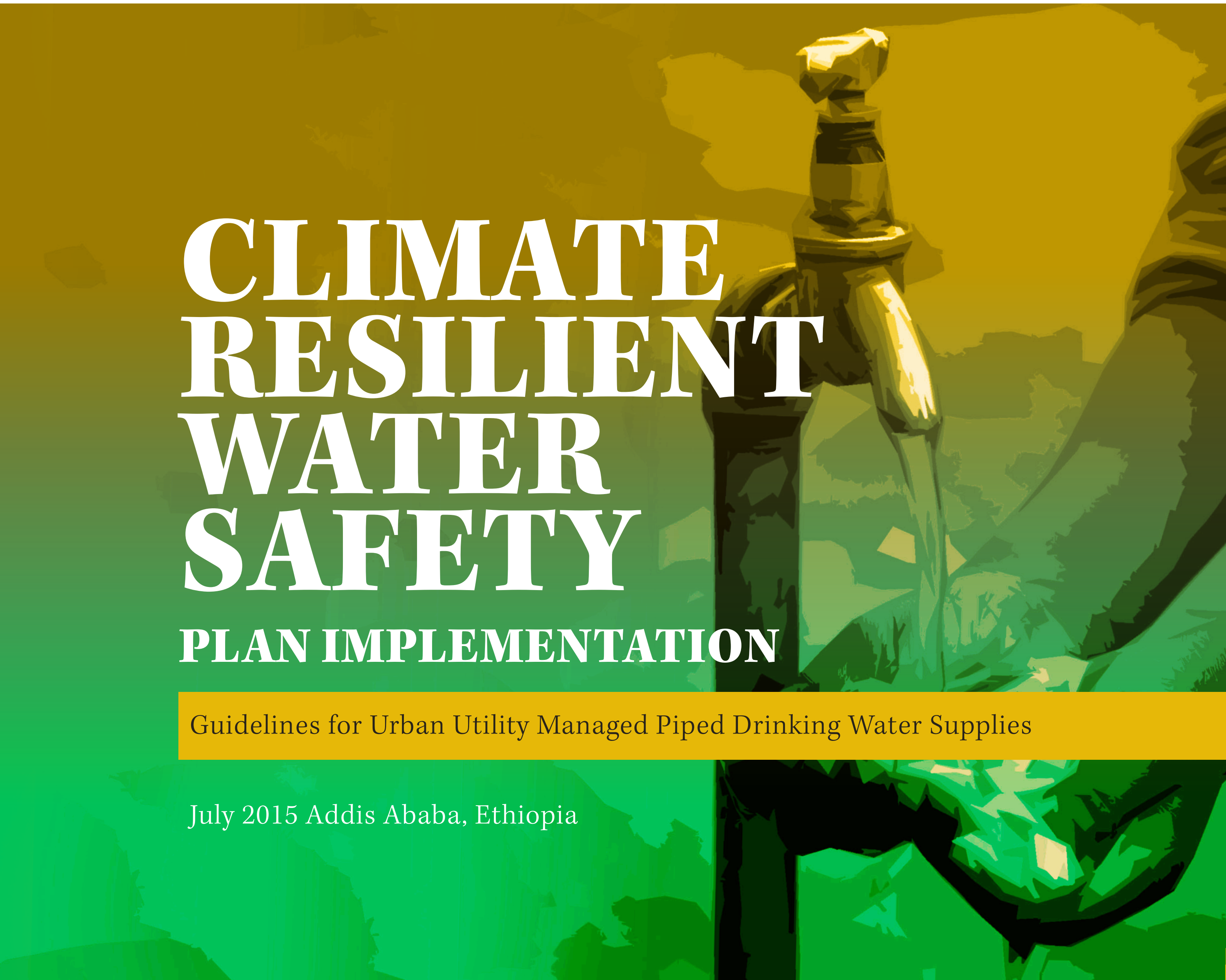
Federal Democratic Republic of Ethiopia
Ministry of Water, Irrigation and Energy



CLIMATE RESILIENT WATER SAFETY

PLAN IMPLEMENTATION

Guidelines for Urban Utility Managed Piped Drinking Water Supplies

July 2015 Addis Ababa, Ethiopia

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Foreword

The Federal Ministry of Water, Irrigation and Energy (FMoWIE) has been implementing the FDRE's water sector policy and water sector development to ensure access to sufficient water of adequate quantity and acceptable quality to satisfy basic human needs of Ethiopian citizens. Safe drinking water in adequate quantities is a prerequisite for health improvement to ensure wellbeing of the population and to sustain socioeconomic development of the country. To realize this demanding social service, the Ethiopian government took a number of actions following the water sector policy development such as National WASH inventory, development of ONE WASH Program, revision of the Universal Access Plan and revision of Drinking Water Quality Standard Specification for Microbiological and Physic-chemical quality, a number of capacity building activities, and institutional arrangement for rural and urban water supply and sanitation.

In urban setting supply of safe drinking water in adequate quantities and sanitation service to the consumers is the responsibility of the urban utilities management through governing board. Though urban water supply coverage is more than 90%, the implementation of National Drinking Water Quality Standard Specification was not given priority attention. Except end pipe testing, proactive systematic and comprehensive drinking water supply risk assessment and risk based management is lacking. Taking this fact into consideration, the Water Supply, Sanitation and Hygiene Sector in collaboration with development partners came up with Water Safety Plans as one of The 5th WASH Multi-stakeholders Forum which took place in 2012.

Thus, the purpose of this guidelines is to provide step-by-step guidance to the operators and managers of the large, medium and small urban water supplies with conventional water treatment systems on how to develop, implement, monitor, and review the water safety plans aimed at protecting human health. Furthermore, it serves as practical tool in identifying and addressing priority risks to the water quality and quantity, reliability and sustainability of the water supply system including risks related to current and future impacts of climate changes by taking into consideration available resources and capacities of the water supply system.

Therefore, it is believed that, this guidelines will serve in strengthening and improving the efficiency and effectiveness of urban utilities management service level quantity, quality, accessibility and reliability. Thus, while the Ministry of Water; Irrigation and Energy is fully committed in making sure this guidelines is used among the urban utilities in the country and urge the utilities management to make Water Safety Plans as part of the water supplies operation and management system for realization of service level including quantity, quality, accessibility and reliability as out lined in the revised Universal Access Plan (UAPII). Furthermore, the Ministry calls up on development partners and stakeholders collaboration and support in terms of availing resource for the utilities to make use of this guidelines for urban water supplies service improvement through risk assessment and risk-based management.

H. E Ato Kebede Gerba
State Minister of Water, Irrigation and Energy

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Acronyms

COC	Certification of Competence
CR-WSPs	Climate Resilient Water Safety Plans
EDHS	Ethiopia-Demographic and Health Survey
EPA	Environmental Protection Agency
ESA	Ethiopian Standard Authority
ETF	Emergency Task Force
FMoEF	Federal Ministry of Environment and Forest
FMoH	Federal Ministry of Health
GIP	Galvanized Iron Pipe
HDA	Health Development Army
HEW	Health Extension Workers
IWA	International Water Association
NAPA	National Adaptation Plan of Action
CESDWS	National Compulsory Standard Drinking Water Specification
NGO	Non Governmental Organization
NQSA	National Quality Standard Authority
NTU	Nephrometric Turbidity Unit
PHCU	Primary Health Care Unit
PLWHA	People Living With HIV/AIDS
FMHACA	Food Medicine, Health Care Control Agency
SOP	Standard Operation Manual
TVET	Technical, Vocational and Education Training
TWG	Technical Working Group
WASH	Water Supply, Sanitation and Hygiene Promotion
WCO	WASH Coordination Office
WHO	World Health Organization
WWT	Woreda WASH Team
DFID	Department for International Development
AfDB	African Development Bank
EU	European Union
UAP	Universal Access Plan

Operational definitions

A **hazard:** is a biological, chemical or physical agent that has the potential to cause harm.

A **hazardous event:** is an event or situation that can introduce a hazard to the water supply system.

A sanitary survey: is an on-site inspection of water supply to identify actual and potential sources of hazards such as physical structure, operation of the system, and external environmental factors, are being evaluated and select appropriate remedial actions to improve or protect the water supply

Climate resilient water safety plans: is an approach which is based on assessment of climate risks to the water supply systems and management through identification of activities to better understand climate risks, plan to address climate impacts and implement adaptation measures to reduce the consequences of climate change to the water supply system from catchment to the point of consumption taking into account service level including quantity, quality, reliability, cost and accessibility.

Climate: Climate is average weather and occurs over long time frames (e.g. 30 years)

Control measures: are activities or processes to prevent or reduce a hazardous event/hazard. The WSP process involves consideration of both existing control measures and new/proposed control measure (or improvements).

Critical limit: is cutoff point that signifies when a control measure has failed or is working ineffectively and therefore emergency action is required

Operational monitoring: Routine monitoring of control measures along the water supply chain to confirm ongoing effectiveness. Carried out by the water supplier and involves defining **critical limits** for relevant parameters and **corrective actions** to take when critical limits are breached.

Risk: is the likelihood that a hazardous event/hazard will occur combined with the severity of the consequences.

Validation: refers to reviewing evidence to determine whether or not the existing and planned control measures can effectively control the hazardous event/hazard. This must be done prior to risk assessment so that the risk assessment considers how well controlled the hazardous event/hazard is currently.

Verification: Monitoring to confirm the effectiveness of the WSP as a whole and involving three elements: 1) compliance monitoring (generally by health authorities to confirm final water compliance with drinking water quality standards); 2) consumer satisfaction survey; and, 3) internal/external WSP auditing.

Water safety plan (WSP): A comprehensive risk assessment and risk management approach that encompasses all steps in the water supply, from catchment to consumer

Weather: is what is happening in the atmosphere at any given time is considered "weather" (including e.g. wind speed and direction, precipitation, barometric pressure, temperature, and relative humidity

CHAPTER 1

INTRODUCTION

1.1 Background

The national water, sanitation and hygiene (WASH) strategies and programs witness the government of Ethiopia's commitments to increase its population's access to safe water and improved hygiene and sanitation; and, thereby to reduce burden of water-borne diseases. The 2013 national Compulsory Standard Drinking Water Specification also requires drinking water service providers to maintain the required microbiological and physicochemical quality (CESDWS 2013).

However, for the past decades, diseases attributable to consumption of unsafe water and poor sanitation and hygiene including diarrhea, intestinal parasitic infections, and protozoan infection remain among the ten top leading causes of morbidities in Ethiopia. Though access to improved sources of drinking water and sanitation increases every year, diarrhea remains the third leading causes of under-five child deaths in Ethiopia (WHO estimates 2004 – 2010) indicating presence of unmanaged risks. Demographic and health survey also confirms that, 80 percent of all incidences of diarrhea are due to unsafe water supply, poor sanitation and unsafe hygiene behaviors. Though child mortality rate shows significant reduction is observed over the last 15 years (EDHS 2000, 2006, 2011), there remains 17% of childhood deaths are associated with diarrhea (EDHS 2011).

Furthermore, in spite of efforts made to improve access to WASH services, the urban water supply services do not meet demands of the population and suffer from recurrent supply interruption due to various reasons including discrepancy between demand and supply (population pressure and rapid urban infrastructure development), system failure due to poor operation and maintenance and infrastructure damage by flooding (like Dire-Dawa Town, 2006) and as a result the users were obliged to revert to and rely on unsafe water sources such as unprotected wells, springs and water vendors. Most of the urban households usually collect water from public stand posts (public fountain) and store water at home to cope with water supply service interruptions where likelihood of re-contamination of water collected from tap/stand post is certain due to poor household storage practices. In urban settings, the public stand posts lack proper care and timely maintenance resulting in water wastage and contamination.

In addition, poor management of solid and liquid wastes together with rampant open defecation practices are a pressing problem in urban settings in Ethiopia exacerbating risks to water safety and public health hazards.

Within the past 10 years, various communities in different parts of the country have been affected by effects of climate variability such as flush and river flooding due to increased rain fall that posed damage to water supply infrastructures and caused gross contamination of drinking water sources which resulted in diarrheal disease outbreaks. There are also communities suffering from the effects of prolonged droughts due to evapo-transpiration, which result in lowering of ground water table, water shortage and drying of shallow water sources (shallow wells) and consequently people are forced to depend on unsafe water provided by water trucking (NAPA 2007).

To respond to the impacts of the climate change on water quantity and quality, as well as its impact on public health, the Federal Ministry of Water, Irrigation and Energy (FMoWIE) established WASH Emergency Taskforce (WASH ETF) that comprises sector ministries and partner organizations. Through this taskforce, the government monitors occurrence and distribution of water supply emergency situations, jointly discuss and develop preparedness and response plan, and take prompt actions when an emergency situation happens. Among other measures to improve quantity and quality; water rationing at household level through trucking and, distribution of point-of-use water treatment chemicals are to be mentioned

Safe drinking water in adequate quantities is a prerequisite for health improvement to ensure wellbeing of the population and to sustain socioeconomic development of the country. Therefore, to address the abovementioned public health hazards and associated challenges of the existing water supply services, it obviously claims for sustainable improvement of water supply. This can be achieved through implementation of the climate resilient water safety plan.

Supply of safe drinking water in adequate quantities to the consumers is the major responsibility of the urban utilities and its efficiency and effectiveness can be achieved through application of the water safety plans (WSPs). A WSP is a comprehensive risk assessment and risk management approach to identify and address priority issues that affect service delivery, which was introduced in the World health Organization's (WHO) Guidelines for Drinking Water Quality, 3rd edition (2004) and continued in the fourth edition (2011) being an effective strategy to ensure water safety from catchment to the point-of-consumption. Climate Resilient WSPs (CR-WSPs) ensure that priority risks to water quality and quantity associated with climate variability and change are identified and addressed through the WSP process. WSPs will identify appropriate adaptation options to address current and anticipated adverse effects on drinking water supply systems so as for them to become resilient to climate change.

The conventional practices of water quality management through end pipe testing are limited to occasional testing of samples of drinking water mainly from consumer taps or in response to incidence of outbreaks. Such practices are reactive and test results are available after too many people are affected and late for preventive action. In addition, it doesn`t include the whole water supply system namely continuity, quantity, users' concerns and sustainability. Therefore, it is high time for urban utilities to adapt the Water Safety Plans (WSPs) which are aimed at improving the water supply system through risk assessment and risk based management approach.

1.2 Scope of the WSP implementation guidelines for urban utilities

Water supplies face a wide range of risks caused by microbial pollution with pathogens typically of major relevance. Furthermore, pollution of raw water sources with agricultural chemicals and siltation of the reservoirs by runoff during rainy season, and enhancement of algal blooming due to increased temperature and eutrophication as well as capacity gaps with the utility to consistently supply safe water in adequate quantity to the population are identified to be the current and future climate change-related challenges to the utilities managed urban water supplies. However, existing WASH policies, regulations and strategies related to water quality and establishment of institutional arrangements are indications of the governments' awareness and commitment about the importance of ensuring the safety of the drinking water and mitigation of impacts of climate change on the sustainability of the water supply sources.

In addition, the IPCC report (2007) in central and east African countries indicates there will be an increased rate of rainfall approximately by 7%, and; consequently, there is a risk of flooding in these countries, including Ethiopia. Furthermore, evidences from different studies (WHO/DFID Vision 2030, NAPA 2007) remind WASH sector actors and the utilities to take proactive measures and to have readiness to respond to increased risk of extreme weather events (flood and drought) on the drinking water supplies. The anticipated effects of climate change on drinking-water supply in Ethiopia include the following:

- Changes in rainfall patterns (increase in some regions, decrease in others)
- Temperature increase leading to increase of algal blooms and eutrophication to surface water reservoirs and dams
- Increase in likelihood of occurrence of extreme weather events such as flood and drought
- Increase in likelihood of events such as fecal matter being washed into raw water sources in case of heavy rain and flood events, due to increased temperatures
- Extreme weather events may lead to increased contamination and decrease in available quantity of raw water

Therefore, increasing the resilience of the utility managed urban water supplies is important to proactively identify and manage risks posed by climate change through implementation of climate resilient WSPs (CR-WSPs). Implementation of the climate resilient water safety plans requires integration and coordination between government, partner organization and the community to effectively manage various risks to water supply system from catchment to point of consumption. Thus, the scope of this WSP implementation guidelines for urban utilities builds on the following two major elements:

1. Adapt the generic water safety plans for urban utilities to Ethiopian contexts;

2. Incorporate the risks posed by climate change on the water supply systems from catchment to point of consumption during development and implementation of the WSPs, leading to the approach of CR-WSPs

1.3 Objective of the WSP implementation guidelines

To provide step-by-step guidance to the operators and managers of the large, medium and small urban water supplies with conventional water treatment systems on how to develop, implement, monitor, and review the water safety plans aimed at protecting human health by identifying and addressing priority risks to the water quality and quantity, including risks related to current and future impacts of climate change. These guidelines are designed to serve as a practical tool to support WSP development and implementation while further considering and integrating the risks posed by climate variability and change and available resources and capacities.

2
CHAPTER

BASIC CONCEPTS AND STEPS OF WATER SAFETY PLAN

2.1 Basic Concepts of the WSP for urban utilities

Water Safety Plan (WSP) is a comprehensive risk assessment and risk management approach that encompasses all steps in the water supply system from catchment to point of consumption. The approach enables the operators and managers of the urban utilities and rural WASH boards to know the system thoroughly, identify where and how problems could arise, put multiple barriers and management systems in place to stop the problems before they happen and making all parts of the system work properly so as ensure safety of water intended for human consumption and other domestic uses as summarized in the following WHO safe water chain frameworks.

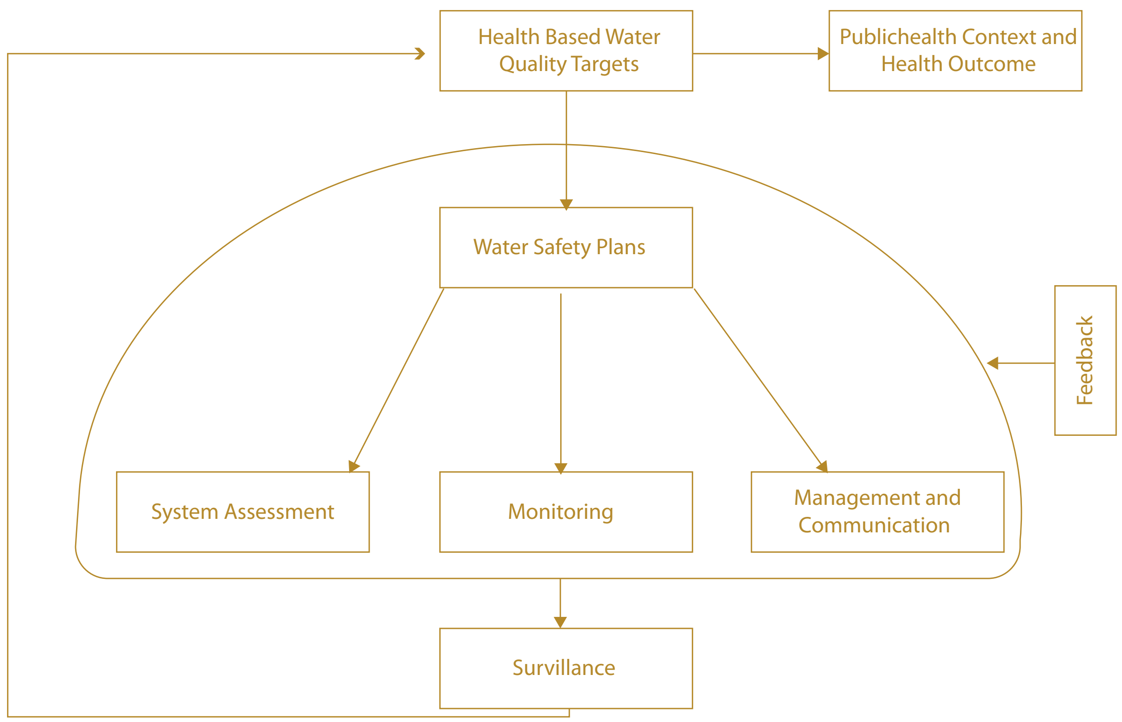


Fig 1: Safe water chain framework adapted from WHO GDWQ 4th edition, 2011

The safe water chain framework has five components important to ensure safety of the drinking water. Three out of the five key components will be planned and implemented by the supply agency (the utilities) and the remaining two components are responsibilities of the surveillance/regulatory agency (the health sector).

- Establishment of health based targets for microbial and chemical quality of water and assuring the safety of water through independent public health surveillance of water safety. Targets are set nationally based on evaluation of health concerns by the FMoH and proper operation of the system is confirmed by the surveillance /regulatory agencies namely: Federal Ministry of Health, Food, Medicine, Health care Administration and Control Agency (FMHACA) and National Quality Standard Authority (NQSA).
- A water supply system assessment to determine whether the safety of the drinking water is maintained from catchment to point of consumption; documentation of the system assessments; monitoring and further preparation of the management plans to address actions to be taken during regular operation and when incident conditions might occur so as to sustainably ensure supply and safety of drinking water in adequate quantity as per the national standards (20 L/person /day within 500 meter walking distance. These components of the framework are led by the supply agencies (operators and managers of the urban and rural piped water supplies).

2.2 Benefits of Water Safety Plan

As mentioned in the introduction section above, lack of safe drinking water is one of the factors contributing to diarrheal disease burden among under-five children in Ethiopia. Provision of safe drinking water has significant impact on reduction of under-five diarrheal disease prevalence. Water safety plan approach is a strong tool to ensure safety of water from source to point of consumption and to provide adequate quantity of safe drinking water to the population. In addition to protecting public health, added value of the water safety plan are stated as follows:

- Protect public health through improved water quality and thereby improved productivity
- Create clear understanding about water supply systems, asset management, and to predict future investment needs
- Improve organizational efficiency and performance of utilities
- Bring together wider range of expertise from different sectors and improve relationship and partnership between stakeholders
- Improve planning, risk identification and management as well as operation and maintenance capacity of the water supply operators
- Improve compliance with national drinking water quality standards

2.3 Major Stages and Steps to be followed to develop WSPs for utilities

Development of a WSP aims at preventing contamination and maintaining yield of the water sources, treating of water to eliminate or remove contaminants, and preventing recontamination of water in the reservoirs and distribution systems, during collection/fetching, transportation to and storage/use in the households so as to meet health based targets set by the health authority. To achieve intended results, the WSP development process passes through FIVE interdependent major stages. Under each stage there are different activities (steps) to be undertaken sequentially by involvement of suppliers, regulators and other internal and external stakeholders. The major five steps include (I) Preparation for WSP development, (II) System Assessment, (III) Monitoring, (IV) Management and communication, and (V) Feedback and improvement (Figure 2).

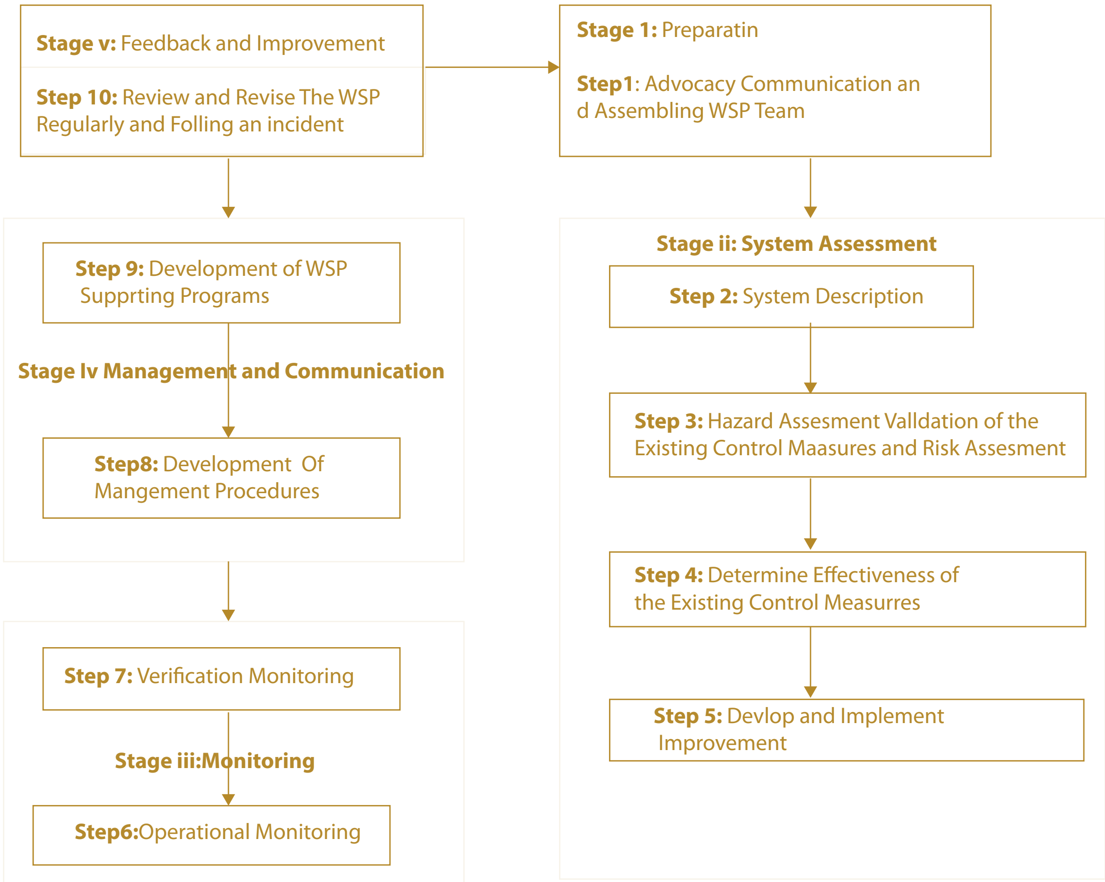
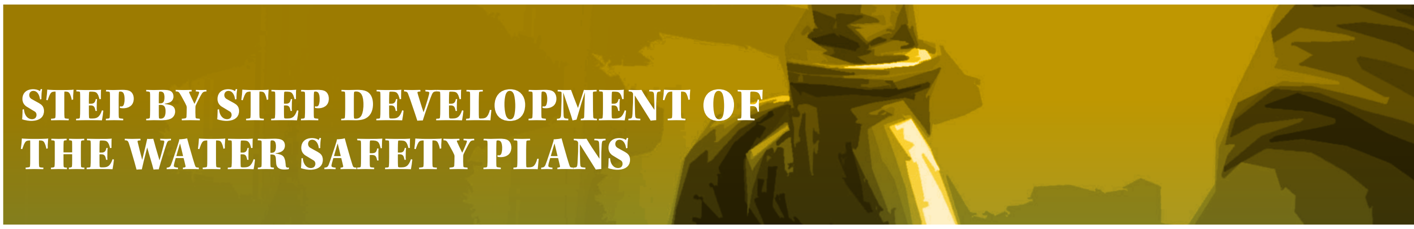


Fig 2: Water Safety Plan Steps (WHO 2004)

3 CHAPTER



STEP BY STEP DEVELOPMENT OF THE WATER SAFETY PLANS

Stage I: Preparation

Preparation phase of the WSP development include advocacy work to gain commitment of stakeholders and establishment of the WSP technical working group at national, regional, and woreda levels and WSP team at utility and Kebele levels.

Step 1: Advocacy, communication and assembling WSP team

1. Advocacy and awareness creation: contribution and support at the national, regional and district levels

Experiences of WSP implementation in different African countries have shown that (IWA 2011), government authorities play pivotal roles in making decision and advocating for WSP demonstration and at scale WSP implementation. Thus, endorsement of the national strategic frameworks, WSP implementation guidelines, and future revision of existing standards and regulations, structures and roles and responsibilities of operators, financial investment decisions, allocation of staff time for WSP development and implementation, leading community participation at all stages of WSP implementation (from catchment to point of consumption) and regular performance evaluation require the federal, regional and local governments' commitment and policy decisions.

Therefore, as part of the preparation phase, a consultative workshop/meeting with decision makers and operators (stakeholders involved in utility and community managed water supplies) and sensitization/training of sector professionals need to be organized to explore their level of understanding and perceptions about WSP approach, create awareness on the benefits of WSP approach over the existing water quality monitoring/testing practices, importance of WSP demonstration as well as on the impacts of climate change (past, current and future) on the water supply systems, to break possible stakeholders'/managers' resistance, and to gain political commitment and support before moving to start WSP implementation. In addition, to increase leadership engagement and support, leadership experience sharing visit between countries with best practices can be arranged (Table 1).

Table 1: Advocacy and awareness creation activities during the preparation phase

S. No	Activities	Target audience	Expected outputs	Responsible body
1	Awareness creation among decision makers and sector and utility senior professionals on the WSP concepts, approaches and its benefits, importance of WSP demonstration as well as on the impacts of climate change (past, current and future) on water supply systems to gain management and operational commitment.	• Federal level = Minister/state ministers/directors of water, health, regulatory/FMHACA-NWQSSA, watershed authority /agriculture /MoFEP/, Utility Managers; RWCO, major WASH sector donor and NGOs • Regional/zonal level = (the regional president, (Bureau of Water, Health and Watershed Authorities), utility managers and board chair person; RWCO and steering committee member offices , major WASH sector donor and NGOs • Woreda level = WWT, WWCO and steering committee member offices, town utility manager and board chair person, mayor and town administrator, urban and rural land development and management heads, NGOs	• Creation/establishment of clear understanding on the concepts and benefits of WSP and its linkage with the water resource and health policies among decision makers and senior professionals, and how climate change considerations can be included into the assessment so as to reduce risks • Gaining leaders acceptance of the approach and approval of implementation of WSP (both demonstration and scale up) • Policy support from federal and regional state down to the local governments (actions required to support WSP implementation at national and regional levels identified) with time frame to monitor water safety planning processes • Consensus reached on the importance of institutional arrangement at all levels and multi-agency cooperation to support WSP implementation. national, regional/zonal and woreda WSP implementation steering committees and technical working group established and technical support put in place • Sensitization of the operational staff on the WSP approach and its benefits is going on in the WASH sector actors and utilities through leaders and senior staff	FMoWIE, FMoH, WCO, WHO
2	WSPs training for Water and health sector staff responsible for promotion and regulation of the safety/ quality, quantity/risk of climate change to drinking water supply	• Operation and maintenance staff, treatment staff, health regulator and promoter and shed authority, WCO and NGOs • Climatologist/Hydrologists	• Clear understanding on the concepts, benefits and applicability of WSP established • Risks posed by climate variability and change to the water system clearly understood • Differences between existing practices and WSP, and environments in which utilities are operating (internal and external stakeholders interactions/influences on the utility) are clearly understood • Woreda level WSP implementation support team formed • The Utility WSP implementation team formed • Roles and responsibility of internal and external stakeholders' identified and agreed	FMoWIE, FMOH, WCO, WHO
3	Exposure visits to other countries with best practices	Federal ministers/state ministers/general directors and regional bureau heads/ core process owners of water, health, big utilities, forest and EPA sectors and WCO	• Clear understanding on how the strategy and the CR-WSP implementation is led by decision makers and their level of engagement in the process of WSP development and implementation, practical experiences gained /exposure on service improvement, etc • Leadership commitment increased and WSP development and WSP implementation facilitated in the regions	FMoWIE, FMOH, WHO and other interested partners

As part of the planning phase, it is important to enlist internal and external stakeholders likely to be involved and identify their level of involvement in the development, implementation and scaling up of WSPs at national, regional, district and utility levels. This process helps for prior identification of the specific roles to be played by the top management and the staff of water, health, regulatory, catchment authorities, and the utilities at all levels in general, and at WSP implementation levels in particular (Annex-4.1).

2. Form WSP technical Working group (TWG) and WSP teams

The National, regional and woreda level WSP technical working groups will be formed from WASH sector organizations mainly composed of water, health, utility, catchment authority, and core WASH partner donor/ UN agencies, NGOs and universities/Technical and Vocational Education Training (TVET) working at each level. This technical working group (TWG) provide technical advisory role to the National and regional steering committees (that comprises relevant directors in the federal ministry of water, health, environment, agriculture and meteorology agency, and representatives of Mega WASH sector partner organizations such as World Bank, WHO, UNICEF, AfDB, DFID and EU), and technical guidance to the WSP teams at training, development, and implementation monitoring and evaluation stages. Involvement of Universities/TVETs creates understanding of the WSP processes and insights to revise and include WSP into pre-service training courses.

As WSP development and implementation is led by the utilities, formation of the WSP team considers composition of utility managers, professionals from different expertise background on the water supply system design, water quality management, quality surveillance, operation and maintenance, watershed management, environmental health, program management, and with knowledge of the socioeconomic dynamics in the population. Therefore, the WSP team includes technicians, water supply engineer/surveyor, water/geo chemist, and socio-economist from the utility and public health laboratory technologist and environmental health from the surveillance agency, environmental protection professionals from the catchment authority. Drinking water sources vulnerability assessment is conducted at climatic zone level and all urban utilities within the same climatic zone use assessment finding to develop and implement water safety plans. In towns where meteorological stations exist, meteorologists are considered to be a member of WSP team. Whereas, WSP teams of other utilities located within the same climatic zone use local climate and weather information from their respective meteorological station.

Level of responsibility and involvement of the WSP team members could vary depending on the WSP development and implementation steps. Number and mix of team members during WSP step two (system assessment and hazard analysis) might require involvement of majority of the team members to establish baseline (benchmark), some of the team members during operational monitoring and management and communication, etc., and, therefore, the number of professionals to be involved will be determined on the size and complexity of the water supply systems, availability of the skilled professionals, and utility managers' decision and urgency to implement the water safety plan.

Table 2: Expected duties and professional categories for WSP team composition

S. No	Professional category	Expected duties of the team members	Remarks
1	Utility technical manager	Make decision and provision of resources (human, financial, and logistics)	Team leader
2	Water engineer/surveyor, technician (operation and maintenance)	Description and characterization of the water supply system layout mapping and technical assessment to water supply system assets from intake to distribution point such as breakage, type and size of materials, age, leakage and wastage rate, catchment delineation/determination, specification of materials for operation and maintenance, identify hazards and risk levels, priority control measures and corrective actions with timeframe and responsible body to implement the corrective action	Utility staff/team member
3	Socio-economist	Description of catchment population/users dynamics including density, number, growth, community concerns related to services of the utility, level of participation, service inclusiveness (need of people with disability and PLWHA, and the poor), system in place for communication and customer awareness to notify water safety/quality changes, on utility responsiveness and accountability), billing system, level of expansion of informal settlement, water demand, cost-benefit and vulnerability analysis to inform future water demand, and utility's financial sustainability, and users satisfaction surveys, etc. Take part in risk assessment process to incorporate customers' (users) perspectives and work on the consolidation of the whole WSP.	Utility staff
4	Water/geo chemist	Determine baseline level of the physicochemical and microbiological quality status of the water supply system from source to point of consumption, monitor critical quality parameter during implementation.	Utility staff
5	Environmental / public health	Characterizing the health status of the catchment population including prevalence of diarrhea among under-five children, problem of sanitation and hygiene services, identification of point and diffused sources of contamination (environmental and behavioral contamination risk assessment from catmint to point of use including HH water treatment and storage practices, use of alternate sources, perception about safety/quality of water collected from different sources, etc. identify hazards, risk levels, priority control measures, corrective actions with time frame and responsible body to implement the corrective action.	Health staff
6	Public health laboratory technologist	Being part of the regulatory/surveillance agency jointly work with water chemist and microbiologist of the utility on the establishment of the water quality baseline using the same method and technique, and periodically conduct quality assessment and verify or assure whether or not the supply system meet health based target indicators.	Health staff
7	Environmental protection	Characterize sources and types of pollution in the catchment of the water source due to various socio-economic activities (agriculture, industry, etc) and analyze potential hazards and risk levels, identify priority control measures, corrective actions with time frame and responsible body to implement the corrective action.	Forest or environment or agriculture staff
8	Meteorologist/Hydrologist (at national/regional levels, where MET stations exist, and also provide weather and climate information for WSP teams in the same climatic zone),	Conduction of a vulnerability and adaptation assessment (V&A) as part of the system assessment. The V&A assessment provides information on current and future vulnerability to the health risks of climate change (with a special focus on water-borne diseases) and of policies and programs that could increase resilience, taking into account the multiple determinants of climate-sensitive health outcomes. Hydrology modeling and climate modeling. Hydrology mapping. Regional forecasts of extreme weather events (e.g. droughts and floods).	NMA and water resource staff

Stage II: System Assessment

Step 2: System description

The main objective of the system description is to have a clear understanding and insight on the physical and operational component of the water supply, i.e., how the water supply system is designed and functioning from catchment to point of use. It is important to verbally describe the system comprehensively, and draw the layout map of water supply system that show location and type of the source (s), intake, treatment plant, reservoirs, distribution systems with primary, secondary and tertiary pipe networks, pump stations, valve boxes, public stand posts or household connections, etc. Similarly, the assessment should cover each component of the supply systems. In order to collect information required for this, as well as for the following steps, it is very valuable to go into the field and visually inspect the characteristics of the water supply as well as their condition.

Water source: The source of water supply systems could be surface water, dam (reservoir), deep borehole, gravity springs or composition of the two or three sources.

- Describe location and type of the water source (river, dam, and/or gravity fed spring) and catchment areas /watershed and if the source is ground water, number and location of abstraction points, depth of the well or abstraction point, flow rate, depth of casing with schematic diagrams /layout map;
- Describe the impacts of the extreme weather events on the source water quality and quantity such as reduced flow rate due to decreased precipitation and evaporation during hot dry seasons, and siltation/ sedimentation due to runoff during rainy season. The WSPs team uses information from the climatic zone assessment report;
- State the nature of the land and its use, including anticipated development in the future, such as economic activities in the catchment including agriculture, animal husbandry/raring, mining, informal settlement, waste disposal, etc.
- Identify different types of existing water uses and planned activities such as irrigation schemes, hydro-electric development, etc., in the water source catchment areas that might introduce microbiological and chemical hazards such as use of agricultural chemicals, reduction in water source recharge (quantity). On the other hand, an ongoing soil and water conservation activities in the water shed/catchment areas contributes to increasing water source recharge and consequently increase water quantity. Thus, WSPs team will cross check and advocate with natural resource management and agriculture sector for necessary action;
- Describe changes of the water source discharge rate (yield) during design phase versus current rate and reliability/adequacy of the source taking population growth rate (water demand) into consideration.
- Figure out water source quality and characterization of types and loads of pollution/contaminants due to different types of the socio-economic development activities in the catchment areas;
- Describe the kinds of source contaminants (e.g. wastes from different sources in the catchment areas) including organic, inorganic, and/or chemical wastes;
- Identify the existing physical, microbiological and chemical qualities of the water and how quality is seasonally affected due to extreme weather events;
- Find out the prevailing affirmative action such as soil and water conservation interventions;
- State the condition of the wellhead works, possible intrusion of surface water such lake, river or runoff, and any physical condition that affect water quality.

Treatment processes: the treatment system depends on the type and extent of source contamination. The conventional water treatment system commonly used for surface water includes sedimentation, coagulation/ flocculation, filtration, and disinfection before distribution. Therefore,

- Description of type and number of treatment units (including availability of backup units) with schematic diagram (layout map);
- Details of the treatment plant including how it is operates and contamination removal capacity of each treatment unit, age and current operational status of the treatment plant compared to its initial design;
- Details of each treatment processes and type of contaminants the treatment works are designed to remove;
- Description of how treatments processes are controlled, and details of standards on how to decide the treatment processes are properly functioning;
- Description of the kind of disinfectant used, disinfection contact time and concentration of the disinfection residuals;
- Details of the kinds of other treatment chemicals used;
- Sketch of the kinds of operational controls to verify efficiency of overall treatment works;
- Description of the hazards identified during assessment of catchment (source) that cannot be removed by existing treatment processes;
- Details of the effects of the extreme weather events on the water treatment processes such as algal blooming due to high temperature, and burden on the water treatment works as a result of siltation and sedimentation due to runoff entrance and future susceptibility of the treatment plant to extreme weather events;
- Description of the frequency of treatment process interruption and reasons such as power failure, raw water characteristic, shortage of treatment chemicals, and problems related treatment work, etc.;
- Details of maintenance of equipment and spare parts management;
- Explanation of the status of the technical knowledge and skills of the operation and maintenance workers (operators); and,
- Details of availability of the standard operating procedures (working manuals) and equipments, etc

Storage/service reservoirs: there are conditions where treatment plant is installed far away from the raw water intake (source of water) and water transported to the treatment plant either by gravity or pumping, and treated water is pumped to main service reservoirs or supply reservoirs located at high altitude and then water is conveyed to the distribution system to the users by gravity systems. Depending on the settlement and number of users, water demand, number of reservoirs with variable capacity are constructed.

Therefore,

- Describe number, capacity (volume), location (site), service age, condition, design and structure of the reservoirs, materials used, and their position of inlet and outlet valves, overflows, manhole cover, shape of top cover slab, vent pipe, etc.;
- State presence of protection from human and animal access such as cattle, birds, rodents, etc.;
- Describe type and size, age, and condition of pipe materials used to convey water from treatment plant to storage/service reservoirs (such as GIP, uPVC, DCI, etc);
- Present range of pressure and retention time;
- Discuss frequency of bursts of raising mains, and growth of microorganisms such as iron bacteria, corrosion, etc. Details of cleaning and maintenance of storage reservoir(s);
- Check for possible entrance of contaminated water through the basement /wall / top of the reservoirs, including vents, or during no pressure in a network (check for any structural defects);
- Check for possible entrance of contaminants during repair of the reservoir and distribution networks (during pipe maintenance, reservoir cleaning, etc.);
- Check for silt deposits at bottom and wall of the reservoirs as well as Algal and/or iron bacteria growth in

the reservoirs and in the distribution systems;
- Check for collection of water over the cover slab, cracks, air vent pipe open due to wire mesh damage, no fencing, birds droppings and nests, uncovered inspection man-holes, uncovered outlet pipe/valve boxes, etc conditions that increase chance of contamination treated water in the reservoir;
- Check for illegal connections, etc.;
- From the viewpoints of reducing effects of the climate change, assessing the energy sources of the water pumps is crucial to discourage green house gas emission through use of alternate low energy source like solar system.

Distribution systems: Compared to description of the sources, treatment process and the storage reservoir, understanding and description of the distribution system network is more complex. Description and analysis of the distribution system is more difficult where the water supply system history is poorly documented and data is not available. In such conditions, involvement of the operation and maintenance workers is important to get information on undocumented system layout and networks. Furthermore, categorizing areas of the town/population that get supply from a particular supply reservoir and distribution pipe grid system is important. Such mapping helps analysis of associated hazards and risks to the population living in that specific area.

In particular, distribution system description and analysis requires:

- Description of the system flow, type, age, length, size of the materials used (pipe and accessories);
- Discussion of the condition of network such as frequency of bursts of raising mains, and growth of micro-organisms in the distribution system such as iron bacteria, corrosion, etc.;
- Description of the number and location of household connections, as well as public fountain present in the distribution system, and how they are operated;
- Description of the location where pipe laid and valves are sited like points where pipe crosses the flood drainage ditches, sewer lines, ponds, etc.
- Checking for back flow of contaminated water from consumer's premises during period of supply interruption (back siphonage)
- Checking for illegal connections, etc.;
- Identification of areas where frequent leakage, breakage and supply interruption occur (information/data can be obtained from operation and maintenance workers)

In summary, distribution system description and analysis primarily relies on review of the secondary data (system design) and information from operation workers to update the network system map and identify possible/probable areas of problem and associated risks.

Collection and household storage (point of consumption): as a rule of thumb, utilities take responsibility to ensure water safety until water meter and/or the public stand post (public fountain). After the water meter/public fountain, responsibility to maintain safety of the water falls under the jurisdiction of the household (customer/user). However, there exists potential hazards and contamination risks either from water collection and storage container and/or the water handler her/him self during transportation and storage in the household. Information on hygiene and sanitation behavioral risk factors (hazard events) during water fetching, transportation and household safe water storage practices; hand washing and defecation practices are collected using observation checklists, which is complementary to sanitary survey of water supply systems. Therefore,

- Describe type, size, age and condition of pipes, type, size, age and condition of the storage/service reservoirs, and any informal connections before the water meter, and water uses;
- Describe type, size, age and condition of storage reservoirs at the household level;
- Describe type, size and observed sanitary condition of the water collection containers (jerry cans, pot, bucket, etc);
- Discuss household sanitation and hygiene practices of the water handlers, and household water storage practices (use of narrow neck, covered, placed off floor, container cleanliness);
- Explain household water treatment practices and reasons for treating;

- State test and analysis quality of water at household level and determine level of hazards, hazardous events and associated risks in the household.
- Check for illegal connections and vending practices; and,
- Check if consumers are using alternative water sources.

Additional information during system description and analysis:

- Describe the number of population using that particular water supply, their intended uses, and socio-economic status of the communities, as well as anticipated population growth;
- Describe service level, and how service addresses needs of disadvantaged groups of population;
- Describe equity distribution of water for intended uses and the vulnerability deferential between communities;
- Describe the community hygiene and sanitation condition (excreta, waste water and solid waste disposal);
- Summarize available information on source and drinking water quality, including sampling frequency, analyzed parameters, trends and seasonal patterns;
- Describe operation, maintenance and system management capacity of the utility; and,
- Furthermore, collect retrospective climate change related weather data needs as part of the system description.

Step 3: Hazard assessment, validation of existing control measures and risk assessment

This section provides guidance on how to identify potential hazardous events and how hazards enter into the water supply system. Objectives of hazard assessment, validation of existing control measures and risk assessment include:

- To identify specific and potential hazards or dangers (microbial and physic-chemical contaminants and quantity) that might threaten the safety and quantity of drinking water supply;
- To pinpoint how and where hazard enters into the stages of the supply system (hazardous events or causes of hazards);
- To identify the effectiveness of existing control measures, and determine whether additional control measures are needed or not;
- To find out future areas of improvements and changes to be made to minimize occurrence of hazard events and likelihood of occurrence of hazards so as to safeguard health of the consumers.

3.1 Identify hazardous events and hazards to water supply system

The system description and analysis provided information on different stages of the water supply system from catchment/source to the point of consumption and potential sources of hazardous events and hazard entry points. Based on information from system description, WSP team identifies the potential hazards, hazardous events, areas where hazard enters into the water supply system (from catchment to the point of consumption) to be assessed in detail during field risk assessment of the effectiveness of the existing control measures.

- **Hazards** are harmful microorganisms (bacteria, parasite, protozoa, and/or virus), or chemicals (fluoride, arsenic, lead, etc) or physical (turbidity etc) and/or lack of water that might affect health of the consumer or affect the water supply system.
- **Hazardous events** are unfavorable condition, through which hazards enter in to any stages of the water supply system such as heavy rainfall causing runoff entering the water source or treatment units with animal/human faces. For example, collecting and storing water with dirty jerry can and unclean hand (hazardous event) introduces pathogenic microorganisms (hazards).

During hazards assessment, WSP team should consider hazards and hazardous events in pairs and assess risks for each pair. The following table (Table 3) illustrates hazards and how (hazardous events) and where it enters at any of the steps in the water supply system.

Table 3: Examples of hazards, hazardous events and entry points in the water supply system

Steps in the water supply system	Hazardous event (how hazard could enter into the water supply)	Hazards type (microbial, chemical and/or physical)
Source	Open defecation, agriculture and garbage disposal in the catchment of the water source and runoff collect human faeces and enters the source	Microbial and chemical contamination
Treatment unit	Heavy rainfall and the runoff collect silt and enter the treatment work	Turbidity
Household (point of consumption)	Collect and store water using dirty and wide necked container	Microbial contamination

Step 4: Determine effectiveness of the existing control measures

Following identification of the hazards and hazardous events, WSP team should look into what control measures have been put in place by the utility to remove /prevent /reduce or eliminate the impacts of the hazards and hazardous events on each step of the water supply systems and to safeguard health of the consumers. Once existing control measures are identified, the WSP team continues to review and validate the appropriateness and effectiveness of the existing control measures based on the following measurements and assess potential risks.

- Preventing contaminants from entering the water supply system
- Removing or reducing the contaminants from the water
- Inactivating /killing the hazards (pathogens)
- Preventing recontamination of water during distribution, storage and handling
- Preventing shortage of water quantity

Some risks may be addressed by existing control measures either during intake (e.g. catchment protection), treatment (e.g. reduction of turbidity and killing/inactivation of pathogens by disinfection), at storage reservoir or on the distribution system. Reviews of effectiveness of existing control measure provide information on the strengths and weakness/gaps of the control measures, as well as risks yet not addressed.

4.1 Assessment of risks to the water supply system

After analysis of the effectiveness of the existing control measures, WSP team should conduct a risk assessment to the whole water supply system from catchment to the point of consumption. During this assessment, the team considers all of the hazardous events and a hazard identified, considers the strength and weakness (effectiveness) of the existing control measures, and then conducts risk analysis and determines risk levels.

Risk assessment uses data collected from the water supply system observation (sanitary surveys to the water supply system from catchment to point of use and water quality test results) and data of the utility and the health offices to determine risk levels, for each hazard and hazardous event in all components of the water supply system. The approaches involve estimation of likelihood/frequency of a certain event to happen and severity/consequences of the event on the quality and quantity of water, on the water supply infrastructures and/or on the health of the water users. It should be noted that the frequency of the occurrence of some hazardous events (e.g. heavy rain falls) may be influenced by climate change, and the team is, therefore, encouraged to consider anticipated developments in their assessment if information is available. The scoring of risks requires assigning numbers to different levels of likelihood and levels of severity. Description of the likelihood of the risk and its consequences (severity) and scores assigned to each level are presented below in Table 4 and Table 5.

Table 4: Definitions for likelihood, consequence level and corresponding risk score

Likelihood level	**Definition**	**Score**
Unlikely	Could occur at some time but has not been observed; may occur only in exceptional circumstances	1
Possible	Might occur at some time; has been observed occasionally	2
Most likely	Will probably occur in most circumstances; has been observed regularly	3
Consequence level	**Definition**	**Score**
No or minor impact	Minor or negligible water quality impact (aesthetic impact, not health related) for small percentage of customers. Some manageable disruption to operation, rise to complaints not significant	1
Moderate impact	Minor water quality impact (aesthetic impact, not health related) for a large percentage of customers, clear rise in complaints, community annoyance, minor breach of regulatory requirement	2
Major impact	Major water quality impact (health-related), illness in community associated with the water supply, large number of complaints, significant level of customers concern, significant breach of regulatory requirement	3

Adapted from Small Community Water Supply WSP Manual (Table 3.4)

- Develop a likelihood and consequence/severity matrix (Table 5)
- Then, calculate a risk score by multiplying likelihood scores with corresponding severity scores.
  RISK = LIKELIHOOD * SEVERITY
- Determine risk level based on the risk score as LOW (score 1 to 2), MEDIUM (3 to 4), HIGH (6 to 9)

Table 5: Suggested semi-quantitative risk rating approach (WSP Manual for SCWS 2012)

		Consequences			
		No Or minor Impact	Moderate Impact	Major Impact	
			1	**2**	**3**
Likeli hood	Unlikely	**1**	**1**	**2**	**3**
	Possible	**2**	**2**	**4**	**6**
	Most likely	**3**	**3**	**6**	**9**
		Risk Score	**(1,2)**	**(3,4)**	**(6,9)**
		Risk Level	**Low**	**Medium**	**High**

Adopted Tables SCWS WSP Manual (Table' s 3.5 and 3.6)	
Low	Clearly Not aPriority
Medium	Midium to Long Term Priority and needs attention
High	Clearlya priority and Requires Urgent attention

For example, if the reviews on the ongoing (existing) control measures have indicated that it is inadequate to eliminate/remove the identified risks, the WSP team moves to identification of additional control measures that strengthen (complement) the ongoing control efforts so as to achieve the microbiological and physicochemical water quality targets.

For management purpose, it is important to show the linkage between steps in the water supply system, hazard event (causes), hazards, existing control measures and its effectiveness, risk analysis, and proposed additional control measures/improvement plan on the same analysis template (Table 6) and the additional control measures and/or improvement plan is further discussed under section 3.2.3 below.

Table 6: Description of hazard analysis, validation of the existing control measures, risk assessment and determination of additional control measures

Steps of the water supply system (from catchment to consumer)	Hazardous events (how hazards could be introduced)	Type of hazards (microbial, chemical and physical)	Existing control measures (measures in place to address hazards)	Are control measures effective?			Validation notes (basis to control measure effectiveness decision)	Risk assessment				Additional control measures needed?		
				yes	No	Some what		Likelihood	Consequence	Risk score	Risk level	Yes	No	If yes, proposed additional control measures or improvement plan
Source/ catchment														
Treatment works/ plant														
Storage reservoirs														
Distribution systems/networks														
Public stand post														
Household														

During risk factors assessment to water supply systems, WSP team can adapt and use WHO sanitary survey tools (Annex 4.3) specific to conventional water supply system by contextualizing to the settings of the water supply system and can use household level contamination risk assessment tool. Based on the findings of the risk factors assessment, the team will assess the level of risk using semi-quantitative risk rating approach (Table 5).

Box 1: Important reminders for WSP team

WSP team is expected to use both secondary and primary data to conduct hazard identification, validation of control measures and risk assessment.

- Secondary data sources include records and reports of the utility, recent study reports, etc) and primary data is gathered during field assessment of risks to the water supply system from catchment to point of use.
- The WSP team uses sanitary survey tools adapted from the survey tools prepared by the World Health Organization (WHO) for different water supply systems and existing tool for assessment of household drinking water contamination risk assessment

Depending on the availability of resources (number of staff to be engaged, budget), the WSP team determines the number of priority problem points to be visited by setting selection criteria, **for example;**

- Problem points in the water supply system located nearby areas of open defecation and flood prone areas,
- Points in the water supply system with history of frequent breakage and supply interruption and compromised quality,
- Age of pipe system, and suspects of wrong connection, etc.

To use resources efficiently, the WSP team should prepare detailed activity plan that includes where to visit (points to be assessed), assign activities to each team member as well as assemble assessment tools, checklists, formats, equipments required for sanitary survey and water quality testing ahead of time

Step 5: Improvement planning

In the previous section (section 3.2.2), the WSP team has identified hazardous events, hazards, and prioritized based on risk levels. Moreover, it has evaluated whether the existing control measures are effective to remove hazards from entering the water systems and whether additional control measures /improvement plan is needed or not.

Using information mentioned above, the WSP team can develop detailed action plan that address priority risks identified at all steps in the water supply systems. These planned actions could be either new /additional to existing control measures and/or strengthening the existing control actions.

Improvement plan needs core and detailed activities under each core activities/actions to be implemented. In addition, there should be responsible body/person to execute core/each detailed activity and when it is expected to be accomplished and resources required for implementation of the improvement plan (Table 7).

Therefore, it is important to put improvement actions and addressed in an order of urgency based on the risk level, costs of implementation, and time required to accomplish the improvement plans. Thus, it is important to consider alternative and complementary control/improvement actions (multiple barrier approach) that are effective and affordable, as well as intermediate solutions until more capital expenditure becomes available.

In addition, the whole processes of WSP development, improvement plan of actions and its implementation status should be documented and shared with the utility manager and with other stakeholders and is important to use the plan for internal and external review of the successful implementation of improvement actions and its effect on removal of hazard events and its contribution to ensure the intended water quality targets.

In conditions where the control measures are difficult to implement within short period of time due to lack of financing, unavailability of effective technologies, etc (like minimizing the concentration of fluoride in the drinking water in rift valley areas of Ethiopia), the utility can plan for sustainable mitigation strategies such as safe sourcing, and/or use of defluoridation technologies.

Table 7: Water supply system improvement plan of action (Sample)

No.	Hazards	Hazard events (causes)	Risk Level	Description of improvement actions	Responsible body/person	Resources (estimated budget)	Implementation Due date	Implementation status
1	The well does not provide adequate quantity of water and long queuing at public fountains	Water table lowered due to prolonged drought (likelihood of event occurrence may increase due to consequences of climate change)	high	Find alternative / complementary water source	Utility management	1.5 Million Birr	6 months	
2	Microbiological contamination of drinking water	Household store water in dirty, wide-necked container allows for microbiological contamination to be introduced	High	Community/HH education and awareness creation on safe water storage practices HH water disinfection Storage container clean-up campaign	Health Extension Workers and leaders of Health Development Army	1,000 Birr	One month	
3	No free chlorine residual at outlet of the storage reservoir	Adequate quantity of chlorine is not added by the operator due to lack of knowledge and lack of guidelines leading to potential microbiological contamination	Medium	Train to the operator Provide standard operation procedure Monitor compliance	Operation and maintenance core process	5,000 Birr	Two weeks	
4								

Stage III: Monitoring

Monitoring is an essential component of the WSP to verify whether or not the control measures are adequate and effective to check the safety of the drinking water so as to meet the health based targets. Therefore, the objective of developing monitoring is mainly to regularly assess the effectiveness of the planned control measures, and timely implementation of the improvement plans to ensure consistent supply of safe drinking water.

Monitoring of the water safety plan has two components; namely, operational monitoring and verification (compliance) monitoring. While operational monitoring is conducted by the WSP team (the utility), verification monitoring is conducted by the local health authority/regulatory body.

Step 6: Operational Monitoring

The objective of operational monitoring is to frequently assess the effectiveness of all existing and planned control measures and define corrective actions for situations when target conditions are not met to ensure consistent supply of safe drinking water in adequate quantities.

Thus, under this section, guidance is given on establishing plans and procedures to measure effectiveness of the control measures, i.e. whether it is performing as intended (i.e. meeting critical limits or target conditions) as determined through water quality testing and/or visual observations.

WSP team is expected to define and document ***what***, ***how***, ***when*** to monitor the corrective actions and ***frequency*** of routine monitoring and ***who*** conducts the monitoring activities, and what should be done if monitoring parameters are outside the set boundaries (corrective action) and use of the monitoring for continuous improvement of the water supply system.

What to monitor: monitoring is important to check;

- Operational water parameters (e.g. odor, pH, conductivity, turbidity, residual chlorine)
- Treatment works, disinfection equipments, reservoirs, distribution systems and household storage practices are in proper running conditions
- That the control measures are working effectively
- That standard operating procedures are followed

How to monitor: methods of monitoring could be:

- Water quality tests to check the quality of drinking water comply with National Compulsory Standard Drinking Water Specification (CESDWS 2013)
- Conduct sanitary inspection to check for improvements made on the water supply system in comparison to conditions before the plan

When to Monitor: Frequency of monitoring could be set on daily, weekly, monthly, quarterly, or on an annual basis depending on how quickly the control measure may fail, the urgency to remove hazard events and to meet set standards. For example, monitoring of the disinfection unit in the treatment processes need strict monitoring of the critical limits set for **pH** and **Temperature** of the water and the **correct dose of chlorine** and concentration of **free residual chlorine** before the water enters the distribution system. On the other hand, other units in the water supply system such as water source catchment and service/ supply storage reservoirs may need less frequent monitoring visits.

Deviation from the critical limits (or target conditions) usually requires urgent corrective action to block supply of unsafe water to the community and to restore the proper functioning of the control measure.

In general, monitoring requires identification of what to be monitored, operational targets, critical limits and decision how and frequency of monitoring, specification of the monitoring procedure, an organization/ person responsible for monitoring and prepare contingency actions when critical limits have been reached or surpassed.

Box 2: Critical limits (or target conditions)

is a measure of control which measures performances that can be objectively assessed by standard techniques (lab test) and by direct observation

- It is a level which indicates water quality/safety has been compromised and a level at which corrective action should be taken to remove the risk.

For example, the utility can set critical limits such as;

- The filtration unit should have a critical limit /performance to reduce bacteria load and turbidity to less than 5 NTU before passing water to chlorination unit,
- Concentration of free residual chlorine at public stand point/consumer tap should not be less than 0.2mg/L,
- No faecal coliform bacteria in the water at household level
- Range of pH limits for effective chlorination
- Access port on storage tank closed and locked
- Area around the water source free of polluting sources (e.g. latrine or garbage disposal)

In the above section, the importance of setting the critical limits for each control measure is discussed. It is also important to regularly confirm whether the stated control measures are implemented and the critical limits are not exceeded and the control measures are capable of removing/reducing the identified hazards to the level it will have no more public health importance.

In summary, operational monitoring is important to check and confirm that, the planned control measures are working properly and effectively remove identified hazards (physical, bacteria or chemical) and risks from the water supply system. These can be done by;

- Regular checks and observations including sanitary inspection to the critical control points in the water supply systems,
- Laboratory testing for indicator of micro-organisms and suspects of chemical hazards and analysis of the critical parameters to check against critical limits.
- Analysis of reasons (shortcoming and challenges) for control measures are not implemented as planned or not effective and identification of future corrective actions.

The following table describes what to be done, frequency and responsible body being parts of and operational monitoring (Table 8).

Table 8: Suggestion for frequency of operational monitoring of the water supply systems, critical limits and possible corrective action if critical limits are surpassed

Where	What	When	Who	Critical limits	How (methods of monitoring)	Corrective actions if critical limit surpassed
Source (intake chamber)	Turbidity	Seasonally	Technician	Less than 1000 NTU	Conduct Visual observation and Water quality test	Divert flood water immediately and suspend raw water harvesting until turbidity drops below critical limit
	Fencing around intake	Weekly to monthly	Technician	Intact and gate secured	Conduct Visual observation / inspection	Repair compromised fencing and/ or secure gate
Clear water tank (outlet)	PH	Daily	Technician	pH: 6.5-8.5	Conduct Water quality test	Investigate change in pH
	Turbidity	Daily	Technician	<5 NTU	Conduct visual observation and water quality test	Confirm water treatment plant performance and check for leaks and breaks in pipe line
	Chlorine	Daily	Technician	Cl2: 0.6-0.8mg/L	Conduct Water quality test	Check and adjust chlorine dose as needed
Distribution network (valve boxes, exposed pipe lines, ditch/ run off crossing etc)	Leakage and vandalism	biannual	Technician	Fault connection, breakage and exposure to run off and damage	System observation / inspection	Maintenance/ rehabilitation of the distribution network
Consumer tap (5 taps each time)	pH	Weekly	Technician	pH: 6.5-8.5	Conduct Water quality test	Investigate change in pH
	Turbidity	Weekly	Technician	<5 NTU	Conduct Visual observation and Water quality test	Confirm water treatment plant performance and check for leaks and breaks in pipe line
	Chlorine	Weekly	Technician	Cl2: 0.2-0.5mg/L	Conduct Water quality test	Check and adjust chlorine dose as needed

Source: Adapted from WHO water safety plan manual (WHO 2009)

Step 7: Verification Monitoring

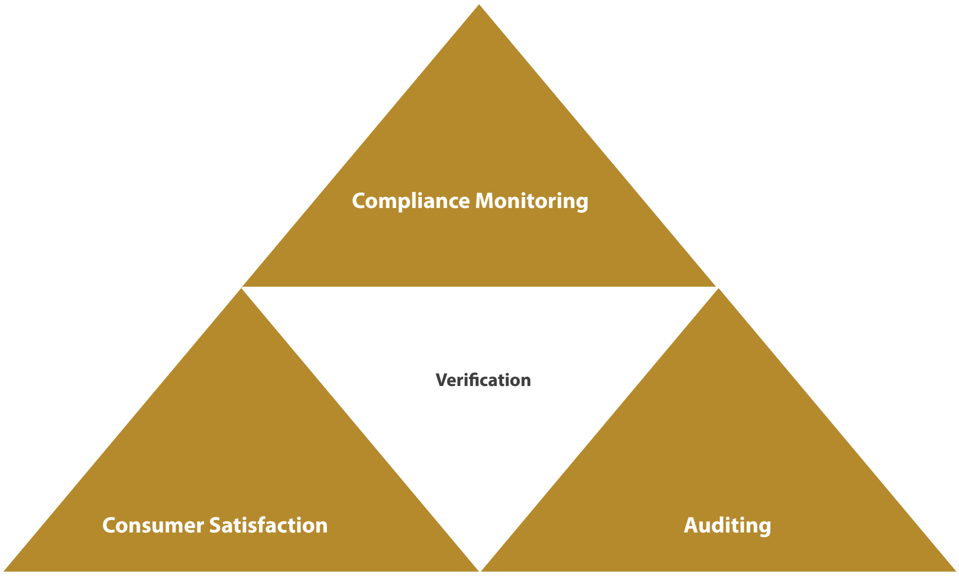


Fig 3: Verification Monitoring, adopted from WHO WSPs training manual 2012

Verification monitoring confirms that water quality targets or objectives are being achieved and maintained and that the system as a whole is operating safely and the WSP is functioning effectively. It is typically based on compliance monitoring, internal and external auditing of the adequacy of the WSP and adherence to operational activities, and checking consumer satisfaction. In auditing, sanitary inspection formats are often a useful tool for confirming that measures put in place effectively control previously identified risks. The results of verification monitoring are typically included in district, regional or national water supply surveillance program.

For realization of verification monitoring, establish a reliable system for information exchange with relevant stakeholders. Verification includes:

- ***Compliance monitoring***: use water quality parameters through water quality testing to confirm that water quality standards are being met. The quality of the water supplied to the users should comply with National Compulsory Standard Drinking Water Specification (CESDWS 2013). This can be done by FMHACA and its structure at regional, zonal and woreda levels. Compliance monitoring requires monitoring plan that include; selection of location where to collect samples, determination of frequency of sampling/testing, documentation/recording and reporting of water quality test results. Water Quality Surveillance will be employed for compliance monitoring. It is not only limited to water quality testing but also include regular monitoring of incidence /prevalence of water-borne diseases and analyze trends. The water quality test being made will include:
    - Microbial quality (indicator bacteria E. coli or thermo-tolerant coliforms, viruses or protozoan of faecal origin, etc at representative control points in the water supply system).
    - Physic-chemical quality such as free residual chlorine, pH, turbidity and Nitrate are regularly monitored. Other toxic chemicals such as fluoride, arsenic, etc., are tested at the beginning of the development of the water supply and monitored with less frequent interval to check effectiveness of the chemical removal technologies. .
- *WSP auditing*: will be carried out by audit committee lead by health authority at the local level with members from regulator, health and water offices. The committee use document from the water supply

system, visual observation using sanitary survey and water quality test results to determine the effectiveness of the WSPs

- Verification process also encompasses assessment of communities' (water users') satisfaction with the quality/safety, quantity/adequacy, reliability, continuity, and cost of the drinking water through regular water users' satisfaction surveys. It is to be noted that, water users may divert to alternative unsafe water sources if their voice is not heard.

Stage IV: Management and Communication

Step 8: Development of the management procedures

Water safety plan includes establishment of clear management procedures to document actions taken when the water supply system is operating under normal condition, including action to take when limits exceed (corrective action) and the system is operating in emergency conditions with the detail steps to follow in incident situations. SOPs are important to create transparency between the operational and the management on the status of the system and to actively engage in the water supply system improvement.

The standard operation procedures (SOPs) are operational procedures (system operational manual) used during normal conditions including on how to implement system upgrading and/or improvement corrective actions. Emergency procedures manage emergency operational conditions during emergency situation such as flood and drought and it includes lists of activities to be conducted by utility staff, responsibilities of the utilities and other stakeholders during emergency situation.

For example, incident situation such as flood and/or drought may occur and create loss of control of the system, and could result in damage of the assets, closure of the treatment works, and/or gross contamination. For example, unanticipated the flood incident in Dire Dawa (2006) and Afar region, Asayita (2010) has resulted in gross damage to the water supply system (NAPA 2007). Therefore, assessment of situations based on meteorological data or information on history of occurrence and impacts of events such as drought and/or floods over the past decades are important to prepare emergency preparedness and response plan.

The following are examples standard operation procedures (operators working manuals) important for utility managed water supply systems.

Operational Procedures under normal conditions

- Prepare/update operational manual that is used at the stage of raw water intake and pre-treatment, screening of raw water intake, calibration of meter to measure water flow, and switching and increasing/decreasing pump operation.
- Prepare/update procedure for Dosing of Coagulation/flocculation chemicals and disinfection/chlorination
- Prepare/update procedure for record keeping and reporting (list of reportable key parameters, failure reporting forms, users' claim form, etc)
- Prepare/update water sampling and testing procedure,
- Prepare/update manual/procedure on certification of competence (COC) for water supply system operators, and water quality analysts
- Develop system of communication between utility and health sector/regulator particularly on sharing of lab test/analysis and sanitary survey results

Management procedures to deal with incidents

- In addition to climate and weather information collected from the metrological agency, organize community consultation workshop and identify trends of climatic changes that occurred during the past years/decades based on the histories and experiences of the elders and/or based on meteorological data, make prediction for possible changes in the water system and establish baseline for future monitoring
- Prepare/update contact information of key personnel including operators and managers and other stakeholders to be informed in case of an emergency

- Prepare/update clear description of actions required in the events of emergencies
- Prepare/update location of backup equipments

Depending on the type and complexity of emergency situation, develop/update the response action which could vary from;

- Modification of treatment of existing sources, or temporary use of alternative sources with appropriate water treatment, or water tracking during worst water scarcity.
- In case of gross contamination due to flooding and damage to different parts of the water supply systems
- Increase disinfection points including at treatment tank, distribution lines, and at household levels.
- Properly document these emergency response actions in the emergency management procedures.

In addition, address the following issues in the emergency communication procedure;

- Prepare response and monitoring actions,
- Identify responsibilities of internal and external stakeholders,
- Develop/update communication strategies (rules for internal information sharing/exchange mechanism, with the regulatory and with media and the public),
- Develop/update user manual for distribution of emergency supplies, surveillance procedures, etc

Step 9: Development of the WSP supporting programs

Development and availing of the standard operational procedures (user manuals) for implementation of WSP under normal condition and during incident condition is not sufficient by itself. Thus, there should be activities that support the utility staff and managers develop necessary knowledge, skills, and commitment to develop and implement water safety plan approach, and capacity to manage water supply systems to deliver safe water. Therefore, need based designing and implementation of the WSP support programs including in-service trainings, research and developments are important.

Therefore, start supporting programs from simple actions, which may include for example;

- Organize sensitization workshop for key stakeholders on the existing regulations/standards and their legal responsibilities,
- Organize in-service training for laboratory professionals/analysts on quality control/calibration of testing equipments, and for system operators on calibration of monitoring devices/equipments and on the preventive maintenance.
- Review of existing operators' training curriculum, and develop standard operators training program and manuals and train new operators (pre-service and in-service training programs) by employing cascaded training approaches (master ToT at national and regional level, then sub-regional, then training of utility operators and managers)
- Organize in-service/refresher training for system operators and managers of the utility on the standard operation procedures and emergency response plans.
- Strengthen hygiene and sanitation promotion interventions to reduce contamination risk at source, in the distribution systems and at household level.
- Identify potential areas of water sources and the supply systems that are likely to be affected or damaged by possible disasters (flood) and prepare necessary protective/preventive measures including training of operators, and sensitization of communities.
- Strengthen soil and water conservation (watershed management) interventions conducted by agricultural sectors and by the communities to improve water storage/recharge through development of recharge ponds and contour trenches
- Establishment of the water quality monitoring/surveillance laboratories following WSP implementation scale up program in the regions, zones and woredas.
- Furthermore, identify researchable issues to generate evidences for informed decision making including:

- Testing/adoption of the best practices,
- Changes in the concentration of chemical hazards due to climate change to be supported by National Technical Working Group
- Changes in level of operator's turnover/job satisfaction and training needs,
- Level of customer/water users' satisfaction,
- Changes in the service down-time rates and water wastage rate by service zone,
- Changes in the pattern of WASH borne diseases (under-five diarrhea),
- Changes in water sources resilience to climate change (increase in ground water recharge and reduced impacts of extreme weather events on the water supply)
- Assessment of the customers' willingness to pay to increase billing rate to improve cost recovery for operation and maintenance, etc., as well as population development

Stage V: Feedback and Improvement

Step 10: Review and Revise the WSP regularly and following an incident

10.1 Reviews of the WSP

The main purpose of the WSP Reviews is to ensure that the WSP is up-to-date and effective, and ensures that it reflects lessons learned from incidents and near-miss. Reviews could be planned that needs regular meetings of the WSP team to look into all aspects of WSP to ensure that WSP is accurate and effective in reducing/removing hazards (hazard events). WSP review also conducted as needed following any significant change and after an incident or near miss.

Therefore, WSP review should be conducted regularly by taking into consideration the following conditions.

- Every three months (quarterly) to assess progresses made on implementation of quick wins and solve ambiguity/confusions related to WSP implementation
- Every year to identify successes, challenges and learn from experiences and update the WSP
  - Biennial to review the whole processes of WSP implementation, outputs, and its effectiveness from the view points of ensuring water safety and meeting health based targets. The following measurements can be used to review operational effectiveness of the WSP;
  - Improvement in water quality and quantity and compliance levels of operational monitoring limits
  - Improvement in operation, maintenance and management capacity of the utility
  - Additional or improved control measures in place
  - Improvement on customers' satisfaction and confidence on the utility's services
  - Improvements in household safe water management practices
  - Reduction in prevalence/incidence of diseases attributable to unsafe water
  - Improvements in continuity of the water supply (Reduction in down time/incidents of supply interruption)
  - Improvements in the commitment of operators and job satisfaction
  - Completeness of WSP e.g. with respect to new hazards and/or hazardous events identified in the meantime

10.2 Revision of the Water Safety Plan

WSP revision serves as a basis for upgrading/improvement of the WSP including identification of new risks to existing water supply system and/or new water supply water sources connected to the existing system and designing of associated control measures and corrective actions, monitoring systems and changes to the existing system.

These might include: further risk assessment, revision of operating procedures, and/or training of operators on the possible causes of incidents and emergencies, etc., that need to be incorporated in the revised Water Safety Plan.

Incidents cause damage to the water supply systems or compromise the quality of water and consequently cause an acute or chronic threat to public health. They may also lead to a shutdown of the facility or parts of it, leading to reduced quantity and related health effects.

It is important to urgently revise WSP implementation following emergency so as to address newly emerging hazards and issues related to adequacy of response actions. In addition, post emergency joint review is important to document best practices; identify gaps to be considered/filled in the future as part of preparedness plan.

Therefore, post emergency WSP implementation revision shall consider the follow issues:

- Determine root causes of the emergency problem (e.g. causes of outbreak, and damage to water system)
- Check/verify whether all relevant hazards have been identified in the previous hazard analysis, and whether risk assessment (i.e. likelihood and / or severity) needs updating
- Check/verify whether all causes were identified (hazardous events) in the previous risk assessment, and whether possible occurrence of the problem is recognized in the previous WSP
- Check /verify whether proper control actions are adequately and timely implemented
- Check/verify if there was communication gap and solutions sought
- Determine the immediate and long-term consequences of the emergency (morbidity, mortality, water system breakdown, dissatisfaction of water users and loss confidence on the service quality, etc)
- Identify future areas of improvement/ additional actions such as risk assessment, training of operators, communication means, capital investment, improved monitoring, regulation etc to be incorporated in to revised WSP and future emergency plan
- Accordingly revise/update the WSP emergency response during emergency conditions.
- Develop early warning system, communication strategy and preparedness plan on how to supply safe water to the community during emergency

In summary, WSP revision shall be considered when either of or all of the following conditions happen to the water supply system and to the WSP team:

- When new activities are initiated in the catchment (e.g. agricultural activities)
- When new treatment infrastructure is constructed /introduced
- When changes are made with existing water quality standards
- When updates to improvement plan is required
- When revisions have been made to management procedures
- When change has been made to WSP team members

CHAPTER 4

ANNEXES

4.1. Institutional Arrangement for WSP implementation

The water sector plays a leading role and is responsible for the climate resilient water safety plans implementation both in the urban water utilities and rural community managed water supplies. However, management and administration of land around the water source catchments, and development activities in the catchment zones, and removal of the hazards/contamination risks from source to point of use are not under the sole management of the water sector.

Therefore, implementation of the WSPs needs multi-sectoral coordination at all administrative levels, and technical and management inputs of professionals from catchment authorities/agriculture, water resource, utility, health, education, regulatory bodies and of the development partner organizations. Thus, the existing WASH coordination mechanisms expected to play significant role in the scale up of the water safety plan implementation being an integral part of one WASH national program.

However, development and implementation of the WSPs by the urban utilities and rural community managed water supplies need strong technical support by the technical working group (TWG) at all levels.

4.1.1 Organization of the WSP implementation

National WSP Technical Working Group (N-WSP-TWG)

Country wide WSP implementation is technically supported by the National WSP technical working group (N-WSP-TWG) composed of senior professionals from water, health, environment/meteorology, hydrology/climatology, agriculture, with expertise in designing of the water supply systems, water treatment works operation and maintenance, water quality monitoring/analysis, natural resource/watershed management, environmental health, vulnerability and adaptation assessment in relation to climate change, and regulation of the standards. In addition, the national TWG encompasses donors, UN agencies and international NGOs working on WASH and promotion environmental protection.

- Development/updating of the WSP implementation guidelines and training materials
- Development/customization of general standard operating procedures/manuals specific for utilities managed urban water supplies,
- Organize, coordinate and facilitate capacity building training for the regions/major utilities, universities/TVETS, and for regulatory bodies
- Identify issues to be researched, and technical guidance through regular supportive supervisions and report feedback, and review meetings to regional TWG on WSP monitoring
- Mobilize resources and coordinate WSP implementation scale-up nation- wide
- Collect WSP implementation reports from the regions and federal town urban utilities; make review of the effectiveness and impacts of WSP implementation at national level.
- Coordinate national drinking water supply system vulnerability and adaptation assessment or support the regions on conduction of regional vulnerability and adaptation assessment
- Coordinate the establishment of systems for compliance monitoring at national, regional and woreda levels
- Facilitate planning and implementation of compliance monitoring to federal town utilities managed water supplies and, facilitate dissemination of results of the monitoring to National stakeholders
- Support the regions by timely provision of national forecast on extreme weather events (e.g. droughts or floods)

Regional WSP Technical Working Group (R-WSP-TWG)

Country wide WSP implementation is supported by the regional WSP technical working group (R-WSP-TWG). Professional mix of the regional technical working group is the same with national working group. However, representation of the partner organizations participating may differ from region to region. Functions of the regional technical working group are described as follows:

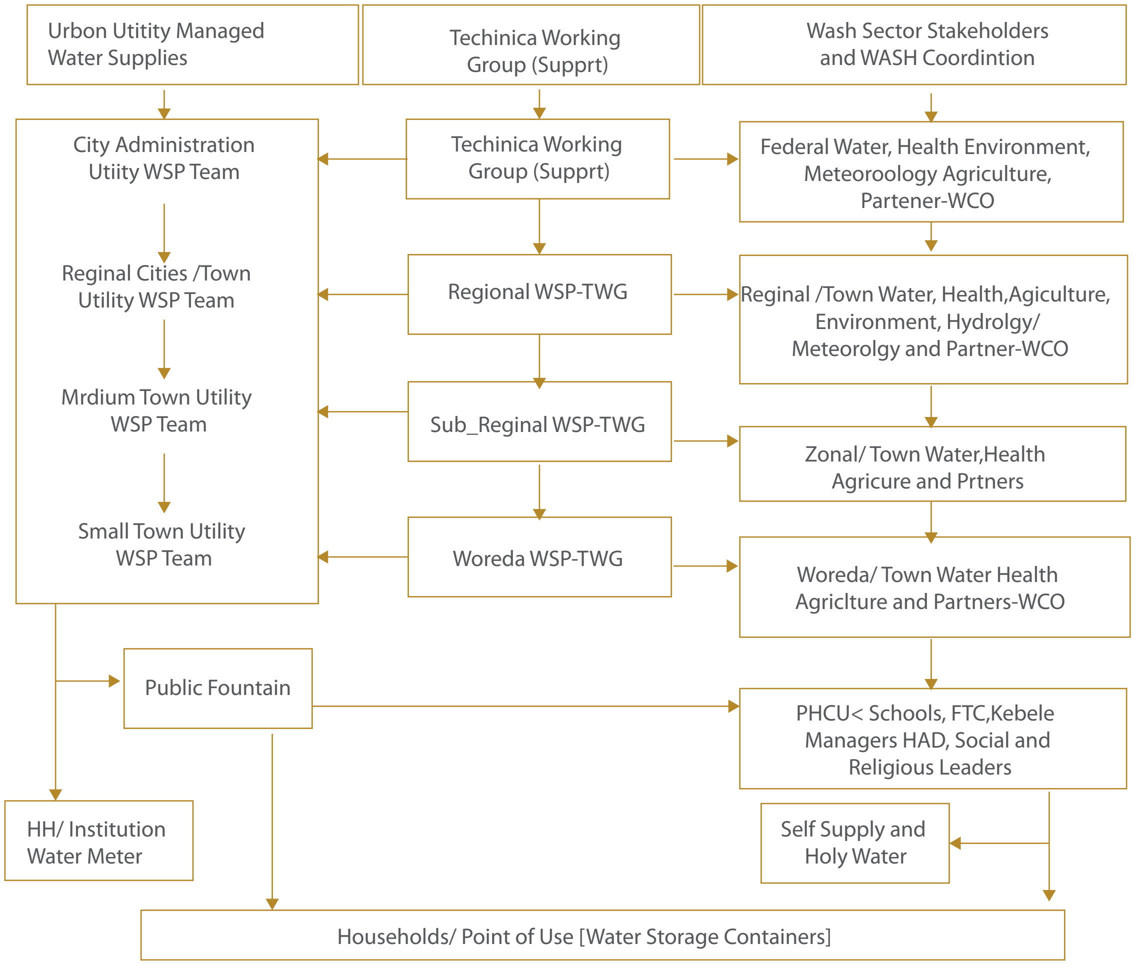
- Sensitize regional stakeholders on concepts and benefits of WSP and its appropriateness to address risks

posed by climate change
- Provide technical support to the regional and sub-regional big town/urban utility on the formation of WSP team, capacity building training, and during WSP development and implementation
- Show cases and mobilize local resources for WSP implementation
- Strengthen water quality analysis capacity of the urban utilities and quality monitoring/surveillance capacity of regional and sub-regional public health laboratories, woreda health offices
- Provide technical support to woredas on formation of woreda TWG and woreda WSP teams, train the WTWG and WSP team, and train small town urban utilities on stand operating procedures/manuals
- Provide research support to the big, medium and small town utilities
- Collect WSP implementation reports from the medium and small town utilities and make review of the effectiveness and impacts of WSP implementation at national level
- Organize annual WSP implementation reviews, document best practices, lessons and share with other regions
- Facilitate establishment networks between urban utility operators
- Facilitate planning and implementation of compliance monitoring to regional/zonal town utilities managed water supplies and, facilitate dissemination of results of the monitoring to regional/zonal stakeholders
- Conduction of regional climate change vulnerability and adaptation assessment to drinking water supplies
- Facilitation of access to regional forecasts of e.g. droughts and floods.
- Perform a hydrology modeling for the region

Depending on the differences in administrative set up between regions, the number of medium town urban utilities and breadth of WSP scale up, regions may organize sub-regional /zonal technical working group and delegate some of their functions

Woreda WSP Technical Working Group (W-WSP-TWG)

- Sensitization of the woreda stakeholders on Concepts and benefits of WSP implementation, including its appropriateness to address risks posed by climate variability and change
- Provide technical support to small town utilities on the formation of WSP team, capacity building training, and support during WSP development and implementation
- Show case and lobby the woreda council through WWT to allocate earmarked budget for improvement of safety of water through implementation of WSP
- Strengthen water quality monitoring capacity of the small town utilities and quality surveillance capacity of woreda health offices
- Facilitate planning and implementation of compliance monitoring to small town utilities managed water supplies and, facilitate dissemination of results of the monitoring to regional/zonal stakeholders
- Organize quarterly WSP implementation reviews of small town urban utilities at woreda level, document best practices, lessons and share with other woredas



4.1.2 Roles and responsibilities of utility WSP team

WSP team is a multidisciplinary professionals' team formed by the water utility from utility, health, agriculture/ natural resource management and socio-economic studies and planning who have experiences and expertise on watershed management, water supply system design, operation and maintenance, water quality analysis, health and socioeconomic dynamics of the population. Manager of the utility play a coordination role to WSP team.

Responsibilities of the WSP team

- Prepare detail activity, milestones and logistics plan for development of Water Safety Plans
- Review/analysis of existing documents including system design and layout, records and reports on operation and maintenance activities
- Conduct site visits from source to point of use, observe operational practices, identify potential sources of hazards, hazard events, and prepare map of the water supply system
- Map hazardous events, identify and validate existing control measures, analyze risks (considering likelihood and consequences), and plan improvements needed to reduce risk to acceptable levels
- Establish operational monitoring plans for each control measure (including corrective actions)
- Conduct field visit periodically to check for proper implementation of operational and observation/inspection of implementation of corrective measures from source to point of use
- Conduct customers' satisfaction survey using qualitative and quantitative techniques

- Provide management support to the utility operators and water quality analysts including facilitation of development/updating of the standard operating procedures (normal and emergency situation), emergency response plans and training of operators
- Produce and submit monthly, quarterly and annual performance reports to the next higher TWG and the TWGs send back report feedback with recommendation
- Conduct annual WSP implementation reviews
- Conduct quarterly and biennial reviews as well as following incidents to evaluate effectiveness of WSPs and document practical lessons and share with stakeholders

4.2 WSP team selection criteria

The WSP team should be composed of professionals with adequate knowledge and experience of the water supply system from catchment and point-of-consumption and have an authority to prepare water safety plan and implement identified improvements and changes. In addition, the team should comprise other organizations that have stake in the catchment (watershed) and on the water use and quality. Specification of the responsibilities of the team member is important for labor division and team management.

1. Authority to approve improvements or changes identified in the water supply system (to decide to make decision about budget, devoting staff time, on training, etc)
2. Knowledge and experience of the catchment, issues and concerns that may exist in the watershed
3. Knowledge and experience with water supply treatment processes and water supply system operations (workers responsible for day to day operation of the water supply)
4. Knowledge and experience of water supply infrastructure design and layout (know about the history of the water supply system such as water source recharge to maintain quantity)
5. Knowledge and experience of water quality monitoring and surveillance processes
6. Knowledge and awareness of local health issues associated/attributable to drinking water supply
7. Understanding of risks associated with various stages of the water supply systems
8. Knowledge of trends of the climate change in the area and how it affects the water supply systems
9. Donor agencies and NGOs supporting the government on improvement access to safe and adequate water supplies.

S/ N	Name	Organization	Position	Areas of responsibility in the team	Address (telephone and e-mail)
		v			

4.3 WSP data collection tools

The following tools (4.3.1 and 4.3.2) are parts of the implementation guidelines and the training package.

4.3.1 Sanitary survey format

The urban utility managed water supplies have multiple sources including surface water, motorized deep boreholes, and gravity springs, combined and connected in the same grid and supplied to the population from the same reservoir using through the same pipe system connected to the public fountain and the households. Thus, sanitary survey tool kits that encompass multiple sources, treatment plants, reservoir, distribution networks including household connections and public fountains will be developed/adapted from first eddition drinking water quality guidelines, volume 3, (WHO 1985) as an addendum to this implementation guidelines.

4.3.2 WHO/IWA (2012), WSP quality assurance tool

Spread sheet developed by the WHO/IWA version 1.3 for water safety plan quality assurance is adopted and used to assess the performances of the Water Safety Plans implementation.

4.4– Sample WSP team training program

Training program on development and implementation of water safety plan for members of the urban utility managed water supplies WSP team

	Topics and training methodology	Time
Day 1	• Introduction to the training workshop • Brainstorm, explain/discuss the national water and health policies specific to water safety, national water quality standards and targets, climate change/weather variability and its effect on the drinking water supplies (Introductory module) • Team dynamics, Team forming, roles, and leading team work towards performance (Module 1)	1 hr 2 ½ hrs 1 hr
Day 2	Module 2, 3 and 4 Brainstorm, explain and discuss using written documents	7 hrs
Day 3	Module 5, 6 and 7	7 hrs
Day 4	Module 8, 9, and 10	7 hours
Day 5	Module 11 and 12 Orientation to field work and sanitary survey tools	4 hours 4 hours
Day 6	Practical field visit and exercise • Field visit to selected community managed water supply and conduct system description, identify hazards and hazard events and existing control measures from catchment to point of use • Discuss in group: characterize risks and evaluate effectiveness of the control measures • Explain and discuss on how to develop and implement an incremental improvement plan	8 hrs

4.5 –WSP implementation monitoring and evaluation indicators (result chain)

Level	Benefits of WSP implementation	Performance /target indicators	Data sources and reporting mechanism
Impact	• Improved health status and productivity of the population	• Reduced incidence and prevalence of diarrheal diseases	• National Health Data (EDHS, Welfare Monitoring Survey, housing and population Census
Outcome	• Sustainable provision of safe water and improved operational efficiency	• Improved water quality and quantity available • Improved resilience of water system • Consumer satisfaction	Water quality data reports WSP monitoring reports
Outputs	• Resilient water supply infrastructures rehabilitated/expanded and increased investments to reduce hazards and risks to water quality • Improved risk management and water safety management, operational, financial and planning capacity of the utilities	• Long term asset management strategy and financing arrangement • Internal and external Quality control and quality assurance system put in place • Regular operational monitoring • Improved water quality and quantity • Increased responsiveness and accountability	• Utility and surveillance agency performance reports • Customer satisfaction survey reports
Activities	• Utility and surveillance body staff knowledge and skill improvement through training programs, including on climate change • Standard operation procedures for water supply systems from catchment to point-of-use made available • SOP for incidents conditions made available • Water supply system asset management information system established • Utility Support programs strengthened	• Number of trained/skilled utility and surveillance workers • Necessary SOPs available at all levels • Clear/full asset information by place, service year, size, length, capacity, etc., documented • Number of utilities implementing CR-WSPs • Information on staff performance and turnover rate documented • Functional water quality laboratories (utilities and regulators)	• Utility and surveillance body monitoring and verification records • Monthly, quarterly, and annual performance review reports

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