WASREB
Water Services Regulatory Board

Guideline on
WATER SAFETY PLANNING
2019

Water Services for All

Guideline on

WATER SAFETY PLANNING

2019

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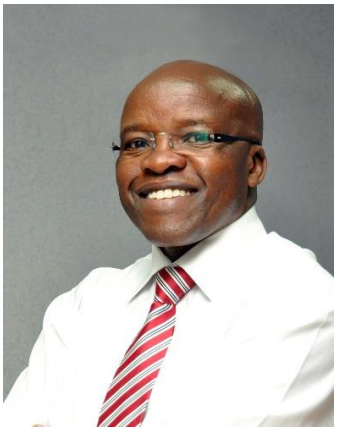
FOREWORD



The Water Services Regulatory Board (WASREB) is the body mandated under the Water Act 2016 to provide regulatory oversight in the water and sanitation sector in Kenya. The principle objective for establishment of WASREB is to protect the interests and rights of consumers in the provision of water services.

The right to water requires that consumers have access to safe and clean water in adequate quantities. It will however be noted that this endeavour remains a challenge considering that water supplies are increasingly being faced with a variety of challenges with respect to water quality. To deal with the challenge, utilities have in the past relied on water quality testing as an integral component of water quality assurance. In view of the above, the end point testing is not enough to guarantee water safety, as the supplier may not be clear on what went wrong, where and when, therefore, the supplier may not know how to correct the problem.

Cognizant of this limitation and in order to ensure safety of a drinking water supply system, water suppliers are required to move away from a reactive approach to a proactive one. In responding to the challenge, water utilities have adopted water safety planning, a comprehensive risk assessment and risk management approach that includes all steps in the water supply from catchment to the consumer.

Apart from the proactive approach to managing risks, the Guideline on Water Safety Planning allows improved management of drinking-water water supply systems through the achievement of incremental improvements by helping utilities to:

- understand the water supply system thoroughly
- identify where and how problems could arise
- put barriers and management systems in place to stop the problems before they happen
- make sure all parts of the system work properly

Towards this end, WASREB has developed this guideline to assist utilities in developing water safety plans, that will help in guaranteeing the quality of water supplied to consumers. The guideline contains a generic water safety planning template to ensure uniformity in approach.

It is the expectation of WASREB that this guideline will assist utilities in the push to realization of safely managed water services in line with the requirements of the SDGs.

Eng. Robert Gakubia
CHIEF EXECUTIVE OFFICER

ABOUT THIS GUIDELINE

This Guideline is a Water Safety Planning tool which is intended for adoption/adaptation by Water Service Providers in Kenya to assist them manage their water utilities appropriately for continuous provision of safe water to consumers. The Guideline has been developed with reference to information/data gathered during field visits to selected water utilities in the country from the four water supply categories that include Very Large, Large, Medium and Small water supplies. The field information/data have been synergised with information/data gathered through literature review to develop the Guideline.

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LIST OF ABBREVIATIONS

BMU	:	Beach Management Authority
CBOs	:	Community Based Organisations
CoK	:	County Government of Kenya
JICA	:	Japanese International Cooperation Agency
KEMFRI	:	Kenya Marine and Fisheries
KEWI	:	Kenya Water Institute
KIWASCO	:	Kisumu Water and Sewerage Company
LVEMP	:	Lake Victoria Environment Management Plan
LVSWSB	:	Lake Victoria South Water Service Board
MUWASCO	:	Murang'a Water and Sewerage Company
NCWSC	:	Nairobi City Water and Sewerage Company
NEMA	:	National Environment Management Authority
NGOs	:	Non-Governmental Organisations
NYEWASCO	:	Nyeri Water and Sewerage Company
PPEs	:	Personal Protective Equipment
QMRA	:	Quantitative Microbial Risk Assessment
SOPs	:	Standard Operating Procedures
WAG	:	Water Action Groups
WASREB	:	Water Services Regulatory Board
WHO	:	World Health Organisation
WRA	:	Water Resources Authority
WRUA	:	Water Resource User Association
WSBs	:	Water Service Boards
WSP	:	Water Safety Panning/ plan

CHAPTER 1: INTRODUCTION

1.1 Background on Water Safety Planning

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 is gaining increasing acceptance worldwide as an unparalleled practice for provision of safe drinking water. In a series of expert review meetings held in Germany, Australia and Britain in 2000 and 2001 to revise the World Health Organization (WHO) Guideline for Drinking water Quality, the importance of the water safety plan approach was underscored and the WHO continues to advocate for adoption of the approach as the most effective way of sustaining supply of safe drinking water to the public. It is imperative for water agencies involved with supply of water to the public to ensure that the water provided to consumers is safe for all forms of human consumption and that it meets regulatory water standards relating to human health ("consumption" in this context includes not only drinking the water, but also other forms of ordinary use or contact such as bathing, washing of clothes and utensils or any other form of washing, and inhaling aerosols contained in water droplets). The water safety planning approach aims to direct management of drinking water-related health risks away from end-of-pipe-based monitoring and response. For the purpose of preparing a water safety plan, a thorough assessment of the water supply from the source to the consumer's tap must be carried out by the water provider. Hazards and risks should be identified and suitable steps for minimizing the risks investigated for mitigation.Kenyan utilities are working with International Water Association at various stages of the development and implementation of WSP guideline. Nairobi City Water and Sewerage Company and Kisumu Water and Sanitation Company already have WSP formulated, KIWASCO is in the process of reviewing while NCWSC has a draft. Other water utilities in advanced stages include Mombasa Water and Sanitation Company and Nyeri Water and Sewerage Company whose staff have undergone training on WSP.

1.2 Scope of WSP

Water supplies face a wide range of risks caused by a variety of pollution sources which are typically of major relevance with regard to water safety. For instance, microbial pollution with pathogens is of major concern. Furthermore, pollution of raw water sources with agricultural chemicals and siltation by runoff during rainy season, and enhancement of algal blooming due to increased temperature and eutrophication as well as capacity gaps within the utility to consistently supply safe water in adequate quantity to the population are identified in several studies to be the current and future related challenges to the existing utilities. All these challenges seem to cut across the utilities of all sizes. The existing 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. Water safety planning has been considered necessary to increase the resilience of the utility towards comprehensive risk management. It should be noted that increasing resilience of the utilities irrespective of their sizes is necessary to ensure that they proactively identify and manage risks posed. Therefore, implementation of 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 the WSP implementation guideline for the utilities of all sizes (small, medium, large and very large) is pegged on the following key water safety planning elements.

1. Incorporate a comprehensive risk management approach in the water supply systems management from catchment to point of consumption in the day to day management of the water utilities.
2. Incorporate the risk management with regard to vendors in the risk management approach.
3. Water vending has been key in complementing the existing water supplies that do not meet the demand within their service areas. However, the quality of water supplies including the sources is at

stake. Have in place a generic water safety plan that can be adopted by the utilities. This shall serve as a guideline for each utility when developing their respective water safety plans.

The purpose of the WSP implementation guideline as stated earlier in this report is to provide a step-by-step guidance to the water utilities, whether very large, large, medium or small (urban or rural), 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. This guideline 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.

1.3 The Water Safety Framework

The *Guideline for Drinking-water Quality* WHO (2004) outlines, a preventive management framework for safe drinking-water that comprises five components (summarized in figure 1.1 three of which combine to form the water safety plan. A water safety plan, therefore, comprises system assessment and design, operational monitoring and management plans (including documentation and communication).Together these components are intended to achieve the desired public health outcome. The framework is applicable to systems of all types from large complex piped systems to community managed sources

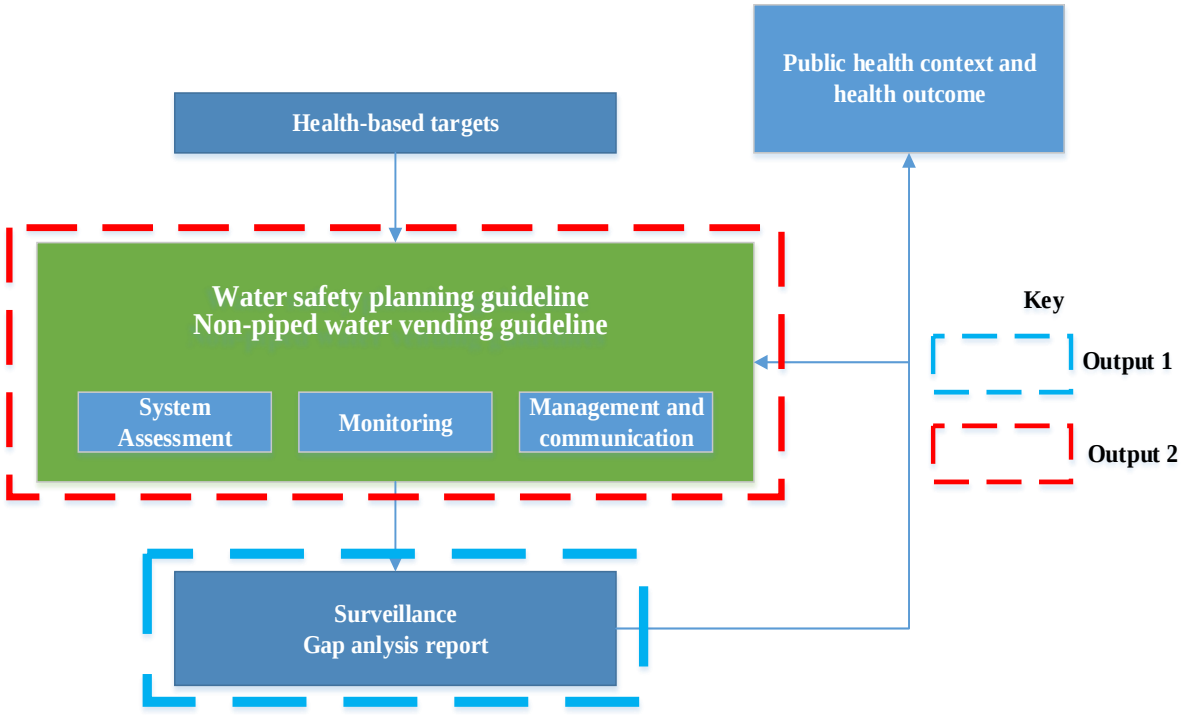


Figure 1-1: WHO Framework for safe-drinking water guideline. (Adapted from: Water Safety Planning for Urban Water Utilities: A practical guide for Asian Development Bank guide - WHO-ADB 2017)

1.4 Water Safety Plans

The most effective means of consistently ensuring the safety of drinking-water supplies is through the use of a comprehensive risk assessment and risk management approach incorporated in a WSP that applies to all steps of a water supply, including the distribution system. Normal practice is to develop an integrated WSP applying to all components, from catchment through treatment and distribution. The aim of WSPs is straightforward: to consistently ensure the safety and acceptability of drinking-water supplies. It is assumed that water is safe to drink at the point of entry, so the aim becomes to maintain safety by preventing contamination after treatment. In simple terms, this includes:

- constructing systems with materials that will not leach hazardous chemicals into the drinking-water;
- maintaining integrity to prevent the entry of external contaminants;
- maintaining the supply of drinking-water to consumers;
- maintaining conditions to minimize the growth of biofilms, microbial pathogens (e.g. Legionella), scaling and accumulation of sediments.

The benefits of water safety plans is outlined in the Table 1-1.

Table 0-1: Benefits of a water safety plan

Component	Benefits
Water quality	• Quality of water improves significantly in utilities with WSP. • Bacteria are considerably reduced in water. • Decreased variability in water quality. • Significant reduction in non-compliance to the recommended water quality standards for drinking water.
Public health	Significant overall reduction in water-borne disease infections characterized mostly by incidences of diarrheal.
Increased Awareness	WSP implementation results in a better understanding of water supply systems.
Maximizing existing resources	WSPs facilitate the identification of water contamination barriers that do not place focus on expensive treatment processes, but rather consider a range of less costly options.
Inform investments	As WSPs are based on risk assessment of water systems and result in a short, medium and long-term investment/upgrade plan, they provide a reliable means for governments, donor agencies and international financing organizations to maximize current and future investments in water supply.
Improve water suppliers' practices	WSPs help improve water suppliers' knowledge and management of the entire water supply system, thereby enabling them, for example, to develop more efficient operating procedures and respond faster to potential incidents.
Decision-making framework for all stakeholders	Stakeholder cooperation is an inherent part of WSPs; Water Safety Planning therefore facilitates appropriate institutions to collaborate in making well-informed decisions on the strategic, financial, operational and regulatory aspects of drinking water quality management.
Possible positive influence from WSP guideline.	• Improved utility management. • Training of staff. •Increased awareness of pathways of contamination. • Regular pipe flushing. • Regular cleaning of tanks. • Change of working procedure during maintenance and pipe work. • Regular maintenance program and improved leakage control. • Program to renew old pipes. • Backflow device. • Regular operational monitoring. *This will prevent contamination and increase safety of drinking water.*

CHAPTER 2: LEGAL AND INSTITUTIONAL FRAMEWORK FOR WATER SAFETY PLANNING

Regulation aimed at ensuring the safety of drinking-water is a powerful tool for protecting public health. Strong drinking-water regulatory systems are needed for achieving the Sustainable Development Goals (SDGs) with regard to achieving universal and equitable access to safe and affordable drinking-water for all. The WHO Guideline for Drinking water Quality recommend to governments to encourage Water Safety Planning as the instrument for achieving the guideline values and the applications of the best practices that the guideline propose, through the establishment of suitable regulations, policies and programs. Decisions on how to proceed with the proposed regulations, policies and programs should be based on the locally existing legal and regulatory frameworks. The frameworks should have, as a minimum, the tools to:

- Support the identification, prioritization and management of risks from the catchment to the consumer.
- Empower relevant authorities to support and possibly audit WSPs.
- Clearly define roles and responsibilities and place the boundaries of institutional mandates as they relate to the WSP approach.

Although regulations do not need to mention WSPs by name, they should clearly support a water service provider in risk assessment and incremental risk management approach. This includes ensuring that the capacity to support WSPs is built and maintained with all relevant stakeholders, including institutions, through education, awareness and training. The legal and regulatory framework should facilitate development of policies with a requirement for all drinking-water systems operators to develop, implement and maintain a Water Safety Plan, taking into consideration the potential risks to the safety of the water from the supply's catchments to the consumer. Water Safety Plans are now being promoted and adopted worldwide to better protect public health by reducing water-borne disease outbreaks as well as the burden of endemic water-borne diseases. A number of countries have integrated this concept in their regulatory framework. The following are some of the existing frameworks that guide the water sector and water safety planning in Kenya.

2.1 Legal Framework

2.1.1 The Constitution of Kenya (CoK)

The constitution of Kenya 2010 recognizes water and sanitation services as a basic right. Water and sanitation services is provided for in Chapter Four (Bill of Rights) of the Constitution of Kenya 2010. Section 43 (1d) of the constitution of Kenya states that "every person has the right to clean and safe water in adequate quantities". In addition, section 22 gives provision to individual(s) to institute legal proceedings if the right is denied, infringed, violated or threatened.

2.1.2 The Water Act 2016

The Water Act 2016 is an Act of Parliament meant to provide for the management, conservation, use and control of water resources and for the acquisition and regulation or rights to use water (GoK 2016). This Act which repeals the Water Act 2002 is also meant to provide for the regulation and management of water supply and sewerage services.. Part III Sections 22, 104 and 107 of the Water Act 2016 provide for the protection of catchment areas Section specifically allows a licensee of water services (water utility) to enter into an agreement with any person for purposes of protecting the catchment of its source of water.
Under Section 72 (a) of the Water Act 2016 WASREB is empowered to determine and prescribe national standards for the provision of water services and asset development for water services and this includes prescribing guideline necessary for achieving water safety and maintaining the quality service. Provision of water safety planning guideline is therefore in line with WASREB's mandate. Further Section 72 (f) mandates WASREB to monitor compliance with standards including the design, construction, operation and maintenance of facilities for the provision of water services by the water works development bodies

and the water services providers. WASREB, therefore will monitor directly and indirectly the development and implementation of water safety plans by the utilities.

2.1.3 The National Water Services Strategy (2007- 2015)

The National Water Services Strategy (NWSS) was derived from the water sector policy contained in Sessional Paper No. 1 of 1999 on National Policy on Water Resources Management and Development. The NWSS was meant to provide a clear, accountable, and transparent road map to implement sector policy in order to improve health, jobs and wealth for all Kenyans. This is also required in The Water Act, 2016 as stated in sections 63& 64.

2.1.4 Guideline on Water Quality and Effluent Monitoring (2008)

WASREB developed the Guideline on Water Quality and Effluent Monitoring (2008) as part of the requirement on its mandate as stipulated under Section 47 of the Water Act 2002 (repealed by enactment of The Water Act 2016). The guideline need to be aligned with the current law, the Water Act, 2016 Sections 72 (a) and (f) and the new water policy (soon to be published) as well as the specification for potable water issued by KEBS (KS EAS 12: 2014).

Water quality is one of the main indicators of the quality of service provided to the consumer by the water utilities. Water quality has an impact on both the public health and aesthetic value of water as a consumable product. For effective monitoring of water quality, both internal self-monitoring by the water utilities and an independent monitoring by the WSBs and WASREB is necessary. The guideline contains information on establishing the minimum number of samples to be taken, water quality parameters to be measured, recording and reporting/ publication of results. The effectiveness of the water quality and effluent monitoring system established in the guideline is based on five factors:

1) Elaboration and application of an appropriate sampling program;
2) Costs of water quality monitoring should be reflected in the annual budget;
3) Sample collection and preservation;
4) Analysis and recording; and
5) Reporting and record keeping.

Improper actions in one of the above areas definitely results to wrong information on the water quality situation. Proper water quality assessment that ensures health safety of the end users (consumers) requires proper planning. Therefore, the proposed water safety planning guideline will form important complement to the existing guideline on water quality and effluent monitoring. The proposed WSP guideline will also include specifics that apply to water vending, an alternative water supply that exist such as non-state water providers (NSPs) including both formal and informal, local private providers to cover the inadequacy in water provision by public utilities in many cities.

2.1.5 Model Water Services Regulations

The Water Act 2016 under Section 72 (n) empowers the Water Services Regulatory Board to make regulations on water services and asset development. The model Water Service Regulations are developed as a guideline by WASREB whose responsibility it is to set, monitor and review rules and regulations to ensure water services provision is affordable, efficient, effective, and equitable. Water Service Boards are expected to adopt them and the principles therein as the regulations for their service board area. . Part VII of the regulations outlines the regulations on the vended water (potable) and non-piped water supplies. Regulation 70 states that any licensed water vendor (potable water services) should meet the regulations of the WSBs under guideline issued by the regulator (WASREB). Water vendors are therefore required to undertake sampling and analysis of the source water for contaminants and make reports at prescribed intervals (WASREB 2002).

2.1.6 The Water (Services Regulatory) Rules, 2012

The Water Services Regulatory Rules, 2012 were promulgated under the repealed Water Act 2002 to provide a procedural and administrative framework for the Water Act. The Rules apply to the Regulatory Board; all licensees in Kenya or their contracted agents or associates; and all water service operators. The Rules are still operational but may be reviewed in future to align them to the Water Act 2016.
Section 4(1) Rules makes it mandatory for Water Service Boards to apply to WASREB for a license that empowers them (Section 14) to, among other things, create infrastructure and networks for the provision of water within its area; create the infrastructure and networks for the safe disposal of waste water or effluent within its area; provide services proceeding and ancillary to all the above including protection of sources of water from which the licensee is authorized to abstract water. Section 16 requires the WSBs to register water system operators in their areas of jurisdiction. The Water Act 2016, however, gives WASREB the mandate to license water utilities directly as stated in Section 86.

Section 47(i and j) requires WASREB to develop model agreements to be used between WSBs and WSPs. There are four categories of SPAs: 1) Category 1 – Medium to large WSPs; 2) Category 2 – Community Projects; 3) Category 3 – Community projects (Third Party Operated) and 3) Category 4 – Bulk water supply. This is a contract between a WSB and WSPs to provide water services in a particular area. The agreement is governed by the Principal-Agent relationship. This means the Agent (water utilities) has no power other than that given by the Principal (WSB).

2.2 Institutional Framework and the Role of Water Services Regulatory Board

The Water Services Regulatory Board (WASREB) is one of the institutions established in 2003 under the Water Act 2002 with the mandate to oversee implementation of policies and strategies related to water and sanitation services. WASREB's role is to ensure consumer protection and have access to efficient, adequate, affordable and sustainable water services and sanitation. WASREB's pivotal role in regulation was maintained in the Water Act 2016. WASREB therefore continues to work closely with Water Services Board (WSBs), and Water Services providers towards sustainable water and sanitation services. Figure 0-1 illustrate institutional arrangements established under the Water Act 2016.

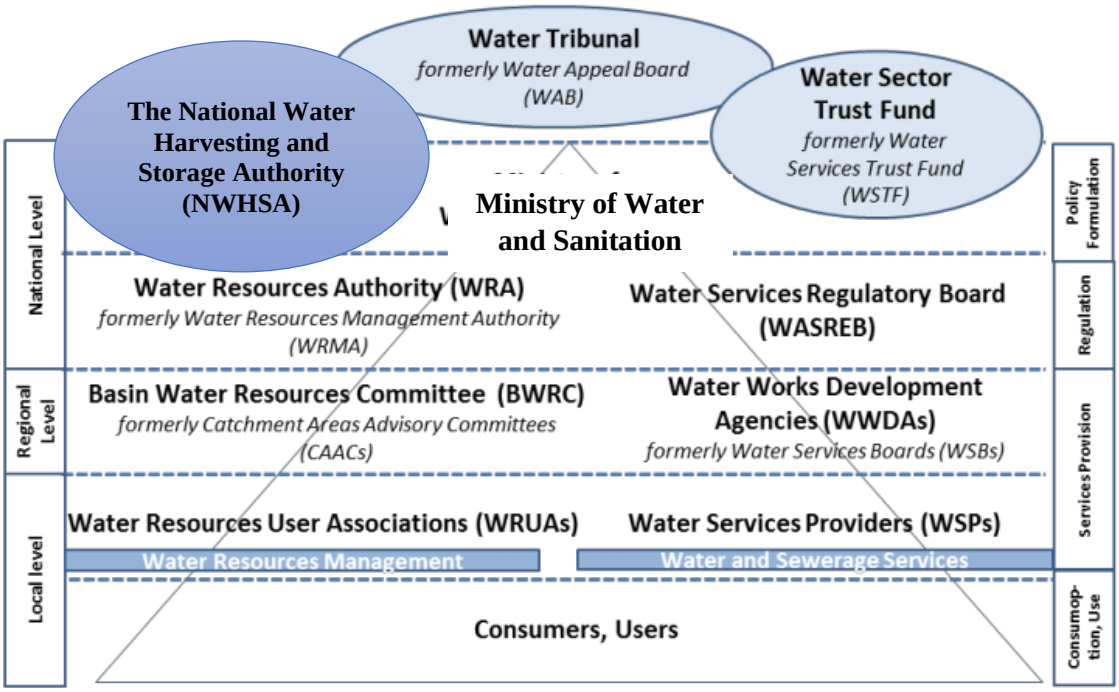


Figure 0-1: Institutional arrangement established under the Water Act 2016

CHAPTER 3: OVERVIEW OF WATER SAFETY PLANNING PROCESS

Even though various water utilities deliver sufficient and safe drinking-water without a water safety plan, the official embracing of a water safety plan and supplementary commitment to the approach can yield numerous benefits. Water safety planning is a step by step approach that should be structured in a number of steps that ensures that all the necessary aspects of water safety are captured. For the purpose of this guide, the planning process for piped systems is structured into ten sections (Figure 3-1). Guideline for non-piped supplies are provided/discussed under vended water.

Section 1: Assemble WSP Team - Set up a team and decide on a methodology by which a WSP will be developed. For large supplies, a multi-disciplinary team of key people should be assembled to develop the plan.	Preparation
Section 2: Water System Description - describe the complete water supply system, from catchment to consumer. System description should also include non-piped water supply and water vending within the utility service area	Assessment of Water Supply System
Section 3: Hazard Identification and Risk Assessment -Identify potential hazards at each step of the water supply chain, from catchment, transmission, treatment, storage and distribution to the consumer. The assessment to include water vending systems as well. Assess the likelihood (level of risk) of incidence of the identified hazards and the consequences (severity) of the effect.	
Section 4: Determine and validate control measures, re-assess and prioritize risks – Identify control measures for each of the identified risk which considered relevant , validate by monitoring and other checks, including monitoring plan (when, frequency, criteria).	
Section 5: Develop, implement and maintain an improvement plan – The process involves review, documentation and formalization of the practices that are not working and addressing of any areas where improvements are needed.	Manage & Communicate
Section 6: Define monitoring of control measures - describe the complete water supply system, from catchment to consumer. System description should also include non-piped water supply and water vending within the utility service area	
Section 7: Verify the effectiveness of the WSP - The reason for water quality verification is basically about confirmation of water quality targets.	
Section 8: Prepare a plan of action including communications, investigations and remedial measures.	
Section 9: Develop supporting programmes - Actions that secondarily support water safety, they are also crucial for accurate operation of the control measures.	
Section 10: Plan and carry out periodic WSP review - Review the overall plan and learn from experiences and new procedures.	Feedback & Improve

Figure 0-2: Steps in Water Safety Planning

CHAPTER 4: WATER SAFETY PLAN TEAM

Water Safety planning and further implementation and maintenance of the WSP is a primary role of the water utility. Developing, implementing and maintaining a WSP within an organization requires a firm top management commitment to the WSP and the allocation of adequate necessary resources. A WSP represents a significant responsibility that is shared by all relevant employees within a water supply organization. The process of development, implementation and maintenance of a WSP is primarily the involvement from a number of supporting and regulatory organizations. Therefore, prerequisite of assembling the WSP team include the following key components: i) Identifying organisations including stakeholders to participate in water safety planning and ii) Undertaking advocacy and creating awareness on water safety planning process and involving the concerned parties.

4.1 Stakeholder Identification, Advocacy and Communication

An important component of a WSP team is the incorporation of the relevant stakeholders. Participation of stakeholders and the affected target population ensures a sense of ownership and hence successful implementation and maintenance. The stakeholders should be drawn from the local, regional, county and where necessary the national level. Table 4-1 illustrates the key stakeholders that should be involved in the WSP planning. Regulators such as WRA and NEMA would be involved on ad hoc basis to advice on policy and/or regulations.

Table 4-2: Relevant stakeholders in water safety planning

Organisation	Point of Contact	Role in Water Services Provision
County Government	Responsible departments; water, environment, social ,community and public health.	Providing materials such as water pipes, assisting in protection of water catchments, seconding support staff to water utilities
Water Services Board	Relevant department responsible for contracting, monitoring and enforcing agreements with Water Service Providers (WSPs), in accordance with regulations set by the Water Services Regulatory Board (WASREB).	Monitors and enforces agreements with Water Service Providers (WSPs), in accordance with regulations set by the Water Services Regulatory Board (WASREB)as well as infrastructure development.
Water Resources Authority, Regional Level	Relevant department responsible for monitoring water resources and catchment management.	Establishing guideline for ambient stream water quality; monitoring the quality of the water resources; and enforcing effluent discharge standards
National Environment Management Authority, Regional / County level	Relevant environmental department responsible for monitoring environmental concerns.	Protection of water sources from pollution (solid waste and effluents) critical by maintaining surveillance
Water Resources User Association	Key management represented, preferably by the chair person	Localised management of catchment (micro-catchments) areas for protection of water courses
Relevant CBOs	Key management represented, preferably the chair person	Partnering with communities in the provision of water.
Water Action groups (WAGs)	A representative of water services	Partnering with communities in the provision of water.
Private water utility within the service area	Key decision maker from the organisation, preferably, the Technical Manager	Complement the utilities established by WSBs in water services provisions. An example is the Runda Water Company Ltd in the NCWSC service area.

Organisation	Point of Contact	Role in Water Services Provision
Private Water Vendors	All forms of water vending to be represented e.g. tankers, kiosks, and human or animal drawn carts	To incorporate water vending aspects in water safety planning
Community/ Consumer/ Customer representative	Any person to represent the community, consumer in the utility water service area.	Illustrate aspects of water safety at household level
Other relevant institutions such as schools, hospitals etc.	Relevant person, preferably from the top management.	Give feedback on water service levels.

Once stakeholders have been extensively and comprehensively identified, an important step before assembling the actual team is advocacy and communication to create awareness on the water safety planning process. Therefore, a consultative meeting involving key decision makers and utility operators including the relevant stakeholders to sensitize/train and explore the level of understanding and perceptions concerning the WSP is approaches necessary. Further, awareness should be created on the benefits of the WSP approach to the existing water quality monitoring programme and the overall impact on the water supply system. Advocacy should also overcome any possible stakeholders/management resistance as well as gain political commitment and support. Whenever necessary, visit to utilities with best practices within the country is undertaken to increase leadership and support. Table 4.2 illustrates a summary of activities during the stakeholder engagement, advocacy and awareness creation.

Table 4-3: Summary of activities during stakeholder engagement, advocacy and communication

Activities	Target Audience	Expected Output and Responsible Organisation
Awareness creation among decision makers, sector and senior professionals in the utility on WSP concepts and relevance on the water supply system operation and management. Highlights of policy and regulations on key aspects such as wastewater and solid waste management and other requirements	National Level – WASREB and relevant ministries Regional Level – County Governments, Regional WRA, NEMA, WSBs, Utilities Local Level – WRUAs, CBOs, consumers representative, private vendors and any other relevant organisation on such a scale that warrants consideration as local relative to the utility service area	~ Clear conceptualization of the WSP approach and the interrelationship with existing frameworks ~ Gain acceptance and approval for development and implementation ~ Sensitization of operational stakeholders on the WSP approach and the benefits in achieving the health-based targets ***Responsible Organisations – WASREB, WSBs, WRA, NEMA, County Governments, Utilities etc***.
Water utility training on the water safety planning. The training should ideally target the entire utility but most importantly water and health sector staffs responsible for promotion and regulation of the safety/quality, quantity/risk to the water supply system.	Water and health sector staff members at county levels and	~ In-depth understanding of the WSP concepts, benefits and applicability ~ A clear cut comparison between current practices, WSP approach and physical utility environments ~ Clear understanding of the roles and responsibility of relevant stakeholders in water safety planning ***Responsible Organisation – Utility, WSB & WASREB, public health department***
Local exposure visits to the utilities with already	Utility professionals from key water safety planning	~ Clear conceptualization of the WSP planning and

Activities	Target Audience	Expected Output and Responsible Organisation
functioning WSP e.g. KIWASCO	departments such as operations, water quality, technical audits among others as well as representatives of private utilities and water vendors association)	implementation strategy and the level of decision makers involvement. ~ To foster leadership commitment in WSP development and implementation ~ To highlight the possible/ expected challenges in water safety planning, actual development and implementation. ***Responsible Organization – Utility, WSB and WASREB***

Note: A catchment spanning several kilometers, might have more than one WRUA. It is important to involve all the WRUAs in the WSP team for effective catchment management. WRA representative shall help in mobilizing the respective WRUAs.

4.2 Assembling the Team

Development of the drinking water safety plan requires an in depth understanding and knowledge of all aspects of a drinking water supply system, from the catchment to the consumers. This implies that the exercise should be carried out by a team that has a wider knowledge and expertise of the entire water supply system i.e. understand water abstraction, transmission, treatment and distribution including the corresponding hazards that can potentially affect the water safety from the catchment to the consumer.

Therefore, assembling a qualified, dedicated team is a key primary stride towards WSP development and further implementation. The utilities vary in size. In small and medium utilities with minimal required expertise, inclusion of external expertise could be helpful. Although, larger and very large utilities have most of the required WSP experts, the utilities may engage external expertise in case they are lacking. Beside involvement of the experts with the desired WSP knowledge, the team may also include relevant stakeholders as highlighted in the previous section. An important early stage task of is setting out a WSP implementation approach/ plan and the methodology to be adopted, most importantly in risk assessment. Table 4-3 below indicates the key stakeholders that should be involved in the water safety planning.

Table 4-4: Illustrates the list of experts that should form part of the WSP team.

Title	Role	Remarks
Team Leader	Make decision on the resource provision, finance and logistics	Utility staff, preferably The Technical manager
Water Supply Engineer/ 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, 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, preferably Water engineer or technician in charge of operation and maintenance of the scheme(s).
Hydrologist/catchment management specialist	Description and characterization of the catchment including delineation/	Outsource, preferably WRA staff or a licensed hydrologist

Title	Role	Remarks
	determination of possible contaminant transport. Assist in the identification of hazards and risk levels, priority control measures including the associated corrective actions.	by the Ministry of Water and Sanitation
Socio-economist	Describe population/ water users including their density, number and the respective concerns related to utility service delivery. The expert to highlight existing community participatory approach and inclusion of all people in the management. Other critical aspects to be assessed by the expert include but not limited to the following: 1) effectiveness of the existing communication system and customer level of awareness with regard to water safety; 2) Existing water tariffs and the perception of the customers; 3) Utility financial sustainability and users satisfaction surveys. The expert to also take part in the assessment process and incorporate the perspective of the relevant consumers.	Utility staff preferably a customer care with a good background with customer relations and billing issues. If the relevant staff, outsourcing from the respective **WSB**. An **independent socio-economist** may also be considered. However, relevant experience **in water utility assessments** is necessary.
Water Chemist/ Bio-Chemist/Hydro-geochemist	To conduct water quality surveillance that informs vital components of water safety planning such as hazards and hazardous events identification, effectiveness of the existing control measures. Water quality surveillance shall involve determination of the baseline level of the physical, chemical and microbiological water quality status at the consumer end pipes.	External experts should be involved. **Water chemist** and/ **biochemist** to be involved in surface water sources. Where a utility exploits groundwater source it is important to involve a hydro-geochemist/hydro-geologist. External/independent laboratories should be used
Water Safety Planning Specialist	~ To provide guidance during the initial stages of planning. ~ To offer initial training on water safety planning	External or Internal expert, preferably utility staff that has undergone through water safety planning training
Human Resource	~ To manage the involvement of external experts as well as utility staffs in water safety planning process. ~ Prepare contract documents in-case the planning process involves external experts. ~ To provide future consideration for involving external experts in matters such as WSP audit.	Utility staff, preferably from the HR department
Legal specialist	To guide the water safety planning team on legal matters that pertain to water safety planning.	**Utility staff**, preferably from the legal department. The utility should consider outsourcing if there is no internal staff
Financial Specialist	Together with the team leader, determine the financial resource availability.	**Utility staff**, preferably from finance department

Title	Role	Remarks
Water Vendors Representatives	To incorporate and integrate water vending as a key component of water safety planning.	All forms of water vending within the utility service area should be involved: Tankers, water kiosks, human and animal power carts and point sources such as wells and boreholes.
Environmental and Public Health	~ Characterizing the health status of the catchment population including prevalence of waterborne and related infections/ disease. ~ Assist in identification of diffuse and sources of contamination in the catchment upstream the intake area as well as the area surrounding treatment and distribution infrastructure. ~ Incorporated the existing efforts in ensuring that water supplied by vendors is clean and safe. Note that in most of the Counties, public health officers undertake routine monitoring of vended water.	**Public health staff**, External expert preferably from the public health department at the county level

Note: In case any of the above experts is available among its staff, the utility should consider out-sourcing. The external experts shall be included only during the surveillance (Hazard identification). The utility might opt to include more staffs where necessary.

4.3 WSP Commitment

A WSP represents a significant responsibility that is shared by all relevant staffs within a water utility. Development and implementation is time consuming and requires significant resources. Implementation requires commitment at all levels within the organization. Maintenance of the WSP requires on-going management attention to reinforce a culture of compliance with the requirements of a WSP.

4.4 Illustrations

Illustration 1: Checklist of skills to be considered when identifying the requirements for all utilities irrespective of the size (Source: WHO Water Safety Plan Manual, 2009).

- Technical expertise and operational system-specific experience required to develop the WSP
- Capacity and availability to undertake the WSP development, implementation and maintenance
- Organizational authority to report through to the relevant controlling authorities, such as the executive of an organization, or leaders of a community
- understanding of the organizational and people management systems and processes that turn plans into actions and that communicate the results of monitoring and reporting
- Understanding the health based targets to be met
- General appreciation of the water quality needs of the end users
- Understanding of the practical aspects of implementing WSPs in the appropriate operational context
- Appreciation of the regulatory and policy environment of the organization
- Familiarity with training and awareness programs.

Illustration 2: WSP Team composition for Kisumu Water and Sanitation Company (KIWASCO)

Table 4-5: WSP Team composition for Kisumu Water and Sanitation Company (KIWASCO)

NO.	DEPARTMENT	JOB TITLE	ROLE IN WSP
1	Technical	Water Production Manager	Team leader
2	Technical	Safety, health, Environment & Quality Manager (SHE-Q Manager)	Laboratory & Quality Activities.
3	Technical	Mechanical Technician	Plant maintenance activities.
4	Technical	Network Maintenance Engineer.	Distribution & network Maintenance
5	Procurement & Finance	Supply chain Manager	Procurement & Finance issues.
6	Commercial	Customer Care manager	Users/Customers issues.
7	Human Resources & Administration	Human Resources Officer.	HR &Administration Issues.

Depending on the size (small, medium large and very large) of a water utility and the complexity of the water supply systems (multiple systems including sources), it may be necessary to assign tasks to small groups or sub-teams, which report to a central overarching team. The groups or sub-teams are only for purposes of initial gathering of data/information and are not WSP teams in themselves The following are key in the development of the such a WSP Team:

- The composition and size of the core team;
- Subordinate teams that undertake particular aspects of the WSP, such as a 'catchment', 'source water', 'treatment' and 'distribution system' sub-team and if necessary, where treatment aspects are complicated and varied for instance, it may be advantageous to have separate treatment teams;
- External team members and reviewers (incorporating government agents and independent experts).

Some of the medium and small utilities may not be having in-house water quality experts (e.g. Matungulu-Kangundo Water and Sanitation Company). Such utilities should have the operators and management on the team and involve external experts to bring in the necessary missing expertise. Refer to able .5 for minimum WSP requirement.

Illustration 3: Stakeholder Identification Matrix for Kisumu Water and Sanitation Company

Table 4-6: Stakeholder Identification Matrix for Kisumu Water and Sanitation Company

	Name of stakeholder	Relationship to drinking water supply issues.	Key point (s)
1.	Lake Victoria South Waster Services Board (LVSWSB)	Asset development & regulation of water companies.	Collaboration in conducting quality tests and related activities that we may not have capacity to carry out.
2.	Water Resources Authority (WRA)	Coordinate catchment protection activities.	Catchment protection instrumental in the water supply activities.
3.	National Environmental Management Authority (NEMA)	Coordination of environmental protection activities.	Protection of water sources from pollution critical.
4.	Water Action groups (WAGs)	Representation of water user issues.	Consumers' involvement critical in water safety.
5.	Kenya Bureau of Standards (KEBS)	Develop and Enforces standards.	Monitoring of the water supplied is critical.
6.	Municipal Council of Kisumu (MCK)	In charge of town planning	Protection of infrastructure.
7.	Lake Victoria Environmental Management program (LVEMP).	Lake Victoria (our main water source) protection activities	Coordination raw water source is important for the water supply
8.	Estate Representatives	Representation of Consumers of the water we supply.	Consumers must be involved in the water safety plan.
9.	Kenya Marine & fisheries Research Institute (KEMFRI)	Carries out research on our main source of water.	Water quality data on the raw water is important for planning.

10.	Provincial Administration	Protection of water supply fittings in the areas of jurisdiction.	Security of the infrastructure important in ensuring water safety.
11.	Fishermen thro' Beach Management Unit (BMU)	Pollutes the parts of the lake where they operate.	To be involved in the lake protection.

The following are sample forms to be adopting essential information when assembling WSP teams and initializing the WSP process.

Illustration 4: WSP team details form

The details of the WSP team including any subordinate teams in-case of multiple systems should be accurately documented as part of the methodology. The list of the team should be updated as this changes.

Table 40-7: WSP team details form

Name	Affiliation	Title	Role in Team	Contact Information
Eng. Anonymous Xyz.	Technical	Water Production Manager	Team leader	+254-123456789, abcdefgh@yahoo.com, fghijklm@gmail.com
↓ Etc				

Illustration 5: WSP resourcing plan form

WSP budget may vary the utility sizes and capacity of in-house staffs and expertise. Expertise out-sourcing might be necessary when there is limited in-house expertise and capacity; it is however important to note that this should be minimized in case of availability of internal capacity. For small and medium utilities, the aspect of out-sourcing may proof to be expensive and thus requires early planning for effective resource mobilization.

Table 4-8: WSP resourcing plan form

Activity	Budget	Aspects sourced from the utility	Aspects sourced from outside	Staff budget
Section 1 of WSP				
↓ Etc				

Table 4-9: Stakeholder Identification form.

Stakeholder Name	Relationship to drinking water supply	Key point	Point of contact in WSP team	Stakeholder point of contact	Interaction Mechanism	Reference to contact details and record of interaction
National Environmental Management Authority	Regulate pollution activities in water resources	Impacts on catchment protection	Regional regulatory officer	Regional Manager	Plan development and annual meetings	Environment file
↓ Etc						

CHAPTER 5: DESCRIBE THE WATER SUPPLY SYSTEM

This is the initial task that should be undertaken by the assembled WSP team. Comprehensive description of the water supply system supports subsequent risk assessment and management approach. Gathering of information should include but not limited to the following:

- ~ Information gathering on the WSP system,
- ~ Prepare a flow chart from source to consumer including the elements described below,
- ~ Inspect the system to verify that flow chart is accurate,
- ~ Identify potential water quality problems.

This stage is the foundation for WSP development and forms the basis of identifying the vulnerable sections of the water supply system, a critical component of hazards, hazardous events and the corresponding control measures identification.

5.1 Description of the conventional water supply system

Key components of water supply system include catchment, treatment process, transmission and distribution, and consumer points. The development of a WSP builds on the information obtained about the catchment and the potentially polluting activities present. For water bodies with small catchments, land uses and other human activities in the catchment may be easier to identify, assess and control that larger catchment areas with intakes in the lower reaches. Knowing the size of the catchment is a pre-condition for defining the extent that the WSP team is to consider. It is thus necessary for the GIS expert on the tem to delineate the catchment boundary prior to the assessment. Catchment and water bodies description involves the following:

- ➢ Describing processes that may influence water quality up to the off take point.
- ➢ Check the potential impacts such as sanitation, storm water, wastewater reuse, agriculture, aquaculture and fisheries, commerce, industry, mining, traffic including recreation activities in the catchment.

Description of the water supply system also involves developing a flow diagram or sketch as well. A flow diagram ought to be comprehensive enough capturing all the critical elements of the water supply system. On-site field visits are necessary for flow diagram validation for use in the risk assessment process. The WSP should check the location of features such as property boundary, sewerage plants, septic tanks among other potential sources of risk. Normally, treated water is conveyed to service reservoirs and later distributed to consumers. At times, water from different treatment plants is conveyed to an number of service reservoirs at different locations within the service area. There may be as well a number of water sources supplying different service reservoirs and distribution system, either linked ore separated. Transmission and distribution can either may involve complete gravity conveyance, direct pumping and combine gravity and conveyance. It is vital to outline all these aspects during the system description. The table below illustrates important key features of the description process.

Table 5-1:Components of the water supply

Component of the Water Supply System	Key features to Consider in the Description
Catchment	~ Geology and hydrology, ~ Meteorology and weather patterns, ~ General catchment and condition of rivers, springs and boreholes, ~ Wildlife, ~ Competing water uses, ~ Nature and intensity of development and land-use,

Component of the Water Supply System	Key features to Consider in the Description
	~ Other activities in the catchment which potentially release contaminants into source water, and ~ Planned future activities
Surface Water Sources	~ Description of water body type (e.g. river, reservoir, dam, lake), ~ Physical characteristics such as size of water body, depth, thermal stratification, altitude, ~ Flow and reliability of source water, ~ Retention times, ~ Water constituents (physical, chemical, microbiological), ~ Protection of the water body (e.g. enclosures, access), ~ Recreational and other human activities taking place in the water body, how the activities impact the safety of the water, ~ Bulk water transport from the water body and how the activity impacts the safety of the water.
Groundwater systems	~ Whether the aquifer intended for water abstraction is confined or unconfined, ~ Aquifer hydrogeology, ~ Flow rate and direction of water, ~ Dilution characteristics, ~ Recharge area, ~ Well-head protection, ~ Depth of casing, and ~ Bulk water transport
Treatment process	~ Treatment processes (including optional processes), ~ Equipment design, ~ Monitoring equipment and automation, ~ Water treatment chemicals used, ~ Treatment efficiencies ~ Disinfection removals of pathogens, and ~ Disinfection residual and contact period time
Service reservoirs and distribution systems	~ Physical components - water transmission mains, pipe materials, pumps, treatment process, metering, stand pipes and water kiosks, water distribution mains, service reservoirs, valves, hydrants and age of infrastructure. ~ Water quality – Chemical and biological quality source water, mixing, customer complaints, types of source water, water quality data, changes in distribution systems (e.g. disinfection by-products), penetration of residual disinfectant. ~ Physical factors influencing water quality – cross-connection control programmes, frequency of water mains breaks, soil conditions that could influence water main breaks, leakage (Non-revenue), and history of external corrosion. ~ Hydraulic (performance) factors influencing water quality – water flows, intermittent or continuous supply, water pressure (including variations), detention times (water age). ~ Environmental factors – Terrain, drainage systems, solid waste dumps, sewerage systems (proximity, open or closed systems)
Water Vendors	~ Description of water body type (e.g. river, reservoir, dam, lake) ~ For groundwater sources, describe as illustrated in the earlier section of this table (groundwater systems)

Component of the Water Supply System	Key features to Consider in the Description
	~ Water transport from the water body and how the activity impacts the safety of the water.

5.2 Illustrations

Illustration 1: Basic arrangement of the water supply system

The description of the water supply system ought to cover all the key and critical components from the catchment to the consumer. The extent of the system description vary with the size of the WSP. In general, most water utilities in Kenya have adopted a conventional system. Figure 5-1 below illustrates the basic elements of the water supply system. There exists several form of water supply systems. For the case of Nairobi City Water and Sewerage Company (NCWSC) has three water treatment plants with the largest TP fed by three source catchments. Further, the service reservoir at Kabate receive water from the three treatment plants with the distribution divided into the trunk main, service reservoirs and the network elements. Most of the utilities have adopted systems that are composed a source, treatment, distribution and the end user (consumer). However, in some cases where the source water do not require treatment except for disinfection, water is piped direct to the consumers.

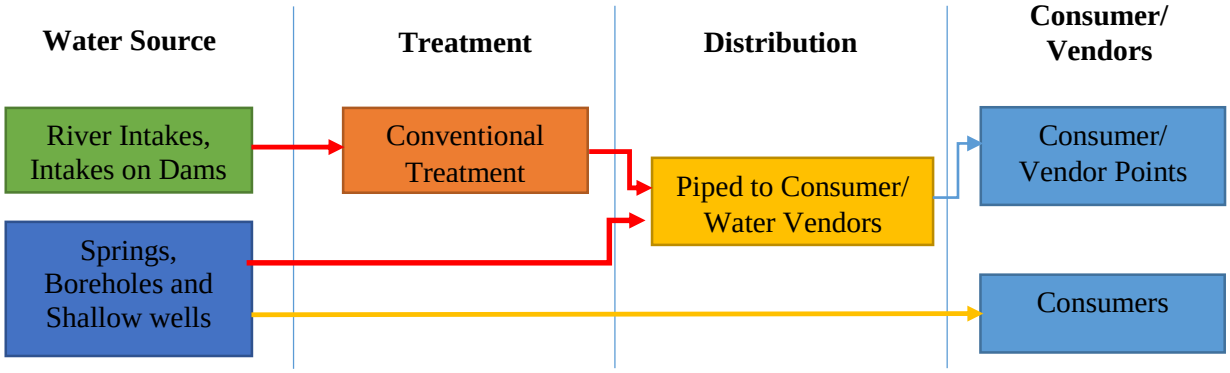


Figure 5-1: Basic elements for describing a water supply system

Illustration 2: Basic Arrangement of a Conventional Treatment Plant

A flow diagram that is accurately and comprehensively described from the source to the consumers is critical for hazard, risk and current control identification. For the systems that have TP, it is vital also to describe the water treatment process. In the description of the water systems, it also vital to split the diagram in to discrete basic elements highlighted above. Such discrete elements are vital for more than one source in the catchment, varying treatment streams and service reservoirs, trunk mains and different network distribution. Figure 3-3illustrates the typical treatment process for a conventional system. In describing the treatment process, it is vital to also identify the chemical used in the treatment process. Further, describing the status of the storage facilities used in chemical storage is necessary guiding hazard identification process.

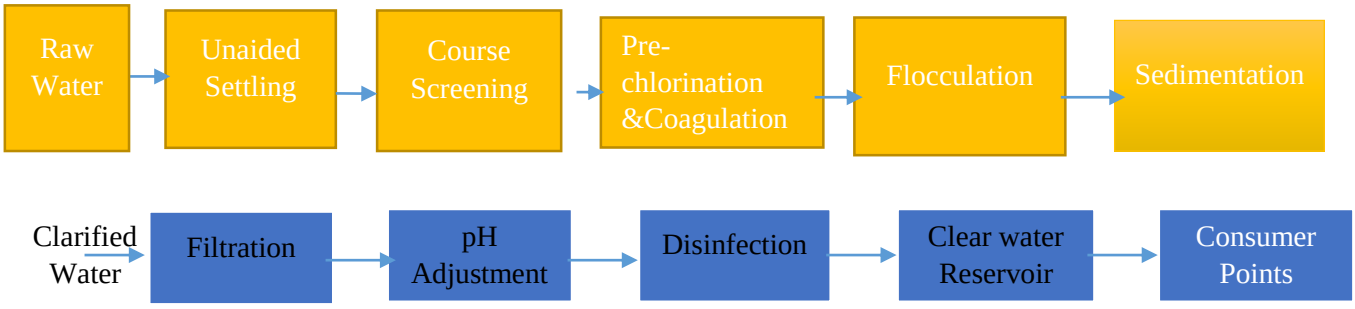


Figure 5-2: Basic elements for a conventional water treatment plant

Illustration 3: Best Case Scenario – NCWSC Water System Flow Diagram

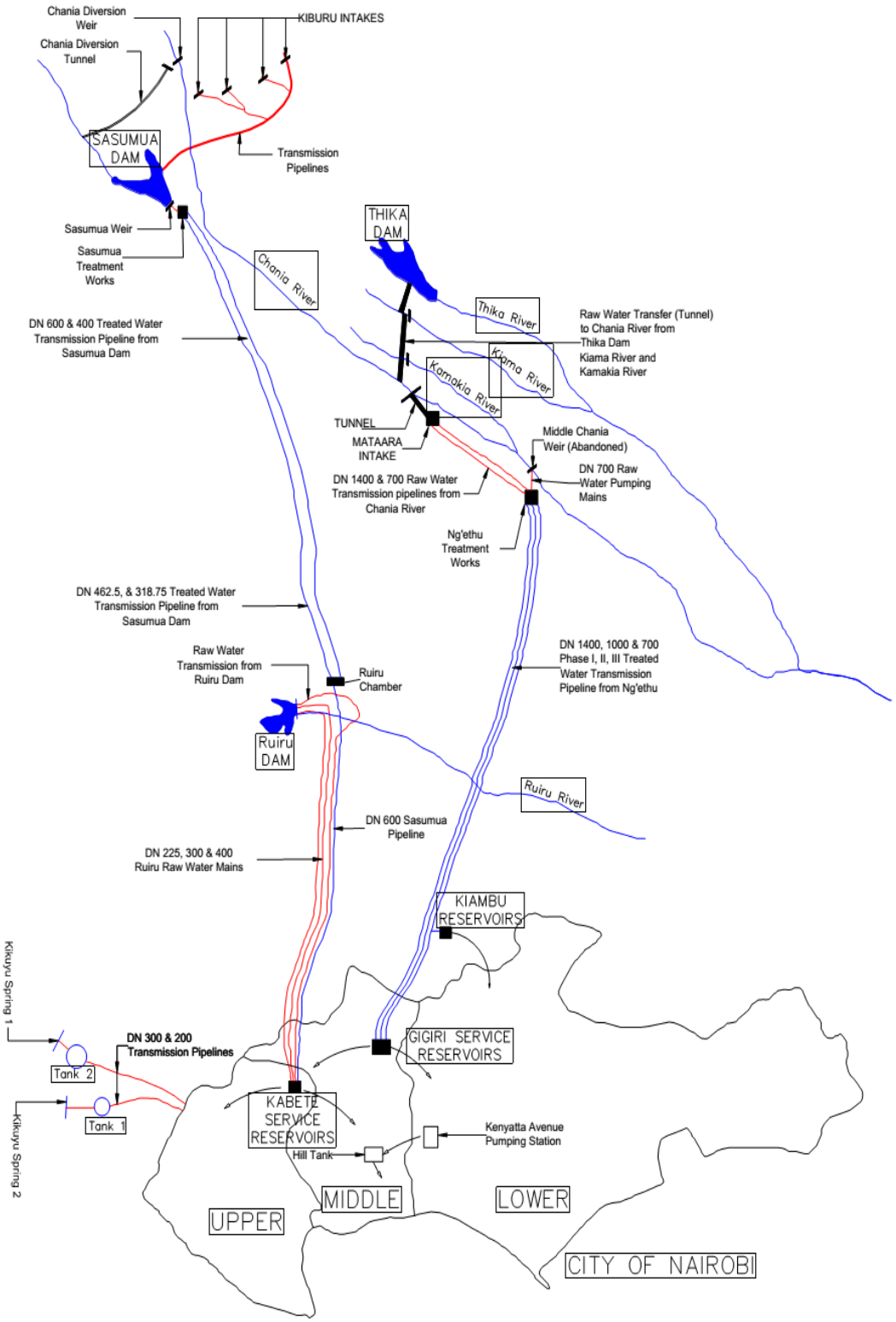


Figure 5-3: An illustration of a water supply flow diagram. The diagram represents the NCWSC system.

5.3 Description of Water Vending Systems

Most of the water utilities do not meet the demand in their respective water service areas. Water vending complements the utilities to ensure that the gap between supply and demand is reduced. In describing the water supply system, water vending should be incorporated. The vending systems in existence include: water kiosks, tankers, human and hand-drawn carts, and water points. Below is a brief description of the systems. The details on water vending including specific guideline are presented in Appendix 2.

i. Water Kiosk Vending System –The water kiosk vending system is a pretty simple system that basically involves a source (piped or borehole), a storage tank and a means of transfer of the water into the customer's container which is usually a tap with a hose pipe extension. The water storage is in most cases an elevated tank mounted on top of the water kiosk with some vending it directly without storage. In describing the kiosk system, it is vital to analyse the source.

ii. Tankers Systems - They are vehicles fitted with water tanks with a capacity of up to 10M3 which are used to deliver water to the consumer premises. They may be either utility or privately owned. The sources of water for tankers are also varied but the most common include utility water, either from designated points or illegally from hydrants, and private boreholes. Tankers may also draw water from a water kiosk.

iii. Human or Donkey Powered Carts Vending Systems - The vendors use carts to transport and sell water in 20L Jerri cans or sometimes drums and small tanks. Handcart and donkey drawn cart vendors get water from any available sources e.g. water kiosks, wells, springs, boreholes, rivers, dams, water pans etc. They are by far the hardest vendors to regulate since they sell water in small quantities whose sources may not be immediately easy to establish. The containers are usually either filled while on the cart using a hosepipe or on the ground before being loaded onto the cart. At the consumers premises the containers are emptied directly into the storage containers or tanks.

Water Points Vending Systems - They mainly include shallow wells and springs from which people are allowed to draw water at a fee. The shallow wells do not require permits and are hand dug where the water table is high. A high water table coupled with the sanitary conditions in the low income areas poses water safety problems for consumers of this water hence some form of treatment may be required. Springs on the other hand are naturally occurring and if well protected the water is safe to use with no further treatment required.

5.3.1 Illustration: Non-piped water supply in the basic arrangement of the water supply system

The existing water utilities ranging from very large, large, medium to small do not meet the water demand. Description of the extent of non-piped water supply and water vending is critical in hazard identification. The common forms of water vending the should be part of the basic water supply system include water kiosks, tankers, human/animal drawn carts, water points (boreholes, shallow wells and springs) among others (*See the details on systems description on water vending in Appendix 2*).

CHAPTER 6: IDENTIFY HAZARDS AND HAZARDOUS EVENTS AND ASSESS THE RISKS

Understanding the whole water supply system from the catchment to consumer points is key to identifying the potential risks. Hazard identification in WSP involves analysis of activities, actions and facilities within the water supply system. Most importantly, activities should be focused towards the contaminant pathways at any point of their entry into the water supply system. The aim is thus not only to create an inventory of potential hazards but characterize the hazards and the corresponding events that cause their release into the water supply system. Hazards are biological, chemical and physical agents that can cause harm to the public health while hazardous events are events introducing the hazards into the water supply system. These resulting risks are described by a combination of identifying the likelihood that hazardous events will occur and evaluating the severity of the consequents of the events just in case they do occur. The following characterization provides the basis for subsequent risk assessment and thus recommended during water safety planning.

- The chemical, physical and/ or biological properties determining mobility and persistent in the water supply system.
- The health relevance of the identified hazards
- Possible maximum loads of the pollution
- Type and time pattern of pollution i.e. point versus diffuse sources and continuous or periodic release of contaminants into the water supply system
- Relevant pathways of contaminants / or pollution transport in the entire water supply system

Definition of hazards, hazardous events and risks

The *Water Safety Plan Manual* (Bartram et al., 2009) and the WHO *Guideline for Drinking Water Quality* (WHO, 2011) define hazards, hazardous events and risk as follows:

- A **hazard** is a biological, chemical, physical or radiological agent that has the potential to cause harm.
- A **hazardous event** is an incident or situation that can lead to the presence of a hazard (what can happen and how).
- **Risk** is the likelihood of identified hazards causing harm in exposed populations in a specified time frame, including the magnitude of that harm and/or the consequences.

Introduction of hazards into the water supply system follows a number of pathways depend on the component of the utility system: Catchment, Treatment, Storage and treatment, and Consumer points. This stage of water safety planning involves two main actions:

6.1 Hazard Identification

The WSP team is required to identify and assess hazards and hazardous events at each step in the validated process flow diagram. All the potential hazards including the corresponding hazardous events that can affect water quality including the design, physical and hydraulic of the water supply systems leading to contamination of the water supply and hence interruption are identified. Potential hazards in the water supply system may include microbial, chemical and physical. Hazardous events are grouped into categories/groups based on the circumstances or events that affect the integrity of the system and the quality of the water within. The categories are briefly illustrated in the discussions below:

- Anthropogenic Integrity – Human activities in the catchment that lead to environmental degradation and hence pose a risk to the water supply. Such activities include but not limited to the following: industry and commerce; human settlements; traffic and transportation; agriculture;

forestry; horticulture; aquaculture; and the generation, disposal and treatment of waste and wastewater. Below is a conceptual model for risk assessment for surface water catchments

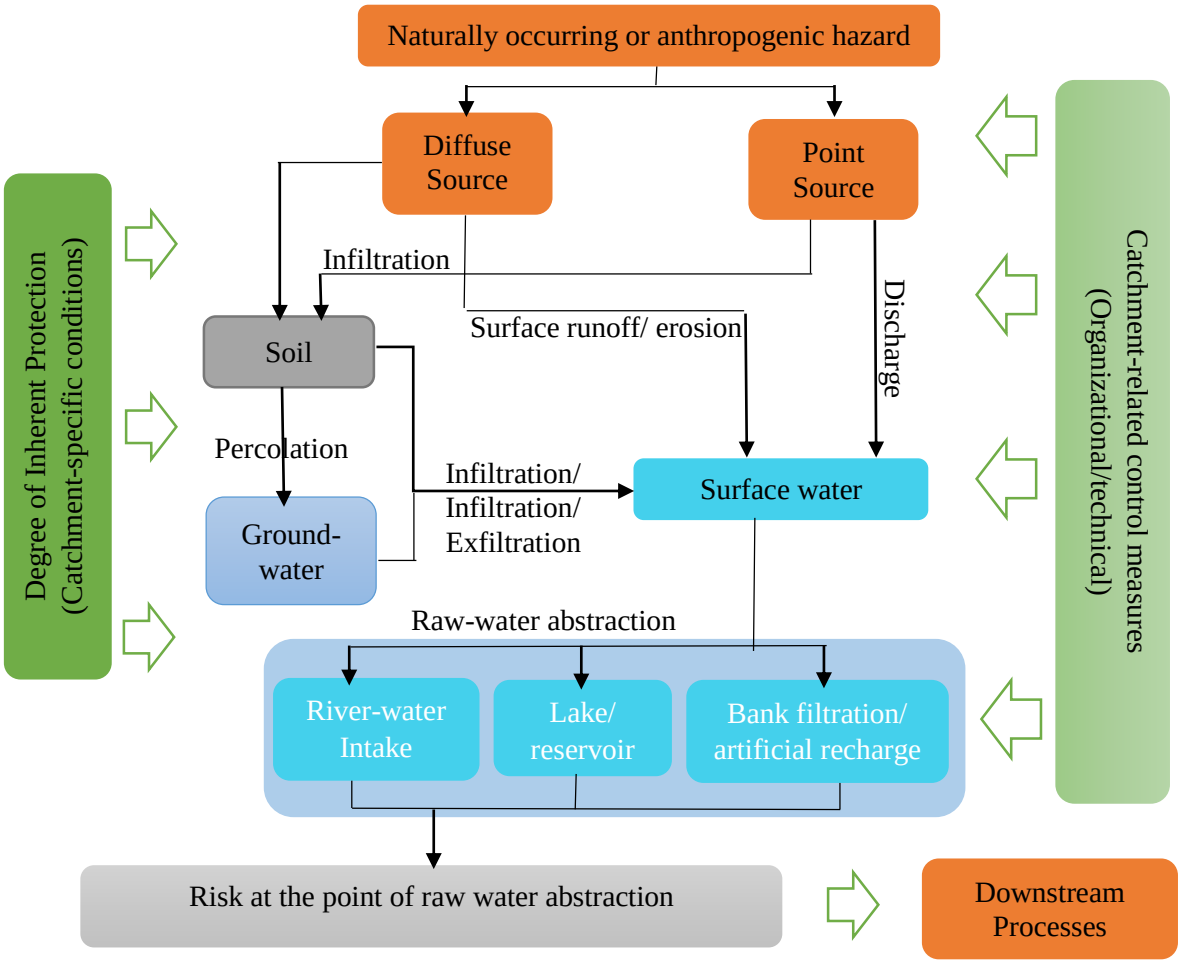


Figure 6-1: Conceptual model for a risk-assessment of surface-water catchments

- Natural process integrity – Natural processes occurring in the catchments or groundwater aquifers can alter the water quality posing a risk to the end users. For instance, groundwater flow through high fluoride and or arsenic bearing rock structure results in contamination with these mineralogical elements. Consumption of high concentration of certain chemical elements that occur naturally have been known to have adverse impacts on human health.
- Physical Integrity – This applies mainly to the transmission, treatment and distribution components of the water supply system. Breaks in the physical barrier of the water supply components that allow external contamination that affects drinking water quality including structural failures of these respective components.
- Hydraulic Integrity – Factors that lead to loss of hydraulic integrity, such as high turbid water that blocks the filters reducing/ completely preventing hydraulic conductivity; changes in flow and pressure resulting from poor operational control of valves, pumps including impacts of maintenance and repairs.
- Water quality Integrity – These are situations leading to water quality loss as a result of the process the occur within the water supply systems. High turbid water beyond the system capacity, biofilm growth, leaching, corrosion, water age and discoloration.

6.2 Risk Assessment

Approaches to risk assessment are more less similar putting into consideration the likelihood of occurrence of a hazardous event and the resultant severity of the consequences. Approaches to risk assessment that should be adopted in water safety planning can be either qualitative, semi-quantitative or quantitative. Generally, the risk assessment method should be as simple as possible depending on the size and type of a water supply system. The purpose of risk assessment should always be focussed towards establishing a risk management approach. The choice of a risk assessment approach that yields acceptable, reasonable and feasible results in a given localised conditions is dependent on the following aspects.

- Resource availability for assessment performance and subsequent data gap filling,
- The extent of water supply system complexity,
- Availability of information that can be easily obtained and or generated,
- The accuracy and quality of available information,
- Approach simplicity visa viz technical and methodological background of the WSP team,\ assembled,
- Availability of additional expertise needed.

It is important to note that potential impact on public health is the most vital consideration in risk assessment. Thus, the approach chosen should clearly and comprehensively define the risks involved. However, other water safety aspects such as aesthetic, continuity and adequacy of the water supplies should also be considered. Below is a description of the approaches that can be adopted in risk management.

a) Simple and qualitative risk assessment – Hazards and hazardous events are assessed and prioritized based on the WSP judgement. The approach considers three aspects: 1) How likely the hazardous event is to occur, 2) How serious the consequence may be, and 3) control measures in place to prevent the hazard from occurring. In this approach, the WSP team documents issues of greatest concern that should be addressed as a priority.

b) Semi-qualitative risk assessment – The approach adopts a scoring or index method. This approach is recommended by water safety plan manual (Bartram *et al*., 2009) as well as WHO Guideline on water quality. In this case, a risk is assessed using a matrix based likelihood and severity of consequences. The approach adopts such terms as minor, moderate, major, etc. and thus it is important for the team to establish the meaning of the terms before the assessment. The purpose of this approach is to distinguish between risks and focus the attention on managing and mitigating the high and very high risk that are more likely to cause harm. Even though the WSP is at will to choose the desirable risk assessment approach, this is the recommended approach. See illustration x for the proposed 3 x 3 risk assessment matrix.

c) Quantitative risk assessment – This is a sophisticated approach to risk assessment that adopts simulation models and further require measured parameters as input data. A common category of this approach is the Quantitative Microbial Risk Assessment (QMRA). QMRA is the process by which the impacts of events like pathogen inhalation and ingestion can be analysed. The method takes into consideration the following: pathogen sources, fate and corresponding transport within the water supply system including exposure pathways. WHO has described a four step framework in the application of the technique: 1) Problem formulation in which the scope and purpose of the assessment is defined (hazards, pathways and outcomes); 2) Exposure assessment in which the dose of pathogens for the defined hazard pathways is predicted (source concentration, barrier reduction and contamination), and frequency); 3) Health effect assessment that zooms into expected health hazards of the defined hazards (Dose – response models, illness and sequel (effect), secondary transmission and immunity, and impact on disease burden; and risk characterization that highlights the expected effect of the predicted dose (risk quantification, analysis of variability and analysis, and sensitivity analysis).

6.3 Illustrations on system description

Illustration 1: Typical Hazards emanating from the catchment

Table 6-10: Typical Hazards emanating from the catchment

Hazardous events	Associated Hazard
Meteorology and weather patterns	Flooding/rapid changes in source water quality, In some cases,
	Drought, inadequate water and increasing contaminant concentration
Agriculture	Microbiological contamination, pesticides, nitrates, ammonia, phosphates, slurry and dung spreading
Transport	Pesticides, chemicals (road traffic accidents) – This is very minimal
Development of roads	Runoff/siltation – Especially for new road constructions where there is heavy excavations
Housing-septic tanks	Microbial contamination, pharmaceutical residues - Affects intakes downstream of urban settlement e.g. Mbagathi Intake operated by Oloolaiser Water Utility
Abattoirs	Organic and microbial contamination
Recreational use	Microbial contamination - Such as boat riding on Maruba dam. Important to note: the Machakos people's park is located just upstream of Maruba dam
Wildlife	Microbial Contamination – The upstream
Solid waste disposal	Blockages, chemical/microbial contamination - Especially for the intakes downstream of the urban settlement.
Raw water storage	Algal blooms and toxins, weeds - This is common for most of the dams. It has been mentioned that algal blooms increases the treatment cost.
Borehole head works not water tight	Surface water intrusion into the boreholes – Very old boreholes that are rarely serviced.
Competing uses	Sufficiency of the available water – For example, Thika dam commonly known as Ndakaini has not filled up even after heavy rains. Even though the cause hasn't been established yet, high abstraction, impounding and diversions upstream and recharge (water loss) into subterranean reservoirs might just be among some of the reasons.
Borehole casing corroded/ incomplete	Surface water intrusion into the existing boreholes – Old boreholes which are rarely serviced
Unconfined aquifer	Water quality changes with season. Responds to the seasonal changes of water quality. Especially for the utilities utilizing river bank filtration

Illustration 2: Typical Hazards associated with treatment

Table 6-2: Typical Hazards associated with treatment

Hazardous Event	Associated Hazard
Power supplies	Interrupted treatment/loss of disinfection
Unapproved treatment chemicals and materials	Contamination of water supply
Contaminated treatment chemicals	Contamination of water supply
Blocked filters	Inadequate particle removal
Inadequate filter media depth	Inadequate particle removal
Insecurity/ vandalism	Contamination/loss of supply
Instrumentation failure	Loss of control
Telemetric hitch	Communication failure

Illustration 3: Typical hazards in the transmission and distribution system

Table 6-3: Typical hazards in the transmission and distribution system

Hazardous Event	Associated Hazard
Mains burst	Ingress of contamination

Pressure fluctuations	Ingress of contamination
Intermittent supply – Also leads to pressure fluctuations	Ingress of contamination
Opening/closing valves – Leads to pressure fluctuations as well	Reversed or changed flow disturbing deposits, introduction of stale water, Even though not mentioned, it is a common occurrence especially in intermittent water supply
Use of unapproved materials (Asbestos has been noted in some sections)	Leakage of contaminants into the water systems e.g. the prohibited asbestos material still exists in few sections
Unauthorized/ illegal connections	Contamination by backflow/ Ingress of contamination as well
Leaking service reservoirs	Ingress of contamination
Security breach / Vandalism	Ingress of contamination
Not cleaning of the reservoirs	Accumulation of sediments

Illustration 4: Typical hazards at consumer points

Table 6-3: Typical hazards at consumer points

Hazardous event (source of hazard)	Associated hazards (and issues to consider)
Containers used	Contamination at household
Poor handling of the pipe fitted on the taps	Contamination with bacteria from polluted contact surfaces
Unhygienic pit latrines that are too close to the water point	Contamination by flies landing on the tap and open water containers
Leaking hose pipes connected on the tap	Admits contaminants into the water
Rusted metallic pipes	Entry of contaminants in the water
Vandalism/heavy floods	Ingress of contaminants
Poor/failure to disinfect/flush out water after repairs and fixtures	Ingress of contaminants from polluted contact surfaces

Illustration 5: A recommended 3 x 3 risk assessment matrix

The level of risks should be assessed for the hazards and hazardous events identified to allow for setting of priorities for risk management. In risk assessment, the seriousness of the identified hazards and hazardous events have been assessed in the context of likelihood of occurrence and consequence of exposure.

Risk is defined as the **likelihood** that a hazardous event will cause harm combined with the **severity** of its consequences i.e.

Risk = Likelihood x **Severity**

The following risk matrix (3 x 3) in Table 6-4 was used to obtain a risk score and hence the risk level). The resulting risk score ranges from a minimum of 1 to a maximum of 9. The risk level determines areas where priority action should be focused by management of utilities in order to ensure water safety.

Table 6-4: 3 x 3 risk assessment matrix

Likelihood	Score	Consequences		
		No/Low Impact	Moderate Impact	Major Impact
		1	2	3
Unlikely	1	1	2	3
Possible	2	2	4	6
Very likely	3	3	6	9
	Risk Score	≤ 2	3 - 5	≥ 6
	Risk Level	**Low**	**Medium**	**High**

CHAPTER 7: DETERMINE AND VALIDATE CONTROL MEASURES, REASSESS AND PRIORITIZE THE RISKS

Control measures are actions that reduce levels of hazards within water supply systems either by preventing entry, reducing concentration, or by restricting their production. Many control/regulation measures are effective against more than one specific hazard while some hazards may require more than one control measure for effective control. The assessment and planning of control measures should ensure that health-based targets will be met and should be based on hazard identification and assessment. Identification and implementation of control measures needs to be based on a multi-barrier principle so that if one barrier fails, the remaining barriers will still operate, thus minimizing the likelihood of contaminants passing through the entire system and being in sufficient amounts to cause harm to consumers. Certain control measures are actions at specific points in the system and are referred to as control points. Defining control points is an important component of the water safety plan and provides water utilities with information regarding where specific actions need to be taken to ensure water safety. Control points should not be the only focus of water utilities to ensure water supply as a collective and preventative approach is required.

The prioritization of control measures and points must be related to the severity of the potential risk. Control points identified as being of higher priority are therefore monitored more frequently to ensure that there is compliance. For each control measure, critical limits should be defined. Critical limits are the performance targets that, when exceeded, compromise the quality of water being supplied. Critical limits define when the control measure is out of compliance and action is required. It is essential that critical limits be directly or indirectly measurable. Limits will be indicators that can be readily interpreted at the time of monitoring and where actions can be taken in response to non-compliance. Critical limits are defined so that they do not automatically lead to a breakthrough of pathogens into the water supply, but signal that actions are required urgently to prevent an unacceptable level of risk occurring. Control measures should be identified for each step in the water supply.

7.1 Identification of Controls

All the existing control measures should be clearly identified singling out clearly all significant hazards without control measures in place.

7.2 Validation of Control measures

Validation is the process of obtaining evidence of the performance of control measures. For many controls, validation will require an intensive programme of monitoring to determine the performance of a control under normal and exceptional circumstances. The efficacy of each control measure should be determined at its point in the water supply system rather than in isolation as the performance of one control can influence the performance of subsequent controls. If a control has been in place for some time, a utility may have sufficient operating data to give it confidence that further validation monitoring is not required. Technical data from scientific literature or data from studies at pilot drinking-water treatment plants may be helpful in the validation process, but care must be taken to check that the circumstances described or piloted are the same or very similar to the risks that have been identified as requiring controls. Validation may also be carried out by seeding challenge organisms or chemicals and determining the effectiveness of removal or inactivation, although this is not a procedure that should be used when water is going into supply. Validation of controls will involve a variety of methodologies. For example, validating buffer distances and fencing in a catchment may be carried out through catchment sanitary surveys to ensure minimal risk of microbial pathogens entering a water intake; and an alternative power source, supplied through an on-site emergency generator, may be validated by demonstrating that it switches on when power is lost, and that it has sufficient power output to run the required process.

7.3 Reassessment of risks

The risks should be recalculated in terms of the likelihood and consequences taking into account the effectiveness of each of the identified control measures. Control measures must be considered not only in their longer term average performance but also in light of their potential to fail or be effective over a short time span. Significant risks that do not have control measures should be identified as remaining significant.

7.4 Prioritize all the identified Risks

Risks should be prioritised based on their likely impact on the capacity of the system to deliver safe water. High priority risks may require system upgrade to achieve the water quality target. Thus, the need for the next step in this process.

7.5 Illustrations

Illustration 1: Typical control measures associated with hazards at a catchment

Table 7-1: Typical control measures associated with hazards at a catchment

Regulated access at the catchment
Ban of human activities that degrade the catchment such as uncontrolled agriculture and irrigation
Gabion construction to minimize impact of landslides on water quality
Afforestation practices
Sanitation practices around springs and boreholes
Alternative water source in case of an emergency
Disaster preparedness procedures for dams
Water Resource User Association involvement in catchment protection and reporting cases of illegal connections/poor water quality
↓

Illustration 2: Typical control measures associated with hazards at treatment

Table 7-2: Typical control measures associated with hazards at treatment

Use of KEBs validated treatment chemicals
Application of the correct dosages of water treatment chemicals
Well-equipped laboratory facility
Display of standard WASREB laboratory procedures/Standards in the laboratory
Availability of equipment monitoring and inspection schedule
Skilled personnel at the facility
Proper and retrievable records
Proper storage of treatment chemicals (e.g. for HTH air tight containers in a dry place)
Jar tests
Daily water quality analysis and reporting (before and after treatment)
Scour pipes and washouts in place for scouring the intake.
Screens on the weirs
Cleaning of the coagulation and sedimentation tanks.
Provision of airtime to facilitate communication between the treatment plant and the main office
↓

Illustration 3: Typical control measures associated with hazards at a distribution network

Table 7-3: Typical control measures associated with hazards at a distribution network

Prompt attention to bursts and breakages
Continuous patrol and inspection along the system
Use of KEBS approved materials for the reservoir tanks and pipelines
Flashing the pipes immediately after repair
Replacement of leaking tanks and pipes
Siting of the pipelines and tanks in areas with minimal interference e.g. in schools to reduce vandalism and away from roads
Issuance of notification to consumers in case of system failure
Routine cleaning of the system
↓

Illustration 4: Typical control measures associated with hazards at consumer premises

Table 7-4: Typical control measures associated with hazards at consumer premises

Sampling and analysis of the water regularly
Sensitize and inspection of consumer points not to mix water from different sources in their storage facilities especially in schools and urban centres
Proper record keeping of the entire consumer fraternity and connections
Provision of contact to consumers to air their complains and report emergencies
Availability of pro-poor personnel and customer care to attend to the community
↓

Illustration 4: Critical limits and actions relating to microbial hazards for piped water

Table 7-5: Critical limits and actions relating to microbial hazards for piped water

Hazard and hazardous event	Example of Control measure	Critical limit target	Critical limit trigger for action
Microbial hazard from contamination due to pipe bursts	Installation of washout valves and flashing out the water after repair	Breaking the pressure of the water, not interfering with the pipelines	Breakage/cracks on the pipes
Microbial hazard due to sewerage contamination	Avoiding installing pipes close to sewer lines	Proper physical planning such that sewer lines/septic tanks are far from water pipes	Leaking sewer lines close to the cracked water pipes
↓			

Illustration 5: Critical limits and actions relating to microbial hazards for groundwater

Table 7-6: Critical limits and actions relating to microbial hazards for groundwater

Hazard and hazardous event	Example of Control measure	Critical limit target	Critical limit trigger for action
Microbial hazard from septic/human waste seepage	Drilling boreholes away from sanitary facilities Considering the terrain of the area before drilling the borehole	Adhere to the national regulations on the proximity of latrines from water points Drilling the borehole on high altitudes where the terrain is undulating	When the sewerage mixes with the groundwater
↓			

Illustration 6: Validation information capture format

Table 7-7: Validation information capture format

Validated Item	Validation	Reference
Residual Chlorine	The WASREB standards provides that residual Chlorine should be between 0.2-0.5mg/l at the consumer point to safeguard against microbial contamination	https://wasreb.go.ke/downloads/Water_Quality_&_Effluent_Monitoring_Guideline.
↓		

Illustration 7:Validate controls before prioritizing risks for mitigation

Risks can only be reassessed and prioritized following validation of control measures. Initial validation of controls can be carried out through intensive monitoring, unless controls have proved their effectiveness over time. If it is clear that the system needs to be improved to achieve the relevant water quality objectives, an upgrade/improvement plan should be developed and implemented.

Illustration 8: Maintaining consistency in reassessing and prioritizing risks

Decide on a consistent risk assessment methodology upfront, as done in section 3;

Be specific about the hazard in terms of :

- Likelihood of the hazard occurring, taking into account the effectiveness of the control
- Consequences of the hazard occurring
- Probability that it will affect the safety of the water supply
- Where and when it can occur

Illustration 9: Establishing cut-off points to prioritize risks

The WSP team needs to establish a cut-off point, above which the reassessed risks will require further action and below which they will be kept under review. Any risk that includes a catastrophic consequence rating should be documented and kept under review even if the likelihood is rare. Classifying the risk from low to very high can be rather subjective but should help to prioritize where the most urgent action is required.

Table 7-8: Establishing cut-off points to prioritize risks

Hazardous event	Hazard Type	Likelihood	Severity	Risk score	Risk level	Control Measure	Basis
Contamination from human waste	Microbial	3	3	9	High	Disinfection using Calcium Hypochlorite etc. Notification of water treatment at household level in case utility treatment is not effective.	Disease outbreak have been seen in similar situations
↓							

Illustration 10: Output of hazard assessment and determination and validation of control measure,(KIWASCO)

Table 7-9: Output of hazard assessment and determination and validation of control measure,(KIWASCO)

	Hazardous event	Hazard type	Likelihood	Severity	Risk	Control measure	Efficacy of control measure	Basis
1.	Fishing activities	Microbial	5	1	5	Engaging the fishermen through BMUs& other bodies on pollution control of the lake and inquiry of the existing programs by other bodies on the lake protection	The programs that are existing if harmonized will ensure success.	Synergy of programs and activities will ensure success.
2.	Industrial and domestic effluents.	Microbial, physical & chemical	5	2	10	Industrial visits and analysis of the effluents	Quality monitoring of the effluents from factories is one way of controlling the quality of water that finally is discharged into the lake	It is easier to manage if we know the quality of water we are dealing with.
3.	Infestation of invasive species (e.g. water hyacinth)	Microbial & chemical	5	4	20	Catchment protection activities to control the nutrient load and barrier construction to facilitate the continuity of process.	Well-constructed barrier is capable of protecting the pumps and safeguard quality	If the water weeds are kept away from the abstraction point, then the quality of water abstracted shall not be compromised.
4.	Agricultural activities Land management.	Physical	4	2	8	Put in place treatment to deal with the increased turbidity and color.	Adequate planning is able to deal with the changing water quality.	The plant can deal with the issue of water clarity effective.
5.	Agricultural activities -Pesticide use.	Chemical	5	2	10	Put in place proper treatment to take care of any impurities that may result from this. Engaging. NEMA & WRA to enforce relevant regulations on the same.	Putting in place a raw water monitoring program to establish the level of chemicals in the raw water helps in planning	Knowledge of the raw water quality facilitates proper treatment in the plant.
6.	Agricultural activities – fertilizer use.	Chemical	4	2	8	Put in place proper treatment to take care of any impurities that may result from this. Engaging. NEMA & WRA to enforce relevant regulations on the same.	Putting in place a raw water monitoring program to establish the level of chemicals in the raw water helps in planning	Knowledge of the raw water quality facilitates proper treatment in the plant.
7.	Agricultural activities – organic waste from sugar factories.	Microbial, chemical & physical	5	2	10	Put in place proper treatment to take care of any microbes/impurities that may result from this. Engaging.	Putting in place a raw water monitoring program to establish the level of chemicals in the raw water helps in planning	Knowledge of the raw water quality facilitates proper treatment in the plant.

	Hazardous event	Hazard type	Likelihood	Severity	Risk	Control measure	Efficacy of control measure	Basis
						NEMA & WRA to enforce relevant regulations on the same.		
8.	Close proximity of effluent discharge points to the abstraction.	Microbial & chemical	5	2	10	Put in place proper treatment for the waste water effluent from the plants	The treated effluent reduces the risks on the water source.	The quality of effluent ensures that the water source is not polluted further.
9.	Open car washing along the water source.	Chemical & physical	5	2	10	Put in place proper treatment for the waste water effluent from the plants	The treated effluent reduces the risks on the water source.	Control of waste emission to the lake is not tenable.
10.	Disposal of industrial waste and oils from open Jua kali garages	Microbial & Chemical	5	2	10	Put in place proper treatment for the waste water effluent from the plants	The treated effluent reduces the risks on the water source.	Control of waste emission to the lake is not tenable.
11.	Waste from wild animals (Hippos and other wild animals from the sanctuary)	Microbial	5	1	5	Put in place proper treatment to take care of any microbes that may result from this.	The waste from animals can be handled by the current treatment processes.	Control of waste emission to the lake is not tenable.
12.	Unprotected abstraction point	Microbial & Chemical	5	2	10	Reinforce the barrier at the abstraction point for uninterrupted process.	The barrier has been used before to protect the abstraction point.	Constructed barriers already in use, improvement necessary.
13.	Receding lake levels	Physical	5	4	20	Intake design to allow for flexibility in water abstraction	The right positioning intake to allow for water abstraction.	Proper intake ensures continued operation at the treatment plant.
14.	Clogging of the raw water screens	Physical.	5	1	5	Develop and implement a diving program me to help clear the clogged water screens.	There are divers working on shift that have been doing the exercise.	The efficiency of the raw water pumps increase immediately
15.	Absence of alternative power supply Dunga supply	Physical	5	3	15	To install an alternative power source.	Alternative power source ensures continuous process, but acquisition is a challenge.	The amount of finances involved is prohibitive for the utility, and therefore asset owner must be involved to finance the exercise.
16.	Lack of filter isolation valves in plant 3.	Physical	4	2	8	Fabrication of more plates to isolate the filters	The plate in place has been effective in control of flows into the filters.	If more plates are in place, the flows to the filters can be controlled.

CHAPTER 8: DEVELOP, IMPLEMENT AND MAINTAIN AN IMPROVEMENT/UPGRADE PLAN

If the previous step identifies risks to the safety of water and demonstrates that existing control measures are not effective or absent, then an improvement plan should be created. For example, if a utility has been identified to have asbestos pipeline which is carcinogenic, then a new pipeline material should be installed. Each identified improvement needs a person to be assigned responsibility within a given period of time to ensure implementation of the improvement. In some cases, this process may involve review, documentation and formalization of the practices that are not working and addressing of any areas where improvements are needed. In other cases, new/improved controls or a major infrastructure change may be needed.

8.1 Development of Improvement/ Upgrade Plan

Upgrade and improvement plans can include short-term (e.g. 1 year) or long-term programmes. Short-term improvements might include, for example, improvements to community consultation and the development of community awareness programmes. Long-term capital works projects could include covering of water storages or enhanced coagulation and filtration. The WSP team should estimate the costs and labour time associated with each improvement to provide information for decision-making. Economies that may be achieved from combining certain improvements should also be estimated. Available resources will need to be balanced against the risk assigned to the hazard and hazardous event. The incremental improvement plan needs to be realistic and appropriate to the utility's limited resources. There are often a number of ways to deal with multiple risks. The WSP team will need to consider the various benefits and costs of all the options, as well as intermediate or temporary solutions until resources become available for the preferred permanent solution. Communities will need to decide how they will raise the funds needed for the implementation of the improvements. The incremental improvement plan will be an excellent prospectus to attract government and other interested local or external supporters to come forward and assist. Funds can be raised through water rates, loans/ bonds or financial support from NGOs or wealthy community members. Utility action for maintenance of the water supply also offers great opportunities for communication and information sharing and facilitates ownership of the WSP. An incremental approach allows for improvements to be made over time to achieve water quality targets or objectives. The improvement plan should be documented and shared with all those responsible for the improvement measures as well as other interested parties like WRA, NEMA, County governments and relevant NGOs like JICA who may contribute funds for the implementation.

8.2 Implementation and Maintenance of Improvement/ Upgrade Plans

Implementation of improvement plans may have significant budgetary implications and therefore may require detailed analysis and careful prioritization in accord with the outcomes of risk assessment. Implementation of plans should be monitored tnfirm that improvements have been made and are effective. Control measures often require considerable expenditure, and decisions about water quality improvements cannot be made in isolation from other aspects of drinking-water supply that compete for limited financial resources. Priorities will need to be established, and improvements may need to be phased in over a period of time.

8.3 Illustrations

Illustration 1: Based Practice Kenya Case - Kisumu Water and Sewerage Company, action plan

Table 0-11: Based Practice Kenya Case - Kisumu Water and Sewerage Company, action plan

SN	Action	Arising from	Identified specific improvement plan	Accountabilities	Due	Status
	Develop and implement a program of working with the respective activities of concern to control pollution activities at the catchment	Human activities have been identified as one source of raw water contamination.	Identification of the other partners and their specific programs, then develop a plan on how to work with them	Team leader/ MD.	.Date	Progress
1.	Implement a waste water quality monitoring activity of industrial effluent that is discharged in the sewer system if applicable	Discharge of poor quality effluent into the system and subsequently to the water source has been identified as uncontrolled risk. There is no confidence that these risks are adequately controlled by the existing measures in place	Develop and implement water quality monitoring at the discharge points	SHE-QM		
2.	Develop and implement a plan for dealing with infestation of invasive species	These species pose great risks to supply if not controlled. There is no confidence that these risks are adequately controlled by the measures in place.	Raw water quality monitoring at the abstraction point.	SHE-QM		
3.	Develop and implement a plan for controlling risks agricultural activities associated Land management practices.	The sediment loading when it rains when farms are being prepared result into deterioration of water quality especially turbidity. There is no confidence that these risks are adequately controlled by the measures in place.	Raw water quality monitoring at the abstraction point.	SHE-QM		
4.	Implement measures to control risks arising from agricultural Pesticide being introduced into the water supply.	Use of pesticide can result into these chemicals getting into the water supply. There is no confidence that these risks are adequately controlled by the measures in place.	Raw water quality monitoring at the abstraction point to determine the level of pesticides in the raw water.	SHE-QM		
5.	Implement measures to control arising from agricultural chemicals from fertilizers being introduced into the water supply.	Use of fertilizers can result into these chemicals getting into the water supply. There is no confidence that these risks are adequately controlled by the measures in place.	Raw water quality monitoring at the abstraction point to monitor the nutrient level.	SHE-QM		
6.	Implement measures to control arising from organic wastes from	Discharge of organic waste from industries can result into these chemicals getting into the water supply. There is no confidence that	Raw water quality monitoring at the abstraction point.	SHE-QM		

SN	Action	Arising from	Identified specific improvement plan	Accountabilities	Due	Status
	factories being introduced into the water supply.	these risks are adequately controlled by the measures in place.				
7.	Implement measures to control arising Close proximity of effluent discharge points to the abstraction.	Discharge of poorly treated waste water into the raw water source can expose the water supply to risks. There is no confidence that these risks are adequately being controlled.	Waste water quality monitoring at the plants.	SHE-QM		
8.	Implement measures to control risks arising from any urban activities along the water source.	Discharge of untreated waste water into the raw water source can expose the water supply to risks. There is no confidence that these risks are adequately being controlled.	Raw water quality monitoring at the abstraction point.	SHE-QM		
9.	Implement measures to control arising Poor workmanship in consumer connection	Poor workmanship has been identified as uncontrolled risks and there is no confidence that it is adequately controlled by the measures in place.	Develop and implement installation standards.			
10.	Implement measures to control risks arising from poor quality materials	Acceptance and use of poor quality materials has been identified as an uncontrolled risk. There is no confidence that the risk is adequately controlled by the measures in place.	Institute a system of inspection of all the materials when delivered			
11.	Implement measures to control risks arising from rampant meter theft	Meter theft exposes the water to risks. There is no confidence that the risks are adequately controlled.	Develop a program of meter protection at the customer premises and quick response to the reported cases of theft to protect any contamination.			
12.	Implement measures to control arising Poor hygiene at storage facility at the house holds	Poor hygiene at the storage facilities at the consumer household has been identified as an uncontrolled risk. There is no confidence that these risks are adequately controlled.	Develop a program of sensitization to educate customers on the need of cleaning tanks and cleaning of the jerry cans used for ferrying water by the operators.			
13.	Implement measures to control risks arising from aged pipe network serving the consumers	Risk assessment for the risk of contaminations both physical and microbial has indicated that these risks are adequately controlled by the existing controls in place.	Develop and implement a line replacement program for these aged pipe networks.			

CHAPTER 9: DEFINE MONITORING OF THE CONTROL MEASURES

The end point of a water supply system is the consumer connection. Water that reaches the consumers should be safe for drinking without any further treatment and thus continuous maintenance of water quality is necessary. Operational monitoring as part of the WSP aims to demonstrate the ultimate performance of the established control measures. This section entails the following: (1) Observations or measurements, (2) selection of process parameters which should be easy for monitoring and (3) setting the parameter limits that should be exceeded. 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. Corrective actions are planned responses to be put in place in case the outcome of an operational monitoring of a control measure indicates otherwise a loss of control during a standard operation e.g. balancing excessive application of fertilizer through imposition of strict limitation, including tight surveillance in the subsequent seasons.

9.1 Selection of appropriate monitoring parameters

The concept of operational monitoring involves selection of the most appropriate parameters to assess during the performance. The most critical monitoring point should be consumer tap that is to reflect the variation in the distribution system including the type of consumer e.g. communal standpipe, water kiosks, high income and low-income consumer taps. For instance, key parameters often necessary for monitoring at consumer taps include but are not limited to the following: (1) disinfection residuals, coliform and *E.coli* colony counts; (2) heavy metals such as lead, arsenic, copper, nickel, Iron etc.; and (3) taste and odour; 4) physico-chemical parameters e.g turbidity, total suspended solids, among others Once it is established that the source of contamination neither emanates from distribution or consumer plumbing, routine monitoring of water supply systems can be focussed to the other components such as catchment, intake and outlet of point of the water treatment plant including other appropriate location in the water supply chain. For the Kenyan case, major parameters, the major parameters, location of sampling points and frequency of sampling are prescribed in the WASREB's Guideline on Water Quality and Effluent Monitoring (2008)

Table 9-1: Operation Monitoring Parameters used in Monitoring Control Measures.

Operational Parameter	Raw water	Coagulation	Sedimentation	Filtration	Disinfection	Distribution system
pH		✓	✓		✓	✓
Turbidity	✓	✓	✓	✓	✓	✓
Rainfall	✓					
Stream/river flow	✓					
Colour	✓					
Conductivity						
Organic carbon	✓		✓			
Algal toxins and metabolites	✓					
Chemical quality and dosage		✓			✓	
Disinfectant residuals, DBPs					✓	✓
Residuals					✓	✓

Adapted from WHO (2004)

9.2 Establish operational and critical limits

Control measures need to have well defined limits for operational acceptability that can be applied to operational monitoring parameters. It is important to note that operational monitoring should be defined for parameters applying to control measure. If monitoring gives an indication that an operational limit has been exceeded, then a corrective action ought to be applied. The detection of the deviation and the subsequent implementation of a predetermined action plan should be such that there is enough time to ensure water safety of the consumers including performance maintenance. It should be noted that deviation in the set critical limits usually requires urgent actions including immediate notification of the relevant authorities.

9.3 Non-piped water systems including water vending

It is necessary that surface water and/or shallow groundwater used as drinking water sources are properly protected or treated. Monitoring of non-piped systems as well as water vendors entails periodic sanitary inspection. Thus, risk factors involved should be related to the activities under the control of the relevant concerned persons and which may affect water quality. For the case of the common water vending practices such as tankers and, animal/human drawn carts, regulation of the source water is critical in ensuring water safety. Controlling the water sources for water vendors only does not ensure water safety. It is also vital to ensure that clean water containers are used for water transport including the transport process. Thus, routine water quality monitoring of both the water sources and water already in the container is critical in ensuring water safety of the consumers. If treatment is applied to water from non-piped water supplies such as boreholes, wells and springs, then operational monitoring is advisable. When household treatment is introduced, it is essential that information (and where appropriate, training) be provided to users to ensure that they understand basic operational monitoring requirements. Water kiosks have water storage tanks that ensure continuous water supply in case of intermittent supply of the piped systems due to water rationing. It has been evident that residual chlorine at times drops beyond the acceptable threshold. Thus, continuous operational monitoring of the water stored in the tanks is further necessary.

9.4 Illustrations

Illustration 1: Detailed description of parameters used in operational monitoring in the varying WSP components:

WSP Component	Parameter
Source waters	Turbidity, algal growth, flow and retention time, colour, conductivity, local meteorological events such as precipitation, floods and drought, integrity of protective and/or abstraction infrastructure or facilities such as intake weirs, well seals and buffer protection fences.
Treatment	Disinfectant concentration and contact time, turbidity, colour, pH
Distribution systems	➢ Chlorine residual monitoring – provides a rapid indication of problems that will direct measurements of microbial parameters e.g. an abrupt reduction of stable residual chlorine indicates contamination ingress. ➢ Heterotrophic bacteria present in the water supply distribution system is a useful indicator of changes such as increased level of microbial growth, increased biofilm activity, extended retention times and/or stagnation/ breakdown of system integrity. ➢ Pressure measurements and turbidity – useful operational monitoring parameter in piped distribution systems.

CHAPTER 10: VERIFY THE EFFECTIVENESS OF THE WSP

In addition to operational monitoring of the performance of the individual components of a water supply system, it is necessary to carry out a verification to provide a reassurance that the system is secure from contamination. Verification usually involves testing for faecal indicator organisms and hazardous chemicals, as well as auditing the WSPs to ensure implementation takes place as intended and works effectively. Verification involves three key activities namely:(1) Monitoring of drinking water quality supplied to consumers; (2) Monitoring of consumer satisfaction; and (3) Internal and external auditing operation of the WSP. A combination of the three activities are vital in determining whether WSP implementation is effective and establish whether water supplied complies to the desired water quality standards.

10.1 Verification monitoring

It involves testing of water supplied and the consumer points to check compliance with water quality standards. Verification monitoring can often be confused with operation monitoring. As stated in section 6, operational monitoring checks the workability of the individual control measures. On the other hand, verification monitoring determines whether a group of control measures combined within the WSP are working. For microbial verification, testing is usually for faecal indicator bacteria in the treated water. Verification of chemical safety is done by testing chemicals of concern at the end of the treatment, in the distribution and or at the consumer point. Sampling frequency is required to give a reflection of the needed beneficial balance and the cost involved in acquiring the information. Plans should as well be developed to respond to the results that do not meet water quality standards. These should include investigation of the cause of non-compliance and, where necessary, corrective action.

10.2 Customer satisfaction

Verification also includes monitoring consumer satisfaction. Consumer satisfaction verification is a powerful tool in detecting faults and measuring improvement e.g. aesthetic water quality problems within the distribution system. One method for performing this activity is to establish consumer communication and response procedures and to monitor and document complaints and feedback. These should be analysed and reported to senior management. Patterns of complaints should always be investigated. Although consumers are subjective and untrained, they can provide reliable reports of water quality problems that enable more rapid follow-up investigation and maintenance by the water utility. Discoloured water, increased turbidity and bad odours can provide evidence of ingress of contamination through backflows from cross-connections, water main breaks and other faults. Recording patterns and frequencies of consumer complaints using a geographic information system–linked database is commonly undertaken to assist in the operational tracking of the water quality issue and identifying the boundary of the affected area. Verification testing of source waters is vital particularly for sources without treatment. It will also be useful following failure of the treatment process or as part of an investigation of a waterborne disease outbreak. The frequency of testing shall depend on the sampling reasons.

10.3 Internal and External Auditing

Auditing the WSP compliance is a critical component of water safety planning. In general, audits involve interviewing managers and the operational staffs. The objective is to assess that the plan is being implemented as intended and is effective. An audit report is to be prepared at the completion of each audit, describing findings, including recommended improvements or remedial measures, together with timelines. Findings should be discussed with the drinking-water provider, and a copy of the report should be provided. Audits may be internal or external processes, and they provide important input to the periodic review of the WSP.

10.4 Internal audits

Internal audits should be based on the principle of peers i.e. auditor and auditee are considered as peers during the audit, irrespective of their formal positions, to facilitate a positive and confident atmosphere. Internal auditing is about continuous improvement as opposed to the blame game and fault. The audit should be performed according to an agreed programme to ensure that all parts of the WSP are audited regularly and prior to the regular WSP review.

10.5 External audits

External audits may form part of independent surveillance and be carried out by regulatory agencies, certification companies or independent experts, depending on the situation. The external audits are third-party assessments of the WSP, to provide independent documentation for compliance with regulatory requirements, consistency with standards or coherence with good practice. Additionally, the external audit provides credibility in relation to public conception of water safety.

10.6 Illustrations

Illustration 1: Critical activities in carrying out an audit:

- checking that the description of the water supply system is accurate;
- checking that significant hazards and hazardous events have been identified and that the risk assessment was logical and thorough;
- reviewing measures and activities designed to monitor and manage potential impacts of connected buildings and facilities;
- assessing that appropriate operational monitoring was undertaken, that results were kept within set limits and that appropriate action was taken to respond to non-compliance;
- reviewing all operational procedures associated with the maintenance and repair of distribution systems to ensure that they are designed and implemented to reduce risk of contamination of distribution systems;
- ensuring that verification monitoring programmes are in place and that results demonstrate that the WSP was effective;
- reviewing responses to incidents and emergencies and application of corrective actions;
- assessing implementation of improvement programmes and adoption of training plans;
- assessing the performance of subcontractors and management;
- ensuring that reporting requirements have been met;
- checking that all activities and results have been documented; and
- ensuring that regulatory requirements have been met.

CHAPTER 11: PREPARE MANAGEMENT PROCEDURES

There should be an elaborate management procedure for the routine operation and maintenance activities when the system is operating under normal circumstances as well as a specific procedure in case the system is operating in 'incident situations'. This is an essential part of the WSP that should be developed by experienced staff and should be updated in regard to the implementation of improvement plans and revision of incidences/emergencies. All activities undertaken including the duties of each staff should be well captured in this management procedure to ensure nothing is left out and also to enhance accountability of each staff. The management staff is fully responsible for ensuring that the procedures are updated and should bring all operators/staff on board. This cooperate involvement is important in enhancing complacency(satisfaction) and free flow of information within the utility. This should be done regularly and efficiency for it to be effective. The preparation of clear procedures, definition of accountability and provision of equipment for the sampling and storing of water in the event of an incident can be valuable for follow-up investigations, and the sampling and storage of water from early on during a suspected incident should be part of the response plan.

11.1 Predictable incidents

Many incidents within the water supply system can be foreseen, and management plans can specify resulting actions. Actions may include, for example, temporary change increasing coagulation dose, change of coagulant or increasing disinfectant concentrations within the distribution systems.

11.2 Unplanned events

Certain scenarios that may cause water to be considered potentially unsafe might not be identified within incident response plans. This may be either because the events were unforeseen or because they were considered too unlikely to justify preparing detailed corrective action plans. A general response plan is thus necessary in dealing with such events. The general plan as the name suggests provides a general guidance the identification approach for incidents inline the specific guidance on responses applicable for varying incidents. The success of general incident responses depends on the experience, judgement and skill of the personnel operating and managing the drinking-water supply. However, generic activities that are common in response to many incidents can be incorporated within general incident response plans. Unforeseen events/incidents that do not have their corrective measures in place may occur as well. In such situations, a generic emergency plan should be followed. If monitoring detects that a process is operating outside the specified procedures, there is need to come with a corrective action. This action will single out the specific procedure following deviations from the limits set or a near miss event. An example of a near miss event is very high turbidity after treatment in the system especially during very heavy rains observed in Garissa Water and Sewerage Company.

11.3 Emergencies

Water utilities should not develop plans to be invoked in the event of an emergency. The developed plans should consider potential natural disasters such as floods and drought and accidents such as spills in the watershed and interruptions in electricity supply including damages to treatment plant and distribution system and human action e.g. vandalism. Emergency plans should clearly specify responsibilities for coordinating measures to be taken, a communication plan to alert and inform users of the drinking-water supply and plans for providing and distributing emergency supplies of drinking-water.

11.4 Illustrations

Illustration 1: Typical Standard Operating Procedures for a water utility

Table 11-1: Typical Standard Operating Procedures for a water utility

Category	Sub-category	Standard Operating Procedure (SOPs).

Facility operations overview	General tasks Sampling	System patrols 24/7. Easily retrievable keeping of records Routine reporting procedures Sampling procedure
Intake and pre-treatment	Raw water Flow measurement	Valve regulation, weir maintenance, monitoring of screens and filters etc. Calibration of meters
Chemical dosing procedure	Dosing chambers/equipment Chemical storage	Accurate handling & measurements Observation of Occupational, Health and safety rules, e.g. use of necessary Personal Protective Equipment,(PPEs). Conducive environment
↓		

Illustration 2: Checklist of management procedures (or corrective actions) to deal with incidents.

- Accountabilities and contact details for key personnel and other stakeholders;
- Clear description of the actions required in the event of a deviation;
- Location and identity of the SOPs and required equipment;
- Location of back-up equipment;
- Relevant logistical and technical information.

Quality control procedures should also be documented for as many features of the WSP as possible. All measurements of control measures, for example, should be subject to appropriate quality control procedures, such as internal and external analytical control within laboratories.

(*Note that this could also be dealt with as a 'supporting programme'*).

Illustration 3: Checklist of characteristics and systems relating to people management which will facilitate ongoing success of the WSP.

- Selecting significant parameters on which to report such as turbidity, pH, and *E. Coli*;
- A well-defined and efficient system failure reporting procedure for example an alarm system or a hot line;
- Involving higher-level management in reporting;
- Planning representative audits that aim areas prone to complacency that cause hostile consequences, e.g. the treatment procedure and skills of the staff involved in the process;
- Embracing the 'no blame' model where failure is shared by utility participants;
- Having an extensively available mechanism for presenting improvement prospects, risk analysis and interpretation and for challenging existing practices;
- Confirm that all procedures are signed off at senior level. This is an important part of the continuous improvement mechanism.

Illustration 4: Emergency management procedures

During an incident it may be necessary either to modify the treatment process of existing sources or temporarily use an alternative water source. It may be necessary to increase disinfection dosage at the treatment plant or to additionally disinfect (e.g. chlorinate boosting at designated points) during distribution. Procedures for such an emergency situation should be documented.

Illustration 5: Checklist of key areas to be addressed in emergency management procedures

- Response actions, including accelerated monitoring;
- Responsibilities and authorities internal and external to the organization;
- Plans for emergency water supplies;

- Communication protocols and strategies, including notification procedures (internal, regulatory body, media and public);
- Mechanisms for increased public health surveillance;
- Emergency procedure should be practiced regularly.

Example 6: The list of the names and reference numbers of the applicable procedure (KIWASCO).

Table 11.2: The list of the names and reference numbers of the applicable procedure (KIWASCO

SN	Name	Reference number	Remarks
1.	Procedure for Quality Control of potable water	KWSC/TEC/QC/01	Maintained by SHEQ-M
2.	Procedure for Production of potable water	KWSC/TEC/PROD/01	Maintained by WPM
3.	Procedure for Network Maintenance.	KWSC/TEC/NETWORK/01	Maintained by NME
4.	Procedure for Plant Maintenance	KWSC/TEC/MAINT/01	Maintained by EME
5.	Procedure for Potable water Distribution	KWSC/TEC/DISTR/01	Maintained by In-Charge Distribution
6.	Procedure for Handling Non-Conforming Products	KWSC/QSP/04	Maintained by QMR
7.	Procedure for Preventive and Corrective Actions	KWSC/QSP/05	Maintained by QMR

CHAPTER 12: DEVELOP SUPPORTING PROGRAMMES

Activities that enhance the development of peoples' skills and knowledge are referred to as supporting programmes. They include trainings, research and development. Programmes may be in place but may not be regularly done. In such a case, these programmes should be reviewed to check why they don't run regularly and address all loopholes/constrains. Examples of such activities include trainings, research and development. Other activities may include equipment calibration, scaling up education levels, maintaining preventive measures, hygiene and sanitation. Supporting programmes may vary from one utility to another based on the major factors affecting them and so their priority is relative to each utility. The following are the key actions in developing the supporting programs:

- Identify the supporting programmes needed for implementation of the WSP approach.
- Review and as necessary, revise existing supporting programmes
- Develop additional supporting programmes to address gaps in staff knowledge or skills that may impede the timely implementation of the WSP.

12.1 Reviewing existing programmes

In developing supporting programmes, it may not always be necessary to develop new programmes. Organizations should assess the programmes that are currently in place to identify any gaps that need to be addressed including updates of existing programmes.All procedures should be documented and dated to ensure that staff follow the most recent version.

Table 0-12: Types of supporting programmes that could be included in the WSP

Progromme	Purpose	Example
Cost recovery system	To ensure sustained provision of the utility's services. Reduce the loses due to non-revenue water	Standard tariff and billing system Provision of notification on deadlines for payment. Penalties on delayed payment

Programme	Purpose	Example
Emergency reporting protocol	To ensure all emergencies like bursts and vandalism are attended to promptly	Alarm installation, emergency hotline provision and enhancement of patrols.
New connections protocol	To enhance service provision as need arises	Call center
Etc. ↓		

12.2 Illustrations

Illustration 1: Supporting programmes could involve:

- controlling access to treatment plants, catchments and reservoirs and implementing the appropriate security measures to prevent transfer of hazards from people when they do enter source water;
- developing verification protocols for the use of chemicals and materials in the drinking-water supply—for instance, to ensure the use of suppliers that participate in quality assurance programmes;
- using designated equipment for attending to incidents such as mains bursts (e.g. equipment should be designated for potable water work only and not for sewage work);
- training and educational programmes for personnel involved in activities that could influence drinking-water safety; training should be implemented as part of induction programmes and frequently updated;
- research and development to improve understanding of water quality, including the quality of source waters, and treatment.

Illustration 2: Implementation of supporting programmes

The implementation of supporting programmes will involve:

- collation of existing operational and management practices;
- initial and, thereafter, periodic review and updating to continually improve practices;
- promotion of good practices to encourage their use;
- audit of practices to check that they are being used, including taking corrective actions in case of non-conformance.

Illustration 3: Codes of good operating and management practice necessary for supporting programs

Codes of good operating and management practice and hygienic working practice are essential elements of supporting programmes. These are often captured within standard operating procedures. They include, but are not limited to:

- hygienic working practices in maintenance;
- attention to personal hygiene;
- training and competence of personnel involved in drinking-water supply;
- tools for managing the actions of staff, such as quality assurance systems;
- securing stakeholder commitment, at all levels, to the provision of safe drinking-water;
- education of communities whose activities may influence drinking-water quality;
- calibration of monitoring equipment;
- record keeping.

CHAPTER 13: PLAN AND CARRY OUT REVIEW OF THE WSP

There should be periodic meetings of the WSP team to review the overall plan and learn from experiences and new procedures. Reviews can also be done from data collected previously. This is the platform for proposing improvements on structures and operational procedures. Reviews may also entail construction of new facilities e.g. construction of new laboratories and other associated amenities. Keep the WSP up to date and convene regular WSP review meetings; To ensure that new risks threatening the production and distribution of safer water, the WSP should be regularly reviewed.

13.1 When to review the WSP.

A WSP should be reviewed immediately when there is a significant change of circumstances or a problem within the water supply chain. A WSP should also be reviewed from time to time, particularly taking into account the results of implementing the WSP. Any change made to the WSP as a result of a review should be documented.

13.2 Illustrations

Illustration 1: Checklist for WSP review

- Notes of last review meeting;
- Notes of any interim review;
- Changes to membership of the WSP team;
- Changes in catchment, treatment, distribution;
- Review of operational data trends;
- Validation of new controls;
- Review of verification;
- Internal and external audit reports;
- Stakeholders communication;
- Date of next review meeting.

Periodic reviews are to be done to ensure that all emerging hazards and issues are well taken care of. The WSP should also be reviewed following an emergency, an incident or a near miss scenario. The WSP may be revised also if there are amendments on the regulations relevant to water utilities.

1.1. Illustration

Illustration 1: A checklist of questions to be asked following an emergency, incident or near miss includes:

- What was the cause of the problem?
- Was the cause a hazard already identified in the WSP risk assessment?
- How was the problem first identified or recognized?
- What were the most essential actions required and were they carried out?
- If relevant, was appropriate and timely action taken to warn consumers and protect their health?
- What communication problems arose and how were they addressed?
- What were the immediate and longer-term consequences of the emergency?
- How can risk assessment / procedures / training / communications be improved?
- How well did the emergency response plan function?

Illustration 2: Following an incident, emergency or near miss the following checklist may be useful to revise the WSP

- Accountabilities and contact details for key personnel, usually including other stakeholders and individuals, are clearly stated;

- Clear definition of trigger levels for incidents including a scale of alert levels (e.g. when an incident is elevated to a boil water alert);
- Review whether the management procedures were appropriate for the incident and if not, revise accordingly;
- Standard operating procedures and required equipment, including back-up equipment, are readily available, and relevant;
- Relevant logistical and technical information is in hand and up to date;
- Checklists and quick reference guides have been prepared and are up to date;
- Does the risk assessment need revising?
- Do procedures/ training / communications need improving?
- Has the incident shown the need for an improvement programme?

CHAPTER 14: SURVEILLANCE

Water supply surveillance is a continuous and vigilant public health assessment and review of the safety and acceptability of drinking water supplies. Water supply surveillance with a focus on quality contributes to the protection of consumers and promotes maintenance of the water supply in terms of quality, quantity, accessibility, coverage and affordability. Surveillance thus is an important component of water safety planning and further improvement of the already existing plans. Hence, drinking water supply surveillance normally include the process of approving water safety plans (WSPs). The approval process involves review of the system assessment, identification of appropriate control measures and supporting programmes including operational monitoring and management plans. The process further ensures that WSP covers normal operating conditions and predictable incidents and has contingency plans in case of an emergency or unplanned event. There are two approaches to surveillance of the drinking water quality: Approaches that rely on water quality and the audit based approaches.

14.1. Audit Based Drinking Water Quality Surveillance

Assessment activities and verification testing is undertaken by the supplier together with the third party auditor to verify compliance. The approach requires that the water utility provides the surveillance team with relevant information regarding system performance against the agreed indicators.

14.2. Direct Assessment Approaches to Water Quality Surveillance

Water utilities are as well obliged to carry out independent surveillance of the water supply system. In such scenarios, the utility ought to have access to analytical facilities with staff trained to carry out sampling, analysis and sanitary inspection. Direct assessment also implies that utilities have the capacity to assess findings, report. Direct assessment may generally lead to the identification of requirements to amend or update the WSP and thus the process to be followed when undertaking such amendments should be clearly defined and identified.

14.3. Surveillance and Adequacy of Water Supply

Usually, surveillance on the quality of the water supplied and thus has an interest of the population at large. However, it should extend beyond water quality in isolation to also include other aspects of water supply such as quantity, accessibility, affordability and intermittency and/ continuity. The description of all these service parameters necessary in the surveillance process is as highlighted below:

- Water Quality - Regular verification of water quality and an approved WSP that have been through a validation process and subjected to periodic audit as a demonstration of compliance with relevant regulations.
- Water Quantity also commonly referred to as *service level* – The proportion of the population with access to the drinking water supply.

- Accessibility and affordability – Population proportion that has a reasonable access to the improved water supply and the water tariff
- Continuity and/ intermittency – Proportion of time for with water is supplied (hourly, daily, weekly and seasonally).

REFERENCES

GoK (2016). Water Act 2016. 1–116.

Sadiq, R., Kleiner , Y., Rajani, B (006). .Estimating risk of contaminant intrusion in water distribution networks using Dempster-Shafer theory of evidence. Civil Engineering and Environmental Systems, v. 23, no. 3, pp. 129-141.

WASREB (2006). Guideline on Drinking Water Quality and Effluent Monitoring

WASREB (2008) A Performance Review of Kenya's Water Services Sector 2006 - 2007.

WASREB (2009) A Performance Review of Kenya's Water Services Sector 2007 - 2008.

WASREB (2010) A Performance Review of Kenya's Water Services Sector 2008 - 2009.

WASREB (2011) A Performance Review of Kenya's Water Services Sector 2009 - 2010.

WASREB (2012) A Performance Review of Kenya's Water Services Sector 2010 - 2011.

WASREB (2013) A Performance Review of Kenya's Water Services Sector 2011 - 2012.

WASREB (2014) A Performance Review of Kenya's Water Services Sector 2012 - 2013.

WASREB (2015) A Performance Review of Kenya's Water Services Sector 2013 - 2014.

WASREB (2016) A Performance Review of Kenya's Water Services Sector 2014 - 2015.

WASREB (2016) A Performance Review of Kenya's Water Services Sector 2015 – 2016/2016-2017.

WASREB (2002) Model Water Services Regulations.

WHO-ADB (2017) Water Safety Planning for Urban Utilities: Practical Guide for ADB Staff.

WHO (2016).Protecting Surface Water for Health Identifying, Assessing and Managing Drinking-Water Quality Risks in Surface Water Catchments. WHO Press. Geneva.

WHO (2014).Water safety in distribution systems. WHO Press. Geneva.

WHO. 2011. Guideline for Drinking-water Quality. 4th ed. Geneva.

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

WHO (2010). WSPs: Managing drinking water quality for public health a brief on the benefits of shifting to a WSP approach. Geneva, World Health Organization

BIBLIOGRAPHY

Rinehold A, Corrales L, Medlin E, Gelting RJ (2011). Water safety plan demonstration projects in Latin America and the Caribbean: Lessons from the field. *Journal of Water Science and Technology: Water Supply*. 11(3):297–308 (http://ws.iwaponline.com/content/11/3/297).

WHO (2016).Water safety plan impact assessment in the Asia Pacific region. Internal report (version December 2016).

WHO (2017).Safely managed drinking water – thematic report on drinking water 2017. Geneva: World Health Organization (https://data.unicef.org/wp-content/uploads/2017/03/safely-managed-drinking-water-JMP-2017-1.pdf).

WHO & IWA (2010). Think big start small scale up: A road map to support country-level implantation of water safety plans. Geneva: World Health Organization (http://www.who.int/water_sanitation_health/publications/thinkbig-startsmall/en/).

WHO & IWA (2016a). Country summary report: Senegal. Internal report (version 29 January 2016).

WHO & IWA (2016b). A practical guide to auditing water safety plans. Geneva: World Health Organization (http://www.who.int/water_sanitation_health/publications/auditing-water-safety-plans/en/).

WHO & IWA (2016c). Country summary report: Tanzania. Internal report (version 23 May 2016).

WHO EMRO (2015). Use and application of WHO Guideline on Drinking-water Quality. WHO Regional Office for the Eastern Mediterranean internal report (version January 2015).

WHO SEARO (2016). Review of water safety plans in Thailand. WHO South-East Asia Regional Office internal report.

WHO & UNICEF (2010). Rapid assessment of drinking-water quality in the Federal Democratic Republic of Ethiopia: Country report. Geneva: World Health Organization; 2010 (http://www.wssinfo.org/fileadmin/user_upload/resources/RADWQ_Ethiopia.pdf).

WHO & UNICEF (2013).RegNet (International Network of Drinking-water Regulators) and Joint Monitoring Programme (JMP) survey. Unpublished survey data.

15 APPENDICES

Appendix 1: Glossary

Control (noun) (for instance control of water safety): The state wherein correct procedures are being followed and criteria are being met.

Control (verb) (for instance control of a hazard):

Control Measure: Any action and activity that can be used to prevent or eliminate a water safety hazard or reduce it to an acceptable level.

Control Point: A step at which control can be applied to prevent or eliminate a water safety hazard or reduce it to an acceptable level. Some plans contain *key* control points at which control might be essential to prevent or eliminate a water safety hazard.

Corrective Action: Any action to be taken when the results of monitoring at the control point indicate a loss of control**.**

Critical Limit: A criterion which separates acceptability from unacceptability.

Deviation: Failure to meet a critical limit.

Flow Diagram: A systematic representation of the sequence of steps or operations used in the production or manufacture of a particular water item.

Hazard Analysis: The process of collecting and evaluating information on hazards and conditions leading to their presence to decide which are significant for water safety and therefore should be addressed in the WSP.

Hazard: A biological, chemical, physical or radiological agent in, or condition of water, with the potential to cause an adverse health effect. Another word for hazard includes "contaminant".

Hazardous Event: A process whereby a hazard/contaminant is introduced into a water supply.

Monitor: The act of conducting a planned sequence of observations or measurements of control parameters to assess whether a control point is under control or whether the water meets quality criteria.

Pathogen: A microorganism that may cause illness or disease.

pH: Units used to measure the acidity or alkalinity of water; the pH scale runs from pH 0 to pH 14, with pH 7 being neutral, <pH 7 being acidic and >pH 7 being alkaline (or basic).

Pre-chlorination: A pre-treatment stage where chlorine is added before water treatment; for example, may be employed to assist with the removal of minerals such as iron and manganese.

Primary chlorination: The addition of chlorine for disinfection of drinking-water; for primary chlorination, chlorine is generally added immediately after water treatment (e.g. after clarification and/or filtration).

Reagent: A chemical substance that is used in a water quality test.

Residual chlorine: The concentration of chlorine remaining that is free for residual disinfection after the chlorine demand has been satisfied.

Residual trim: Where an instrument continually measures the chlorine concentration in water and adjusts the chlorine dose rate accordingly.

Risk Assessment: For the purposes of this Manual, risk assessment has the same meaning as hazard analysis.

Risk Score: The score assigned to a hazard based on the risk analysis process.

Secondary chlorination/Chlorine boosting: The addition of chlorine to boost the residual chlorine concentration within acceptable levels; generally occurs within the distribution system.

Source water: Raw (untreated) water for drinking-water supplies; includes groundwater, rainwater and various types of surface water sources, including rivers, lakes, ponds, creeks, irrigation channels, seawater or constructed reservoirs.

Spore: A life stage of certain microorganisms (e.g. bacteria) that is characterized by a type of durable shell for environmental survival outside of a host.

Standby pump: A back-up pump, required when the duty pump fails.

Step: A point, procedure, operation or stage in the water supply chain including raw materials, from primary production to final exposure.

Total chlorine: The concentration of chlorine remaining after the chlorine demand has been satisfied and disinfection has occurred; consists of residual and combined chlorine.

Turbidity: The opaque (or cloudy) appearance of water caused by the presence of organic and inorganic particles.

Under-dosing (in reference to chlorine dosing): The addition of too little chlorine for effective disinfection.

UV light: A particular wavelength of light that has the capacity to kill or inactivate microorganisms.

Validation: Obtaining evidence that the elements of the WSP can effectively meet the water quality targets.

Verification: The application of methods, procedures, tests and other evaluations, to determine compliance with the WSP, i.e. checking whether the system is delivering water of the desired quality and whether the WSP is being implemented in practice.

Appendix 2: Specific Guideline for Regulation of Water Vending

Appendix 3: Generic Water Safety Plan

Example text is highlighted in yellow

GENERIC WATER SAFETY PLAN

NAME OF WSP

Replace the Picture

Version:
Insert Version No.
Last Updated:
Insert Date

Table of Contents

Important note:

Please print additional sheets as needed to complete each step.

INTRODUCTION

A Water Safety Plan (WSP) is widely considered to be the most effective means of consistently ensuring the safety of a drinking-water supply. A WSP follows a comprehensive risk assessment and risk management approach that encompasses all steps in water supply, from catchment to consumer, and it is a valuable tool to help water suppliers effectively operate and manage the water supply system. It also encompasses water vending systems in situations where the water utilities do not meet the demand in the service area.

The following figure gives a summary of the 11 sections of the WSP process. This WSP follows each of these steps in the same order.

- Section 1: Assemble WSP team
- Section 2: Describe the water supply system
- Section 3: Identify the hazards and hazardous events
- Section 4: Determine and validate control measures, assess & prioritize risk
- Section 5: Develop, implement & maintain an improvement plan
- Section 6: Define monitoring of control measures
- Section 7: Verify the effectiveness of the WSP
- Section 8: Prepare management procedures
- Section 9: Develop supporting programmes
- Section 10 & 11: Review and revise the WSP regularly and following an incident

WATER SAFETY PLAN TEAM (SECTION 1)

Key action: Document the details of the WSP team members and outline their key role and responsibilities, and contact details.

WSP Team

Title	Role	Remarks
Team Leader		
Water Supply Engineer/ technician (operation and maintenance)		
Hydrologist		
Socio-economist		
Water Chemist/ Bio-Chemist/Hydro-geochemist		
Water Safety Planning Specialist		
Human Resource		
Legal specialist		
Financial Specialist		
Water Vendors Representatives		
Environmental and Public Health		

Refer to Table 3-3 for the details

Stakeholder Identification

Organisation	Point of Contact	Role in Water Services Provision
County Government		
Water Services Board		
Water Resources Authority, Regional Level		
National Environment Management Authority, Regional / County level		
Water Resources Association		
Relevant CBOs		
Water Action groups (WAGs)		
Private water utility within the service area		
Private Water Vendors		
Community/ Consumer/ Customer representative		
Other relevant institutions such as schools, hospitals etc.		

Refer to Table 3-1 for details

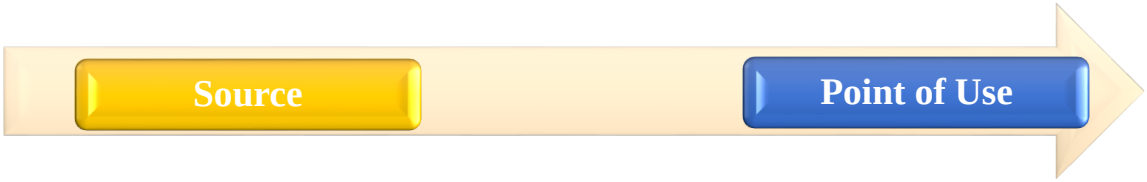
WATER SYSTEM DESCRIPTION (SECTION 2)

Key action: Briefly describe in words, and in a diagram, the water supply system from the catchment/source right through to the point of use by the consumer. Include any known or suspected water quality challenges.

a) Piped Water Supply

Describe the catchment *(e.g. forested, agricultural, protected etc.)*, the source(s) of water *(e.g. borehole, pond, river etc.)* and the no. of people served, and any other relevant information	If there is any centralized water treatment facility present, describe the steps involved (e.g. sedimentation, clarification, filtration, chlorination, UV, chemical used etc.)	Describe the different kinds of water storages *(if any)* and how people receive or collect/transport the water *(e.g. piped to premises, tap stand, kiosk, vendor etc.)*	If practiced, describe how people treat *(e.g. boiling, filtration, chlorine tablets/solution)* and store *(e.g. in a household tank, jerry can, open bucket etc.)* drinking-water at the household level
Catchment: • Human settlements with limited sanitation facilities, open defecation, bathing/washing • Agriculture (pig farming, crops, irrigation, pesticide application, manure spreading) • No protection zones • Seasonal flooding *Source:* • Surface water (Blue river); pumped to 1 ML raw water storage (open) • Serves approx. 40,000 customers	Coagulation/flocculation (with aluminum sulphate dosing) Filtration (rapid sand) Chlorination (1% solution prepared from bleaching powder) 1 ML treated water storage	Treated water storage tank • 500 kL • Built 1980 • Closed tank • Steel construct Low level area: 20,000 customers (mixture of piped supply and tap stands) High level area: 20,000 customers; piped supply directly to household Consumers collect water in open buckets to bring back to households	No household treatment Household water stored in large plastic tanks, on ground level and dedicated to water storage Use of dipping tool varies from household (e.g. cup, hand, ladle)

b) Water Vending including Non-piped Water Supply

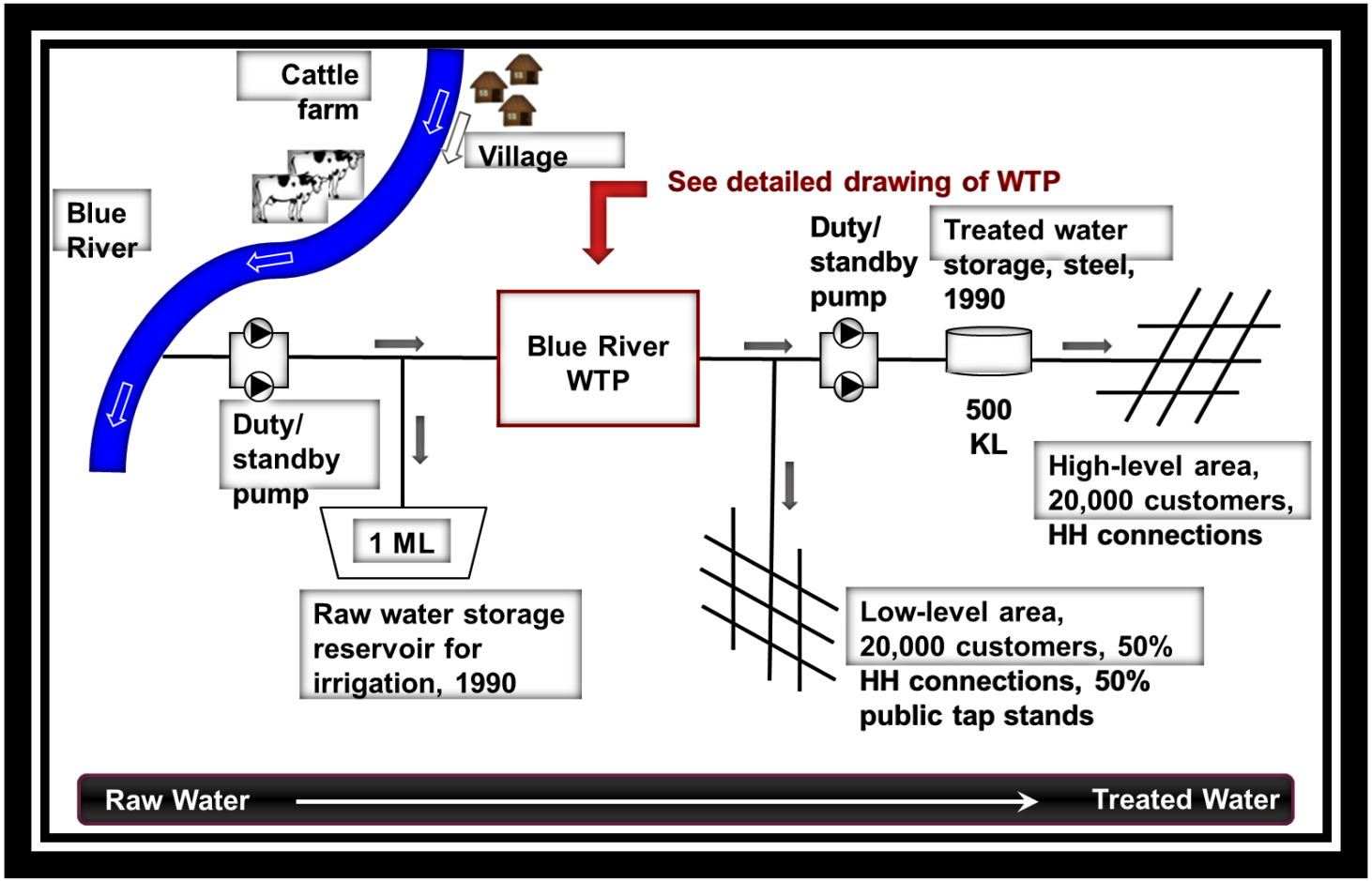


Describe the catchment *(e.g. forested, agricultural, protected etc.)*, the source(s) of water *(e.g. borehole, pond, river etc.)* and the no. of people served, and any other relevant information	If practiced, describe how people treat *(e.g. boiling, filtration, chlorine tablets/solution)* and store *(e.g. in a household tank, jerry can, open bucket etc.)* drinking-water at the household level
Water Kiosks systems – Describe catchment and sources	
Tanker systems – Describe catchment and sources	
Animal and Human drawn carts systems – Describe catchment and sources	
Water Points – Describe catchment and sources	

Refer to Appendix 2: Specific Guideline on Water Vending Regulation

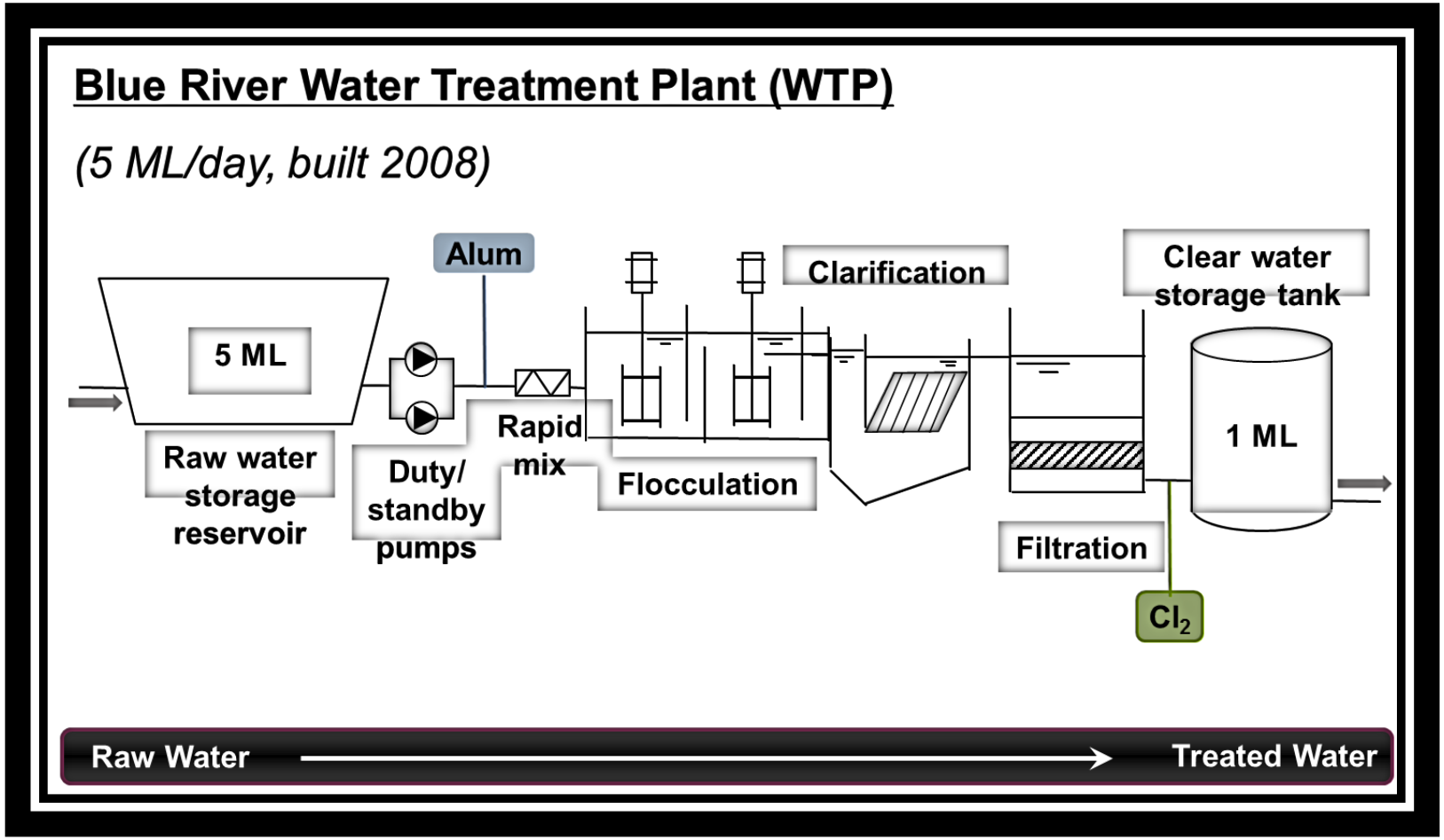
Map of the water supply system (Level 1)

Draw a basic overview of the entire water supply system. Include any activities in the catchment (e.g. agriculture, industry, human settlements)**, the source(s) of the water** (e.g. well, river, bore)**, any treatment steps** (e.g. filtration, chlorination; referring to the Level 2 diagram on the next page for detail), **any storage or distribution infrastructure** (e.g. tanks, pipelines)**, any collection points** (e.g. tap stands, kiosks), **household water treatment and storage practices and any other information that may be relevant to hazard identification.**



Map of the water treatment facility (Level 2)

Draw a basic overview of the water treatment facility and the key treatment steps (e.g., sedimentation, clarification, filtration, disinfection, chemical addition, treated water storage etc.)**. Include information on production capacity and the demand, the size of storage tanks, chemical addition points, pipe/tank materials, by-pass lines, sample points etc.**



Water Vending Sketches

Include sketches of all the water vending systems identified

HAZARD AND CONTROL MEASURE IDENTIFICATION, RISK ASSESSMENT AND PRIORITIZATION (SECTIONS 3 & 4)

Key action: At each step of the water system, identify the possible threats to water safety (i.e. hazards/hazardous events) that may impact water quality and the water supply system. Assess the effectiveness of any existing control measures that are already in place to manage these hazardous events, and assess and prioritize the risks.

Key terminology

- 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, or fail to remove, a hazard to the water supply system.
- **Risk** is the likelihood that a hazardous event/hazard will occur combined with the severity of the consequences.
- **Control measures** are activities or processes to prevent or reduce a hazardous event/hazard.
- **Validation** refers to reviewing evidence to determine whether or not the control measures can effectively control the hazardous event/hazard.

Risk assessment approach (3 x 3 Matrix):

			CONSEQUENCE		
			No/minor impact	Moderate impact	Major impact
			1	2	3
LIKELIHOOD	Unlikely	1	1	2	3
	Possible	2	2	4	6
	Likely	3	3	6	9

Risk score:	≤ 2	3 - 5	≥ 6
Risk level:	Low	Medium	High

Clearly not a priority

Medium- or long-term priority; requires some attention

Clearly a priority; requires urgent attention

Definition of likelihood and consequence:

Likelihood level	Definition
Unlikely	Could occur at some time but has not been observed; may occur only in exceptional circumstances
Possible	Might occur at some time; has been observed occasionally
Most likely	Will probably occur in most circumstances; has been observed regularly

Consequence level	Definition
No/minor impact	Minor or negligible water quality impact 9e.g. aesthetic impact, not health related) for a small percentage of customers; some manageable disruptions to operation; rise in complaints not significant
Moderate impact	Minor water quality impact (e.g. aesthetic impact, not health related) for a large percentage of customers; clear rise in complaints; community annoyance; minor breach of regulatory requirement
Major impact	Major water quality impact; illness in community associated with the water supply; large number of complaints; significant level of customer concern; significant breach of regulatory requirement

Definition of risk level:

Risk level	Meaning	Notes
	Clearly a priority	Actions need to be taken to minimize the risk. Proposed actions should be documented in the improvement plan and implemented based on priorities and available resources
	Medium Priority	Currently no impact on drinking water safety, but requires attention in operation and/ or possible improvement in the medium and long term to continue minimizing risk
	Clearly not a priority	Actions may be taken but not a priority, or no actions is needed at this time. The risk should be revisited in the future as part of the WSP review process

Risk assessment table:

Process Step ***(catchment, source, treatment plant, etc.)***	Hazardous Event ***("X happens because of Y")***	Hazard ***(M, C, P)***	Existing control measures ***(measures already in place)***	Are these controls effective?				Risk assessment				Is additional control needed?		
				Yes	No	Somewhat	Validation notes ***(basis of control measure effectiveness decision)***	Likelihood	Consequence	Risk score	Risk level	Yes	No	If yes, proposed controls ***(see improvement plan for detail)***
Catchment	Human effluent contaminating the water source water due to open defecation and run-off following heavy rain.	Microbial	Diversion ditch			X	Existing diversion ditch is somewhat effective as it is prone to clogging/ overflowing during heavy rain. Water quality results often show *E. coli* present.	2	2	4	M	X		Establish a buffer zone of vegetation along the river bank.

Process Step ***(catchment, source, treatment plant, etc.)***	Hazardous Event ***("X happens because of Y")***	Hazard ***(M, C, P)***	Existing control measures ***(measures already in place)***	Are these controls effective?			Validation notes ***(basis of control measure effectiveness decision)***	Risk assessment				Is additional control needed?		
				Yes	No	Somewhat		Likelihood	Consequence	Risk score	Risk level	Yes	No	If yes, proposed controls ***(see improvement plan for detail)***

Note: Use additional sheets as needed.

IMPROVEMENT PLAN (SECTION 5)

Key action: Document the details of the <u>additional</u> control measures needed that were identified in Step 3 (last column).

	What improvement is needed? ***(From last column of the table in Section 3)***	*What is the priority level for the improvement?* ***(High/medium/low)***	*Who is responsible for completion of this improvement?*	*How much is it estimated to cost?*	*What is the funding source?*	*When is this action due by (date)?*	*What is the status?*
1	Establish a buffer zone of vegetation along the river bank.	**Medium**	Catchment management officer	10,000 USD	Catchment Management Authority	December 2017	In progress
2							
3							
4							
5							
6							
7							

Note: Use additional sheets as needed.

OPERATIONAL MONITORING PLAN (SECTION 6)

Key actions: Document the details of the operational monitoring plan for the existing control measures identified in column 4 in the table in step 3

Operational monitoring plan (use additional sheets as needed):

Control measure ***(from column 4 in Step 3)***	*How will this existing control measure be monitored/inspected?*		*When is the control measure considered to be not working?*	*What needs to be done if the control measure is not working?*
Drainage ditch to divert effluent from entering the river	***What needs to be monitored?***	Condition of the drainage ditch	When the diversion ditch is clogged and/or overflowing.	• Notify WSP team leader • Stop harvesting raw water from the river Remove material from drainage ditch as soon as possible.
	How will it be monitored?	Visual inspection		
	When will it be monitored?	Dry season – monthly Wet season – weekly		
	Where will it be monitored?	At the pig farm perimeter		
	Who will monitor it?	Caretaker		
	What needs to be monitored?			
	How will it be monitored?			
	When will it be monitored?			
	Where will it be monitored?			
	Who will monitor it?			

Note: Use additional sheets as needed.

VERIFICATION MONITORING PLAN (SECTION 7)

Key actions: Document the details of the verification monitoring plan for verification that the WSP is working effectively.

Verification monitoring plan (use additional rows or sheets as needed)

What needs to be checked?	*What locations will be checked?*	*How often? And how many samples will be taken?*	*Who will do the checking?*	*What is the target outcome?*	*WSP team member to report the outcome to?*
Water quality testing (compliance monitoring)(e.g. E. coli, faecal coliforms, turbidity)					
E. coli	Household (1 per month)	Monthly	Environmental Health Assistant	0 *E. coli*/100 mL	WSP Team Leader
Sanitary inspection (e.g. at source, collection point, household etc.)					
Sanitary condition	Storage tank	1 survey per month	Environmental Health Assistant	"Low" risk score	WSP Team Leader
	Tap stand	1 survey per month	Environmental Health Assistant	"Low" risk score	WSP Team Leader
WSP implementation (e.g. WSP assessment [see Annex 3])					
Implementation of WSP	Whole WSP (source to household)	1 assessment per year	District Environmental Health Officer	Assessment pass	WSP Team Leader
Consumer satisfaction (e.g. satisfaction survey)					
Level of consumer satisfaction	Households	Performed once per year; covering 25 households	District Environmental Health Officer	"High" customer satisfaction from 80% of households	WSP Team Leader

MANAGEMENT PROCEDURES (SECTION 8)

Key actions: Document key management procedures and response plans.

Standard operating procedures

Using the template provided in Appendix 4, standard operating procedures (SOPs) should be developed for all routine operational tasks; for example:

- filter operation and maintenance
- chlorination
- jar testing
- water sampling
- water testing (for various parameters)
- storage tank cleaning
- pipeline repair practices
- pump operation and maintenance etc.

Emergency response plans

Using the template provided in Appendix 5, emergency response plans should be developed for emergency situations; for example:

- microbiological exceedance
- high turbidity event
- Loss of chlorination
- prolonged power outage
- boil water advisory
- alternative water supply arrangements etc.

SUPPORTING PROGRAMMES (SECTION 9)

Key action: Document the details of programmes for on-going education & awareness raising for the WSP team, stakeholders & consumers.

What specific awareness-raising activity will be carried out?	*How often will the activity be carried out?*	*Name of the person in charge of this activity?*
e.g. Water safety awareness during an emergency, such as a flood; Household sanitation and hygiene; Community sanitation and clean-up campaigns; Household water treatment and safe storage; School education programmes; Water treatment operator/caretaker training programmes; Emergency drills for flooding events	Every 12 months	Ms. Y

Note: Use additional sheets as needed.

WSP REVIEW/REVISION (SECTIONS 10 AND 11)

Key actions: Review the WSP (both routinely and following incidents/emergencies) to check that it is up-to-date and accurate. Revise the WSP as necessary.

Date of WSP review meeting	*Reason for meeting (e.g. routine or post incident/emergency)*	*Participants present*	*Topics discussed*	*Key outcomes/ actions*	*Person responsible*	*Date completed*
1 Oct. 2016	Routine monthly meeting.	Mr. X Ms. Y Ms. Z	Status of improvement plan implementation	District Technical Team to be updated on improvement plan implementation	Mr. X	Open

Note: Use additional sheets as needed.

Standard Operating Procedure Template

To document systematic instructions for carrying out routine tasks in your water supply system, use the following template.

Task to be completed	*Frequency*	*Instructions*	*Person responsible*
Inspection of the diversion ditch	Dry season – monthly Wet season – weekly	• Start inspection at the east end of the pig farm • Walk along the drainage ditch from east to west until you reach the west end of the farm perimeter • Visually check the diversion ditch for obvious signs of clogging (e.g. branches, sediments etc.) or damage to the diversion ditch banks. If the diversion ditch appears to be clogged/obstructed/damaged/overflowing, report to the WSP team leader immediately.	Caretaker

Emergency Response Plan Template

To document your actions in response to an emergency, use the following template (Note: use additional sheets as needed).

Possible emergency situation(s)	**Detection of faecal contamination (*E. coli*) in the treated water supply.**
Person(s) to be notified and method of notification	WSP team leader (Ph. 12345678) Public health officer (Ph. 12345679) Community leader (Ph. 12345670) District health officer (Ph. 12345677)
Method of notifying the community	Public announcement. Sign at tap stands. Door to door visits.
Source of alternative water supply	None available. Community to be advised to boil the water before consumption until further notice.

WSP Assessment Template

To carry out an assessment of the WSP, use the following template. The person carrying out the assessment should ideally be independent of the WSP team.

General information	
District:	
Water supply name:	
Date of assessment:	
Assessor(s):	
Water supply type: ***(e.g. point source [well, spring etc.], piped water supply, any treatment etc.)***	
Primary contact for the water supply system ***(name, contact details)***	
Overall WSP assessment summary: ***(to be completed at the end)***	

WSP Assessment			
#	**Question**	**Assessment** *(Good/Average/Poor)*	**Comments/Areas for improvement** *(include reasons for your assessment mark and list any possible ways in which this area can be improved)*
1	**Is the WSP team list current?**		
2	**Is the system description accurate and up-to-date?**		
3	**Is the hazard identification, control measure assessment and risk assessment understood and thorough?**		
4	**Is the improvement plan up-to-date and being implemented?**		
5	**Is operational monitoring being carried out as per the plan?**		
6	**Is verification monitoring being carried out as per the plan?**		
7	**If in use, are standard operating procedures and emergency response plans appropriate and being followed?**		
8	**Is the awareness raising plan appropriate for the needs of the staff/community and being implemented?**		
9	**Are the WSP team meeting routinely and the WSP being revised as appropriate?**		

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Date **Name and position of assessor(s)**

Household Survey Tool Template

WATER QUALITY SURVEILLANCE AND DEVELOPMENT OF WATER SAFETY PLANNING GUIDELINE HOUSEHOLD SOCIO-ECONOMIC SURVEY TOOL MAY 2018
WATER SERVICES REGULATORY BOARD

IDENTIFYING VARIABLES

County……..

Name of Water Service Board (WSB)……

Name of Water Service Provider (WSP)/ Water Utility……..

Category of Water Service (WSP)/ Water Utility……. ……..
1. Very Large 2. Large 3.Medium 4. Small

Type of Water Service Provider (WSP)/ Water Utility…….……..
1. CBO/NGO 2. Institutional 3.County 4. Private

Respondent(s) Name _____

Relationship of respondent to household head _____

1=head 2=spouse; 3=own child; 4=step child; 5=parent; 6=brother/sister; 7=nephew/niece; 8=son/daughter-in-law; 9=grandchild; 10=other relative ; 11=unrelated; 12=brother/sister-in-law; 13=parent in law: 14=worker

Age of respondent: 1. below 18 year 2. 19-35 years 3.36-60 years 4.>60 years

Sex of respondent: 1. Male 2. Female

HOUSEHOLD DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS

1) Name and Age of household head (HH) ……

   Age……

2) Gender of Household

   Head……..…

3) Highest education level attained by HH
   1. a) None b) Primary c) Secondary d) Tertiary e) University
   2.
4) Size of Household …… Male……..

   Female……..

5) How many household members that fall into these categories live in your household?

3.	Children Under 15	4.
5.	Disabled Persons	6.
7.	Elderly (over 55)	8.

6) How many children are enrolled in school…… Male…… Female……..

7) Household type (Select only one)
   1. Male headed and managed
   2. Male headed, female managed (wife makes most household/agricultural/ financial decisions)
   3. Female headed and managed
   4. Child headed (below age 18)/Orphan;

8) What is the primary occupation (***in terms of time spent on that activity***) of the household head

   1. Crop Farming 2.Livestock production 3.Business owner
   4. Salaried Worker 5. Self-Employed 6.Labourer
   7. Retired

9) How long have you been performing this activity (years)……

10) In which of the following categories do you estimate your total monthly household income (Kshs.), **from all activities, working members, business income, pensions and remittances**?

   1. < 1500 2. 1,500 – 2500 3. 2,500 – 5000 4. 5,000- 10,000
   5. 10,000 – 20,000 6. 20,000 – 30,000 7. 30,000 – 40,000 8.above 40,000

11) Please indicate your monthly household expenditure.(**Estimate monthly school fees from the annual or term figure)**

Food_____ Clothing_____ School fess_____ Medicare_____

Entertainment_____ Donations_____ Other (Specify)_____

12) How do you suppose your income is now considering three years ago?
   9. Higher
   10. Lower
   11. About the same
   12. Can't remember / Don't know

WATER SITUATION ANALYSIS

1. Please tell me the different sources and uses of water for your household and state how you perceive its quality during the dry and wet season

		1.River	2.Spring	3.Well	4.Borehole	5.Piped	7.Rain harvesting	8.Other (Specify below)
1.1 Name source(s)								
1.2 Uses of Water								
1.3 Perceived Quality 1.safe/potable	**Dry**							
	Wet							

2. unsafe/not potable								
1.4 Taste of the water (1)Tasteless (2)Salty (3)Chlorine (4) Metallic (5) Rotten egg (6)Musty (7)Turpentine	**Dry**							
	Wet							
1.5 Colour of the water (1) Colourless (2)Red-Brown (3) Yellow (4) Blue-Green (5) Cloudy white/foamy	**Dry**							
	Wet							
1.6 Smell of the water (1)Odourless (2) Chlorine (3) Bleach (4) Musty (5) Mouldy (6) Soapy	**Dry**							
	Wet							
1.7 Water Treatment 1. Yes 2. No								
1.8 Time Taken to access water								
1.9 Average distance to water point								
1.10 Water Treatment Methods. 1. Boiling 2. Chlorination 3. Alum 4. Herbs 5. Decantation 6. None 7. Others…….								

2. What is your main source of water for drinking?
   1. River 2. Spring 3. Well 4. Borehole 5. Rain harvesting

   6. Piped

3. Is your main water source reliable?

1. Yes 2. No

4. If the source is not reliable, what do you do to ensure that you have water at all times?
   1. Use store/ reservoir (specify)
      a) metal container b)open plastic c)closed plastic
      d)open traditional pot e)closed traditional pot
   2. Collect water from alternative sources….please specify……
5. What is the main cause for the interruptions in water supply?
   1. Drought
   2. Breakage of Pipes
   3. Nonpayment of bills
   4. Communal Misunderstandings
   5. Other (Specify)……
6. Have you experienced any water rationing in the past one year?
   1. Yes 2. No
7. If yes, what could be the reason why?
   1. Fall in water levels
   2. Increase in demand/ population
   3. Pollution of main water source
   4. Poor management of existing water source
8. Is the water source exposed to any pollution components?
   1. Yes 2. No
9. Please specify (multiple reasons allowed)
   1. Dust
   2. Industrial pollution
   3. Human activities (farming, dumping of solid and liquid waste)
   4. Other…Specify…….

Land use

1. What are the main uses of land in this area?
2. What do you normally use your land for?
3. What are you planning to use your land for in the next one year?
4. Does the area experience soil erosion due to farming activities?
5. What are some of measures put in place to curb soil erosion in the area?
6. Do you or anybody else in the area practice irrigation farming?

WATER USE AND WATER CHARGES

1. Do you pay water fees as expected?
   1. Yes 2. No 3. Sometimes
2. If No, Please state reasons.
   1. ……..
   2. ……
   3. …….
   4. ……..
3. Who collects your water fees?
   1. Water point manager 2.Vendor 3. Water Utility
   4.Other…..specify……
4. How often do you pay your water fees?

1. Daily 2. Weekly 3.Monthly 4. Other (specify)……..

5. What is your average monthly water bill? ……..
6. How much money do you pay for one 20L jerry can of water? .....
7. Would you pay for improved quality of water/ service delivery? …….
   1. Yes 2. No
8. If Yes, how much……..
9. What would discourage you from paying your monthly water bills?
   1. Economic hardships
   2. High prices of water
   3. Mismanagement of water point
   4. Poor quality water
10. How many 20L jerry cans of water does your household use per day? .....

SANITATION

1. How frequent do you clean your water storage containers?
   1. Twice a month
   2. Monthly
   3. Twice a year
   4. Annually
2. Has any member of your household suffered from any water-borne disease?
   1. Yes 2. No
3. If yes, Please state which one?
   1. Bilharzia
   2. Diarrhoea
   3. Typoid
   4. Amoeba
   5. Cholera
   6. Dysentry
   7. Others…Please specify…….
4. How long did the disease last?
   1. Less than one week 2. One week 3.Two weeks 4.One month 5. More than a month
5. How much money does the household spend in treating water-borne diseases?.....
6. What, in your opinion, what possibly caused the water-borne disease?
   1. Drinking contaminated water
   2. Eating contaminated food
   3. Other……Specify…….
7. Type of Toilet facility
   1. None
   2. open pit latrine-no wall
   3. pit latrine with wall
   4. pit latrine with raised slab
   5. Pit latrine without raised slab
   6. Ventilated Improved Pit
   7. Flush
8. How do you dispose waste water from your home?
   1. Sewer system

2. Open ditches
3. Open land
4. Septic tank
5. Don't know
6. Others specify……

9. What are some of the challenges you experience in regards to sewer and waste water
    1. High cost of connection
    2. Regular blockage/bursts/general maintenance problems
    3. No existing sewer lines
    4. Inefficient waste water treatment
    5. Any other, specify……..
10. Do you have a hand wash facility next to toilet?
    1. Yes 2. No
11. How do you dispose off your solid waste?
    1. Compost pit
    2. Burning
    3. Open land
    4. Garbage collectors
    5. Others…..Specify…….

CONSUMER PARTICIPATION AND REPRESENTATION

1. In your opinion, what would you say are the main risks that the water utility/sewerage is exposed to?
    1. ……
    2. ……
    3. …….
    4. ……..
2. What mitigation measures would you propose to reduce/ prevent the above risks?
    1. ……
    2. ……
    3. ……
    4. ……
3. How would you rate your service provider in regards to the following: (SCALE 1-Not satisfied, SCALE 2-Neutral and SCALE 3-Satisfied)
    1. Public and stakeholder consultations: (1) (2) (3)
    2. Quality of water/sewerage system: (1) (2) (3)
    3. Cost of service provided: (1) (2) (3)
    4. System maintenance: (1) (2) (3)
4. Any other comment in regards to water supply, distribution, supply and sanitation issues?
    ……
    ……
    ……
    ……
    ……
    ……

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