MINISTRY OF FEDERAL AFFAIRS AND LOCAL DEVELOPMENT
Department of Local Infrastructure Development and
Agriculture Roads (DoLIDAR)

Hand Book on Community-Wide Water Safety Planning

"Water Safety Plan for Incessant Safety of Drinking Water"

2013

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Acknowledgements

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Glossary and Definition

BPT	:	Break pressure tank
DDC	:	District Development Committee
DEO	:	District Education Office
DHS	:	Demographic Health Survey
DPHO	:	District Public Health Office
DTO	:	District Technical Office
DWASHCC	:	District Water, Sanitation and Hygiene Coordination Committee
DWSS	:	Department of Water Supply and Sewerage
GFS	:	Gravity Flow System
MoFALD	:	Ministry of Federal Affairs and Local Development
MoHP	:	Ministry of Health and Population
MoUD	:	Ministry of Urban Development
RWSSWN	:	Rural Water Supply and Sanitation Project Western Nepal
UC	:	Users' Committee
UNICEF	:	United Nations Children's Fund
VDC	:	Village Development Committee
VWASHCC	:	Village Water, Sanitation and Hygiene Coordination Committee
WHO	:	World Health Organization
WSSDO	:	Water Supply and Sanitation Divisional Office
WSP	:	Water Safety Plan
WQS	:	Water Quality Surveillance

The Government of Nepal
Ministry of Federal Affairs and Local Development
Department of Local Infrastructure Development and Agriculture Roads (DoLIDAR)

Preface

It is my great pleasure to introduce the "*Handbook on Community-wide Water Safety Planning*," which is prepared in a community-wide approach to implement water safety planning in the program districts of Finland supported Rural Water Supply and Sanitation Project in Western Nepal (RWSSP-WN). This handbook will be used as guidance in all the 75 districts of Nepal, instead of being confined in the areas covered by *RWSSP-WN* program at present. Essentially, I believe the dedicated professionals, who are working hard in securing and supplying fresh water, such as the respective district engineers, sub-engineers, technicians, social mobilizers and facilitators representing at the district, VDC and community levels, will find this handbook substantially helpful. I am thankful to the Project Support Unit and Project Coordination Office staff of RWSSP-WN who facilitated and delivered this valuable guide for the welfare of our people.

The Government of Nepal remains committed to increase the access of its people to safe drinking water and to reduce the burden of water-borne diseases. It can be mentioned that the *National Drinking Water Quality Standard* (NDWQS) and the *Implementation Directives 2006* require all service providers to maintain NDWQS benchmark. In this context, the "*Handbook on Community-wide Water Safety Planning*" provides a systematic approach to implement Water Safety Plans in all types of water systems within VDC under the leadership of V/MWASHCC. The major concepts included in the handbook are (1) WSP for all types Rural Water Supply technologies thus adopting community-wide approach; (2) O&M as backbone and integral part of the WSP; (3) Simplified steps of WSP applicable to local situations; (4) Integration of climate change uncertainty/ vulnerability assessment into WSP steps; (5) Simple illustrative pictorial views (animated figures) for all aspects of WSP tasks; and, (5) Safe water zone/VDC declaration process.

In addition, the handbook provides a framework on how to apply WSP within VDC as a community-led and community-wide measure that serves water to the local people. I further believe that the "*Handbook on Community-wide Water Safety Planning*" will be used by WSP teams in coordination with and support by VMWASHCC and other agencies, and WSP will be applied in all water supply systems in line with the Government of Nepal's existing policies and guidelines. Finally, I envisage this handbook will be used as a supporting document to any national level measure in areas such as water quality improvement and water safely planning.

Bhupendra Bahadur Basnet
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Background

One of the common diseases in developing countries is diarrhea which is caused by unsafe water and poor sanitation. National Demographic Health Survey (NDHS) data shows that the provision of improved water supply system in the country has not reduced prevalence of diarrhea in under-five children and indicates presence of more unmanaged risks. This clearly demands for applying Water Safety Plan (WSP).

Safe water is the precondition for health improvement and ensuring human rights. The concept of Water Safety Plans (WSPs) was developed in WHO Guidelines for Drinking-water Quality, 3rd edition (2004) and was continued in the 4th edition (2011) as the most effective approach for continuous safety of drinking water.

Government of Nepal is committed to increase access to safe water and thereby reduce burden of water-borne diseases. National Drinking water Quality Standard (NDWQS) and Implementation Directives, 2006 require all service providers to maintain NDWQS. Sector agencies (authorities) provide support for improvement of system and Ministry of health to carry out water quality surveillance. This hand book helps systematically implement. Water Safety Plan in all kinds of water system within VDC under leadership of VWASHCC as community led and community wide approach. The hand book will be used by WSP team and supported by VWASHCC and agencies.

WSP will be applied in all water supply systems by existing service providers in the country in line with policy and guideline. This document provides WSP framework on how to apply WSP within VDC as community led and community wide considering all sources of waters that people using.

This handbook is intended to be used by the district, VDC and community level audiences like district engineers, sub-engineers, technicians, mobilizers and facilitators.

1

Part

Water Safety Plan

Water Safety Plan: Concept

The supply of safe drinking water is vital for public health. Concept of safe water is guided by health- based targets and overseen through drinking water supply surveillance system. Water Safety Plan (WSP) will be applied for continuous safety of drinking water by meeting physical, chemical and biological parameters set by the country. Surveillance system is for ensuring the effectiveness of WSP. The most effective means of continuous safety of the drinking water tends to minimize contamination at source, reduce contamination during treatment process and prevent contamination during storage, distribution and handling of drinking water. If the system is theoretically capable of meeting health-based targets, the WSP is the management tool which, through systematic steps, assists in meeting these targets. WSP is based on risk management through principle of hazard analysis and control measures. It

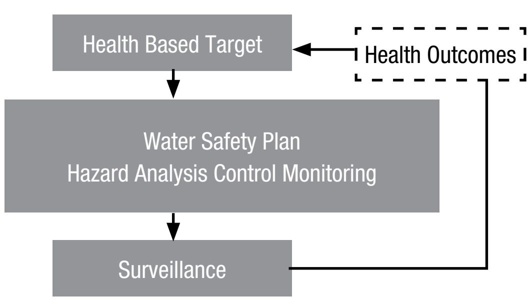


Diagram 1: Theory of WSP

applies multiple-barrier approach from catchment to consumer. Community participation is vital for its success. Active WUSC and well-managed system is a precondition for effective application of WSP, which is applied at the system level and guided by coordinated national institution for WSP. WSP mainly involves six process tasks.

(1) Team assembly
(2) System Analysis
(3) Hazard Analysis and control measures
(4) Action for improvement
(5) Monitoring and verification
(6) Review and documentation

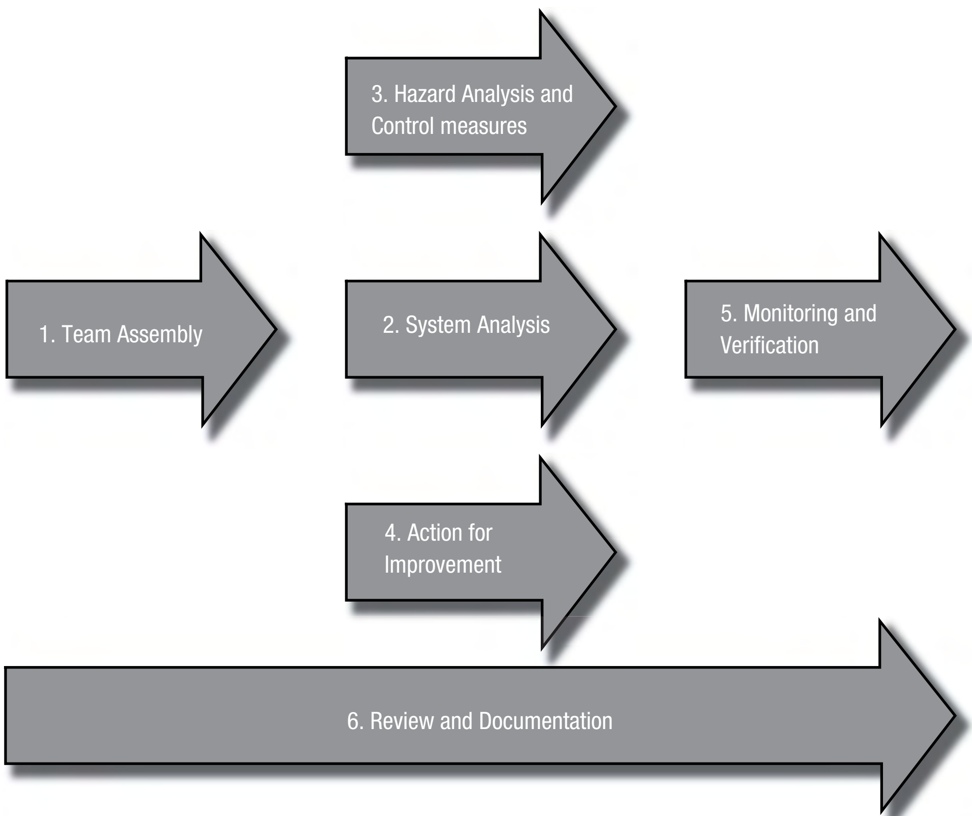


Diagram 2: Process Tasks of WSP

Water Safety Plan: Institution

National WSP Team

National WSP team will comprise of key agencies responsible for directing, supporting and strengthening WSP and WQS in the country. Agencies represented in the core team of WSP are: MoUD, MOHP, DWSS, DoLIDAR, INGO, Civil society and WHO.

District WSP Team

District-level WSP team will be formed for guiding and supporting WSP in all projects and communities within the district. District WSP will consist of: DDC, DWASHCC, WSSDO, DPHO, DEO, DTO and representatives of civil society.

VDC WSP Team

WSP team will be formed at the village level as a functional group of VWASHCC. WSP team at the village level will ensure that both organized and unorganized water supply systems apply WSP. The WSP focal point of water supply system and clusters will be a member of WSP team. In addition, representatives from health office, VDC, school and civil society will be members. Community-based organizations and women's groups will also be represented in WSP team.

National WSP Team

- Develops WSP concept and modality for the country
- Reviews and updates WSP training modules
- Reviews WQ monitoring system
- Reviews WQ surveillance system
- Orients district WSP team for applying WSP in the districts.
- Orients district WSP team for supporting WSP in communities.

District WSP Team

- Develops WSP concept and modality for the district
- Reviews and updates WSP training materials
- Reviews WQ monitoring results
- Reviews WQ surveillance results
- Supports WSP team at community level
- Approves safe water zone at community level

VDC WSP Team

- Visits from Catchment to Consumer of Water Supply System and understands all components
- Identifies all possible hazards and control measures
- Prepares an urgent and long term action plan for improvements
- Develops a plan for regular monitoring and organize periodic monitoring by team
- Verifies performance of WSP by regular WQ testing
- Reviews WSP through users satisfaction survey and Up Dates the WSP document
- Makes a plan for source conservation, protection and vulnerability
- Declares the safe water zone criteria
- Helps WQ surveillance done by health agencies.

Water Safety Plan Task 1: Team Assembly

A team dedicated to WSP is necessary at the VDC level for applying WSP in all water supply systems and sources that people are using. WSP team is a kind of sensor, supporter and director for continuous safety of drinking water and effectiveness of WSP. Basically water supply in Nepal is managed by users committees. All users committees in VDC need to assign one of the members as a focal person for WSP. WSP in the water supply system becomes an integral part of operation and maintenance. Hence, the focal person works closely with the scheme operators and also becomes a member of WSP team at the VDC level. In the area where people use point sources, WSP focal person will be nominated at the cluster level. WSP team at the community level comprises of focal persons of systems and clusters (using point sources), health worker, school teacher, civil society, women's groups, community-based organization related to environment and VDC. A coordinator for the team will be selected by the team members and the coordinator can be changed after one year with consensus.

Figure 1: WSP team assembly

The team needs to link WSP with O&M of the system, health surveillance, consumer's education and, sources conservation & protection and disasters risk reduction in view of climate change. In the beginning WSP team needs to give more time for establishing WSP process. Once WSP is established, time input required from the team decreases. WSP becomes a part of operation, maintenance and safe water management. The team continues to review, update and internally verify the tasks periodically, which requires minimum time.

Water Safety Plan Task 2: System Analysis

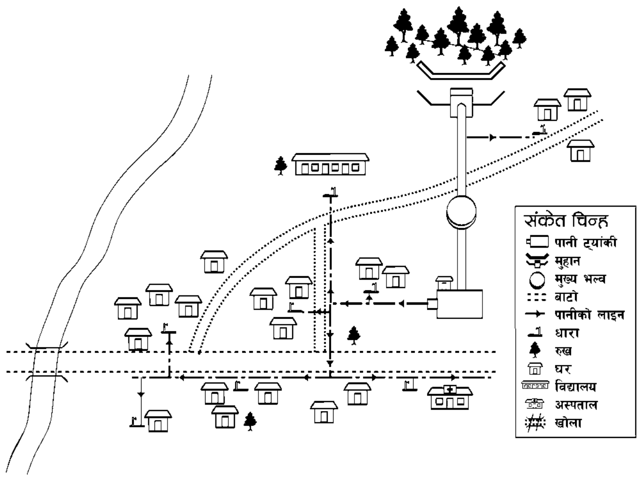


Figure 2: System Analysis

System analysis involves understanding of water supply system including physical structures, placement and its functions. The team needs to understand its systems as a whole and its components and its locations. The team needs to understand Standard Operating Process (SOP) of all components of the system. It needs to prepare a layout map of individual water supply system showing all components (source, treatment, distribution and consumers) and community features (roads, rivers, forest, public buildings and communities). Maps will be prepared by users' committees and WSP team will collect all the maps. Similarly, WSP team needs to prepare one map of the whole VDC showing all sources, key features of water supply systems and village.

The team needs to define the catchment area and understand how climate change and various disasters may affect the water supply schemes (water quantity, quality and timing) because of excessive rains causing floods, runoff, landslides, or decreased rain causing drought, source depletion and water scarcity. Community should analyze the potential effects on the catchment area. For all the sources a protection zone for pollution control should be defined.

Water Safety Plan Task 3: Hazard Analysis and Control Measures

Hazards: All the physical, chemical and biological contaminants above the standard values are considered hazards, and the points from where they can enter into the system are hazard points. The team needs to visit across system areas from catchment to consumer and observe all points from where contamination is likely to occur. The team needs to discuss each hazard and determine how to control them. The team should have an idea about the risk of each hazard considering likelihood and severity, and prioritize them for control measures (from min 1 to max 5). Prioritization scores will be given for each hazard of the four areas (Source, Treatment, Distribution and Consumer). The team can give the highest priority for the hazards with highest risk and then adjust scores relatively to other hazards. For example, a hazard causing fecal contamination at source can have the score of five and absence of fencing can have one or two. The team needs to think that climate change and various disasters may exacerbate the severity of the existing hazards. The team can utilize advice of experts in the community and beyond.

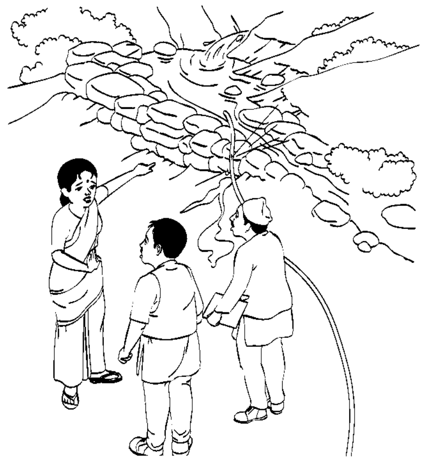


Figure 3: Hazard analysis

Control Measures: Control is the barrier to contamination. Contamination can be prevented at source, removed by treatment, inactivated or and prevented to further contamination by chlorination. Preventive approach is wiser investment than treatment because treatment itself can pose risk if it is not operated properly. Control measures, on the basis of how it is serving its purpose, can be categorized as (i) existing, (ii) needing improvement, and (iii) needing new kind of establishment. Priority should be given based on significance of hazard for causing

Figure 4: Control measures

contamination. It is not possible to control all the hazards in the sources. If water is heavily contaminated, a treatment plant is necessary. If contamination is only bacteriological, it can be controlled through chlorination. The concept of multiple barriers should be used to minimize risks. A treatment system itself is a hazard if not operated properly. If nothing can be done at the system level, users should be notified and asked to treat drinking water at their house using one of the point of use treatment facilities/system convenient for them in the community context.

Water Safety Plan Task 4: Action for Improvement

Figure 5: Action for Improvement

The team needs to work out an appropriate action for improvement for those control measures which are not in place or need to be upgraded. Some system modification may also be required. System upgrade option depends on economic and environmental aspects and available technologies. Some action can be taken by the community itself but some action may need technical or financial support of VDC, DDC and other agencies. Users' committee makes a plan for improvement in its system and cluster, whereas the WSP team makes a plan for upgrading system in the VDC level as a whole in the longer term. Examples:

Source: Catchment protection, fencing at intake, drainage to divert surface water. Sustaining the source through groundwater recharge, use of excess water for recharge or other purpose

Treatment: Installation of a treatment plant and operations. Protection of reservoir works, chlorination

Distribution: Leakage corrections, avoiding drainage, protection of pipes, protection of valves from external contamination, avoiding scaling on internal pipe surfaces.

Consumers: Cleanliness of tap points, safe storage of water and sanitary behaviors at households.

Water Safety Plan Task 5: Monitoring and Verifications

Purpose of WSP is to ensure that control measures are in place and fulfilling their function. The team needs to prepare a monitoring plan. The monitoring plan consists of required conditions of controls with respect to each potential hazard in each area as indicators. Indicators should be derived from control measures written in the hazard and control matrix. Regular monitoring is done by operators and focal persons of the systems and clusters. Operators should be trained and oriented for safe water management and operation process. Periodic monitoring should be done by WSP team in coordination with VWASHCC. Following types of monitoring is required:

- *Operational monitoring:* This is monitoring of hazard and controls done by operators and focal person of the system or clusters. This should be a part of the normal operation of the system.
- *Validation:* WQ testing after modification or new establishment is also known as validation. All parameters of NDWQS need to be tested in the first verification. Then after, only potential parameters may be tested.
- *Verification monitoring:* This monitoring is done by WSP team periodically for verification of all controls. WSP can be also verified by testing water quality. VWASHCC can also involve in this monitoring.
- *External verification:* Government needs to have a WQ monitoring and surveillance system which is not in process now. In this context, water authority can verify WSP by WQ testing. Similarly, health authority can verify WSP through auditing and assessment of water quality. These two verifications (Monitoring and Surveillance) are called external verification from the community point of view which increases user's reliability on water quality. The team should have its own laboratories within VDC or link to other laboratory for regular and periodic testing of water quality.

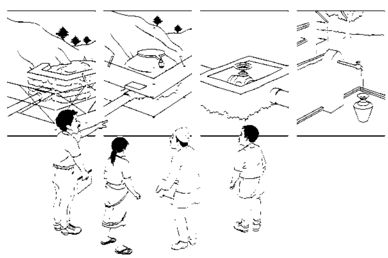


Figure 6: Monitoring

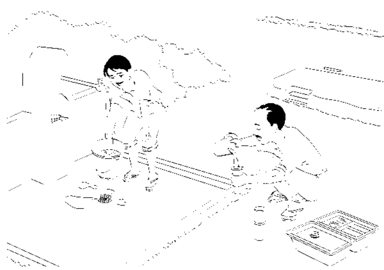


Figure 7: Verification

Water Safety plan Task 6: Review and Documentation

The team needs to review six WSP tasks periodically, normally once a year. This is done by visiting whole water supply system from catchment to consumer and reviewing WSP activities and records. As part of review, WSP team needs to conduct user's satisfaction survey to know performance of WSP works and safety of water from the users' point of view. Only their satisfaction can sustain WSP.

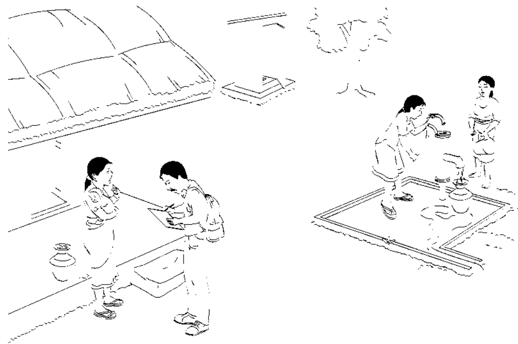
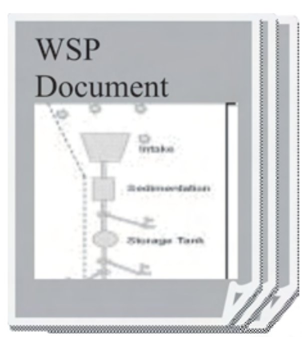


Figure 8: WSP review

User's satisfaction survey can be done in two ways. One is by focus group discussion in different clusters and the other is by sample survey. Five questions can be asked to garner opinion of the users.

1. Are you aware of WQ and its relation to health?
2. Is the water supply system safely managed?
3. Is water supplied through the system safe? (How do they use tap water?) (by boiling, using filter, applying SODIS, chlorination, or by other means)
4. Any incidence of Diarrheal disease in the past one year?
5. Is there safe storage and handling practice of drinking water at houses?

Answers to each question in a cluster (area) should be converted to percentages and recorded in the format. User's satisfaction survey gives feedback for reviewing WSP as well as need for organizing awareness raising.



WSP team needs to compile WSP document as a living document for WSP. Document includes all six tasks in the format available in the chapter two

2

Part

WSP Document Formats

WSP Document: Information

A. Introduction of the Water Supply Systems				
1. Name of the supply system:				
2. District:		VDC:		
3. Number of Households:		Daily Water Supply (liters/Day):		
4. Type of system and coverage:				
Type of source system	Clusters	No of sources NO	House Holds	Contaminants

5.	Number of taps: Private: Public/community:
6.	Sanitation status of VDC: Red(Poor)/Orange(ODF)/Yellow(Plus Hand Washing Practices)/Green(Plus Solid Waste Management)/Blue(Plus Waste Water management) If Red how many HH have sanitary toilets in use (in %):
7.	
8.	How do people drink water supplied from the system? (%) a. Directly from tap: b. Boiling: c. Filter: d. Other methods:
9.	Diarrhea prevalence for U5 children in past year (%):
10.	Treatment units in place: Intake filter ( ) Sedimentation tank ( ) Roughing filter ( ) Slow sand Filter ( ) Rapid Sand Filter ( ), Chlorination ( ) Others
11.	Nearest Labs:
12.	Other information including WQ and O&M status etc.

Note: This information form needs to be compiled by WSP team for VDC based on the information provided by focal persons and members and need to be revised annually. Type of the system can be Gravity system, Lift system, Over Head system, Hand Pump, Dug well, Rain Water Harvesting, Protected spring etc

WSP F1: WSP Team Formation

SN	Name	Representation	Role in WSP
1			
2			
3			
4			
5			
6			

Note: WSP team comprises of WSP focal person from each water supply system and clusters and representatives from school, health post, forest association, women group and VDC. The team is coordinated by one of the members selected by the team and he/she can be changed after one year.

WSP F2: Community Map

Name of the Water Supply System:

	Intake
	Tree
	Valve
	Tank
	River
	Road
	Pipes
	School
•	Tap
	House

Note: This map consists of key features of water supply water supply systems (source, structures, pipe lines, taps) and community features like roads, rivers, forests, community buildings, catchment area etc. This map is to be developed by users committee at system level and by WSP team at VDC level.

WSP F3: Hazard analysis and control

Area	Hazard Events (Point, event or process that is likely to cause contamination)	Controls (Required condition to minimize hazard risk)	Present status (A: in place, B: need improvement, C: need new installation)	Priority (1 Lowest, 5 Highest)
Catchment/ Source/Intake				
Treatment/ Storage				
Distribution				
Consumer				

Note: Priority for control for each hazard needs to be analyzed by focal person in consultation with users committee. This matrix will be completed at system level and submitted to WSP team. This needs to be reviewed annually or updated any time differences are found during monitoring.

WSP F4: Action for Improvement

Area	Action required for improvement	Time frame (Month or Year)	Responsibility (Operator, Community or VDC/DDC)
Catchment/ Source/Intake			
Treatment/ Storage			
Distribution			
Consumer			

Note: Action is required for all hazards needing improvement or new control based on the previous hazard and control matrix. Time and responsibility need to be fixed based on priority and capacity of the community. Action should be taken as early as possible by the community. This form is prepared by the focal person in consultation with users committee and operators.

WSP F5: Monitoring and Verification

Area	Indicators (required conditions)	Responsibility	Frequency
Catchment/ Source/ Intake			
Treatment/ Storage			
Distribution			
Consumer			

Note: monitoring is done for verification whether the required condition of control is in place or not. Monitoring is responsibility of operators and focal persons. WSP team also needs to monitor periodically all the systems. Monitoring needs to be verified by WQ testing separately. Monitoring needs to be recorded and improved continuously if any differences are found.

WSP F6: Water Safety Plan: Review

SN	Questionnaire	Clusters					
		1	2	3	4	5	Average
1	Are you aware of WQ and its relation to health?						
2	Is water supply system safely managed?						
3	Is water supplied through the system safe? (How they use tap water?)						
	By Boiling						
	By using Filter						
	By applying Chlorine						
	By applying SODIS						
	By doing nothing						
4	Any incidence of Diarrheal disease in the past one year						
5	Practice of safe storage and handling of water at HH						
Data Interpretation and plan for action:							

Note: Express each answer in as percentage of HH in the cluster (area) based on sample survey or focus group discussion

3

Part

Water Safety Plan Works

Capacity Building

VDC Level Workshop

Introduction: Community level WSP team is responsible for applying WSP in all water supply systems and sources used by the people in the VDC. They need to know WSP concepts, tasks and related information and processes and for that purpose. A three day workshop at community site will be held. The workshop may be supported by VDC, DDC and other related agencies.

Learning objectives: At the end of the workshop participants will be able to

- Describe Water Safety Plan Concepts and its key tasks.
- Identify formats and practice some of the tasks in their field situations.
- Describe the process to apply community wide WSP.
- Prepare an action plan for systematic application of WSP.

Methodology: Training will be conducted on the basis of experiential learning principle. Participants will be familiarized with theoretical concepts, exposed to scenario through case studies and field visits, they will reflect from their point of view and come out with their own plan for learning and how to perform tasks.

Materials: Materials required for this training are: Presentation on WSP concepts and Tasks including the formats working formats in loose sheet chart on WSP concepts and tasks chart on map and hazard analysis matrix.

Module 1: Water Safety Plan (WSP) Concept and Tasks: Day one		
Competence: participants will be able to explain the concept of WSP and its six essential tasks, exercise team formation process, system analysis, prepare a community map and indicate conservation, protection and vulnerable areas.		
Content	**Methodology**	**Time**
National drinking water quality standard. Concepts, principles and tasks of water safety plan	Explain national targets, WSP role of service providers and WQS role of MoH. Explain WSP concept of WHO, Hazard analysis and control form catchment to consumer, multiple barrier concept, continuous safety. Encourage participants to share experiences and ask questions. Explain six tasks and process. Explain sustainable O&M as basic requirement for WSP.	2 Hr
Team formation	Facilitate community to form WSP team and clarify their role at community and system/cluster level. Process of team formation will be initiated and it may be completed later.	1Hr
System analysis	Community will prepare a project level map indicating all systems, key components, sources, community features. They will also prepare a community level map indicating ward wise division and location and service areas of systems. Community will also indicate conservation and protection areas and vulnerable areas for special attention.	2 Hr
Module2: Hazard Analysis and Control Measures and Actions: Day Two		
Competence: participants will be able to identify hazards, control measures and action for and make a plan of action for improvement.		
Content	**Methodology**	
Site visit	Arrange visit to a system from catchment to consumers. Observe all hazards; discuss about control measures and action required. Complete maps and discuss on source protection zone. Resource Persons team needs to visit for monitoring.	3 Hr
Model WSP	Facilitate participants to complete model WSP including hazards, controls, monitoring and corrective actions	2 hr

Module3: WQ monitoring, safe water zone and action plan : Day Three		
Competence: participants will be able to explain WQ monitoring system in the community with lab facilities, Discuss on safe water zone and process to prepare an action plan for systematic application of WSP in the community.		
Content	**Methodology**	
WQ monitoring	Explain why WQ monitoring. Describe options for lab establishment and facilitate discussion among participants.	2hr
Safe water zone	Explain concepts, criteria and facilitate discussion among participants	1 hr
Action plan for WSP application	Prepare a format for action plan including tasks, time and responsibilities. Actions are: Six tasks of WSP, Source protection and conservation, WQ testing and lab establishment, climate change and vulnerability analysis, Safe Water Zone declaration, coordination with related agencies. Prepare one year time plan	1 hr
Learning test	Conduct the learning test through discussion on test questions.	1 hr

District Level Workshop

D-WASH-CC needs to organize a district level workshop on VDC wide WSP for review and evaluation. Similarly agencies need to organize training for related staff and volunteers for supporting VDC for applying WSP. Model of training depends on approach of districts. Training and workshop can be combined with other activities of D-WASH-CC and agencies. One day workshop for review and three days training with one day field works will be appropriate.

Center Level Workshop

Departments can organize one day workshop for review and three days training for district staff.

Community Action Plan for WSP Process

Community wide WSP process starts from the community level workshop. In the workshop community team understands concepts and key tasks of WSP and practices some of the tasks. In the workshop team prepares action for systematic application of different tasks of the WSP. An action plan can be prepared for period of 6 to 12 months. This is a typical model for action plan for one year.

NO	Activities	Methods	Time (Month)					
			2	4	6	8	10	12
1	Nomination of WSP focal persons at all systems and clusters and formation of WSP team and selection of coordinator.	Focal persons selected by Users committees with priority of women and WSP team formed in consultation with related agencies under leadership of VWASHCC	x					
2	System analysis and preparation of map at project and VDC level with indication of protection zone, conservation zone, vulnerable areas	Site visit in team and discussion in team with other stakeholders.	x					
3	Development of hazard-control matrix for all systems and technologies	Site visit and discussion meeting	x					
4	Prepare action plan for improvement at system level and community level and take actions	Sites visit, discussion meeting and consultation with technician	x	x	x	x	x	x
5	Develop of plan for regular monitoring by focal persons and operators and periodic monitoring by WSP team	Discussion meeting	x	x				
6	Carry out users satisfaction survey at all clusters, analyze data and make plan for awareness. Develop WSP document	Sample survey in the clusters and focus group discussions			x			
7	Mark protection zone for all sources	Site visit, discussion and consultation		x	x			

NO	Activities	Methods	Time (Month)					
			2	4	6	8	10	12
8	Carry out Selected WQ parameters for all system and sources.	From nearest laboratory		x	x			
9	Establish WQ testing lab within community or link with other place and monitor WQ on routine basis.	Community meeting, procurement and consultation with district office				x	x	x
10	Declare water safety zone.	Site visit, WSP-Team meeting and community meeting					x	x
11	Assessment for effects of Climate Changes and adaptation plan	Community meeting				x		
12	Maintain linkages with related agencies	Coordination and communication				x	x	x

WSP Team: Roles

WSP team comprises of focal persons of organized water supply systems and clusters with unorganized or point sources. Other members of the team formed under the coordination of V-WASH-CC include representatives from school, women's group, health center, forest association and VDC. The coordinator of WSP team will be selected among members by themselves. The coordinator can be changed after one year in turn at community's convenience.

Responsibilities of WSP team are:

- Visit all sites, understand projects and O&M practices, and prepare system-wide and VDC- wide maps.
- Prepare a system-wide WSP model indicating hazards, control measures, monitoring and corrective actions and arrange regular monitoring by operators and focal persons.
- Define protection zones for water sources and apply code of conduct for pollution control.
- Discuss potential impacts of climate change and prepare a plan for source protection and conservation.
- Arrange WQ testing of all sources for all parameters in the beginning and regular testing for potential parameters.

- Establish WQ testing facilities or make linkages with other laboratories based on capacity, requirement and convenience.
- Prepare improvement works at project and community level.
- Visit all systems and clusters to verify status of controls in team regularly (6 month) with special focus on catchment and protection zone of the sources.
- Carry out users' satisfaction survey using sample survey and focus group discussion and analyze results and develop required changes as part of awareness and WSP strategy.
- Review the WSP document and revise it annually.
- Set criteria for declaration of community (VDC) as water safety zone and update the same annually.
- Coordinate and communicate with related agencies for support and recognition.

Maintenance for Water Safety Plan

Managing effective operation and maintenance of rural water supply systems is challenging. Traditional management approach is based on problem solving. Operation is guided by demands and complaints of people and maintenance is followed by failure. Water Safety Plan requires well-planned operation and preventive maintenance. An active users' committee, good management and regular maintenance of water supply system are preconditions for the effective Water Safety Plan. Water Safety Plan requires that all hazards in the system from catchment to consumer to be controlled and regularly monitored. This helps maintain quality of work, augment and minimize the water loss and ease operation. Operation and maintenance staff are vital to the monitoring of controls and preventive maintenance. In some stage, users' committees find that the cost of operation and maintenance has gone down. Safe water management requires following points to be considered.

- Assign a focal person from users' committee for O&M, assign an O&M worker as in-charge and operators.
- Develop Standard Operating Procedure for each and every component of the system and use it for operation and maintenance.
- Link O&M with Water Safety Plan mainly for hazard control and monitoring.

- Establish preventive maintenance system and separate annual budget so that O&M team can work independently.
- Establish linkage with VWASHCC and VDC for support beyond capacity of community.
- Maintain close coordination with VWASHCC and report them about O&M status of the systems.
- Get regular feedback from users and organize meetings in clusters.
- Give equal importance to quality and quantity and verify from VWASHCC.
- Explore more effective and efficient ways of O&M and adopt knowledge and technology.

Safe Water Zone

Unsafe water is the one of the most prominent causes of diarrhea which leads to death among children under five years of age. Safety of water requires safe water system and good sanitation and hygiene practices in the households. Supply of continuously safe water is possible with the help of Water Safety Plan. A community needs to have all sources and water supply system with WSP in place. It needs to have all hazards identified, controlled and continuously monitored and verified. People with safe water handling practices can lead to concept of safe water zone. Here in the context of VDC-wide water safety plan, safe water zone has been introduced.

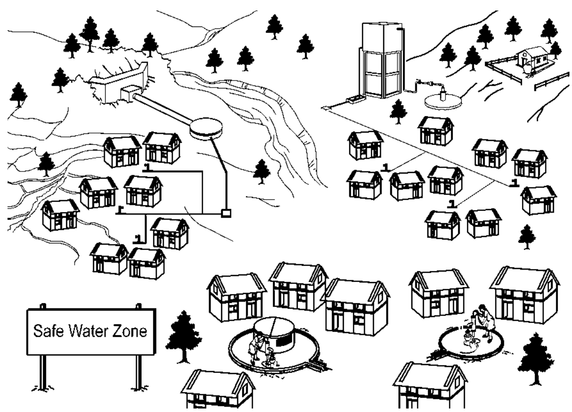


Figure 9: An ideal safe water zone

Criteria for safe water zone:

1. Well-managed system. Water Safety Plan team in action. VDC-wide WSP including all systems and sources in place.

2. All water supply systems tested on routine basis and verified as meeting standard at tap points.
3. Open Defecation Free VDC with solid waste management and wastewater management.
4. Source Protection Zones defined in all sources and protection in place.
5. Safe water storage and handling practices in place within community.
6. Prevalence of diarrheal diseases does not exceed two percent, and no case of U5 Mortality rate caused by diarrhea. Causes of diarrhea analyzed for each cases in coordination with the health post.
7. Confidence level of users on safety of water maintained. For houses using drinking water directly from tap, it should be above 95%.
8. WSP and water qualities should be verified by health agencies.

Process to declare the safe water zone:

Safe Water Zone will be declared by the VDC upon report of VDC wide WSP team. Team will verify all criteria and make recommendation. Safe water Zone once declared is valid for one year. It needs to be verified and renewed every year through the review process by WSP team.

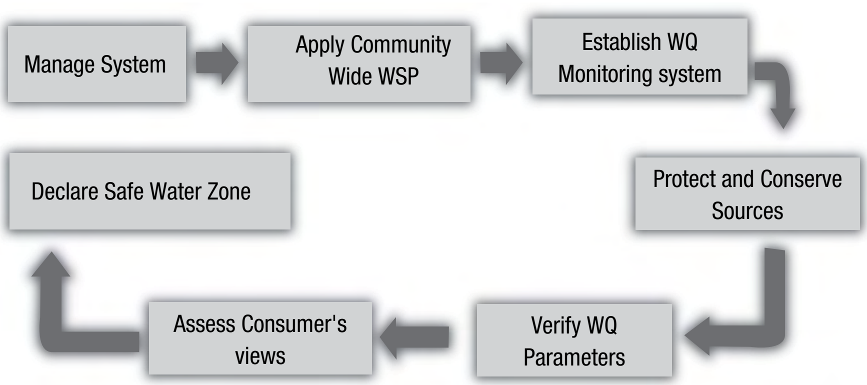


Diagram 3: Steps of safe Water Zone Declaration

Source Protection Area

Water sources used for water supply system need to be defined with Protection Area. It means that there are water sources within the region that provide drinking water to the public.
It is voluntary program which assists communities in preventing contamination of their water supplies. We have to define Source Protection Zones for groundwater sources, springs and streams used for public drinking water supply.

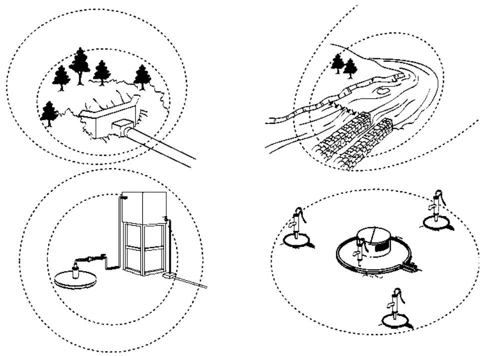


Figure 10: Source protection zones

These zones show the risk of contamination from any activities that might cause pollution in the area. The closer the activity, the greater would be the risk. The maps showing three main zones (inner, middle and outer) can be prepared, and to monitor the activities of potential polluters nearby.

Technically it is very difficult to calculate exact protection for water sources. Community can fix protection area based on available data and traditional knowledge. Approximately protection zone can be defined within 20m for inner zone, 50m for middle and 100 to 300m for outer. In case of shallow tube well the whole community should be considered as protection area with protection measure equivalent to middle zone. The first protection zone may be protected physically by fencing. Other zones are defined and declared with some kind of indication and community is made aware of the zones and protection measures.

Protection form	Inner Zone	Middle Zone	Outer Zone
Human activity	Strict	Observe	none
Agriculture	None	Control pesticide	none
Defecation	None	Avoid open defecation	Avoid open defecation
Solid waste	None	Prevent form dumping	Safe management
Waste water	None	Avoid exposure	Safe management

Protection form	Inner Zone	Middle Zone	Outer Zone
Chemical pollution	None	None	Safe management
Forest	Keep as it is	Preserve	Encourage
Recharge	None	Encourage with clean water	Encourage

Process to declare protection area:

WSP team will visit all catchment area, source area, and community. If necessary, the community can invite people from water supply, forest, hydrologist environmental engineers or other experts. Team declares protection zone for each source in different circle like high, medium and low. Team prepares a code of conduct for each circle or protection. The code of conduct can be posted in the boundary of protection areas. Penalty can be imposed for better control.

Water Quality Monitoring

Figure 11: Water Quality Monitoring

Effectiveness of Water Safety Plan has to be validated by testing WQ parameters at various levels of water supply system. WQ testing is also a means of verification for continuous safety of water of drinking water. In the system where treatment units are installed WQ is regularly monitored. In the first verification all parameters (NDWQS) need to be tested in all source. Then in the regular verification only potential parameters may be tested. Frequency of testing depends on likely hood of changing water or likely hood of changing hazards or uncertainty of function of controls. A source located at safe place needs less frequent testing. A system with treatment plant needs more frequent testing. If chlorination has been done it needs daily verification for Free residual Chlorine (FRC). But WSP team can change frequency of testing based on analysis of the past data. The only function of WQ testing is to verify that controls are effective.

Generally, samples are taken from source (outlet of intake), Reservoir tank (outlet), treatment units (outlets), taps (sample form clusters) and houses (sample from clusters).

The VDC wide WSP team is responsible for regular monitoring of Water Quality. There are four ways that WSP team can establish facilities for WQ testing.

1. WQ laboratory at one of the large size systems in the VDC: Project can have a mini lab with equipments and facilities required for regular monitoring for the nature of sources in the VDC. This lab can provide WQ testing services to other systems and clusters within VDC based on the service charge fixed by WSP team or VDC.
2. Common WQ testing laboratory: VDC can have its own laboratory in its office or in one of the project site. External agency can provide equipment and support for establishing laboratory. This lab will provide WQ testing services within VDC. Cost of service will be fixed to raise sufficient fund to operate and maintain the laboratories. VDC can also provide services to neighboring VDCs and projects.
3. Link with other laboratories: VDC can establish linkage with other laboratories or laboratories of other projects outside the VDC for testing or some of the WQ parameters.
4. Strengthen School or health center laboratories: VDC can also strengthen existing laboratories of Schools and Health center and make use of them for water quality testing for essential parameters.

If chemical pollution is suspected in the community, WSP team needs to test potential WQ parameters beyond NDWQS for the verification. WQ testing is not only for an organized system. It should cover all sources used by users on routine basis. Even the source which is planned for future use needs to be tested for making WQ data base.

System	Sample locations	Test parameters	Test Frequency	Remarks
System1 (No treatment)	Source, RT, Taps, HH	*pH, Tu, E-Coli and FRC*	Monthly	
System 2 (Treatment)	Source, TP, RT, Taps, HH	*pH, TU, E-Coli, FRC*	Weekly	
System 3 (Point sources)	Source, HH	Fe, E-Coli	Yearly	

Climate Change and Disaster Risk Reduction

Climate change is change in climate over time, whether due to natural variability or result of human activity. When people cannot cope with adverse effects of climate change they become vulnerable. Vulnerability is a function of the character of climate change to which a system is exposed, its sensitivity, and its adaptive capacity.

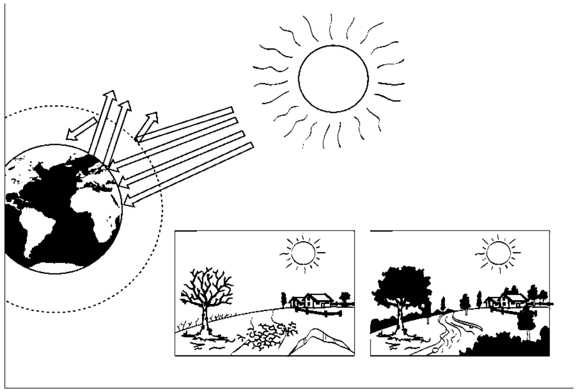


Figure 12: Climate change

Measures to reduce the vulnerability of natural and human systems against climate change effects is known as adaptation to climate change. WSP is a relevant tool for adaptation.

Climate change can be reduced by decreasing carbon dioxide and methane emissions which are causing climate change. Mitigation of climate change is to be done collectively in the global level. Water Safety Plan also supports mitigation of climate change by seeking low energy systems requiring simplified maintenance. WSP ensures safe water at tap thus discouraging boiling of water which contributes to carbon emissions.

Water resources will be impacted by climate change. Observed warming over decade has been linked to change in the hydrological cycle. Water supply storage in glacier and snow cover have declined in the course of century. Extreme floods and drought periods impact water quality and quantity. Current management practices may not be robust enough to cope with climate change. Adaptation options designed for average and drought conditions require best management for demand and supply of water. Several gaps in knowledge exist and more research is needed.

The main potential climate change risks are drought due to not enough rain ("too little water"), and more intensive rainfall ("too much water") causing floods and landslides. So communities need to discuss on how to deal with these risks to the water supply systems. Communities can protect and conserve catchment areas and increase natural water storage in ground (groundwater recharge through ponds and other structures). Communities should also identify other optional water sources in case one source fails at the time of catastrophe (drought, disasters).

Community people need to understand the ways to assess the advesre effects of climate change and related adaptation practices and be involved during the analysis process in the context of WSP and climate change. The community needs to discuss how they faced effects of climate changes in past, how climate change will impact on water resources, how they should design and maintain water supply systems, how the systems can be protected from the impacts of climate change and disasters, and how they can protect and conserve the sources.

Steps for Climate Smart Water Supply System

1. Discuss and make a list of environmental changes that occurred in the community during the past years based on stories told by elderly people and their own experiences. This will help the community to realize the climate change and establish baseline for monitoring the future changes.
2. Collect the views on how water systems have been affected over the long past years and how they are related to climate change. Predict the possible changes on the water system that the community using and/or planning to use.
3. Discuss and make a plan for source conservation and protection including catchment protection (conservation) and improving the water storage through different measures for example recharge ponds and contour trenches.
4. Identify the potential area of sources and water supply systems that are likely to be affected or damaged by possible disasters and prepare necessary protection measures. Reflect all point sources and areas in the community map.
5. Make an action plan for community awareness on climate change, its impacts on water supply system and potential adaptation practices.

Technology	Description	Climate risks	Possible impacts	Responses - adaptation
Rainwater harvesting	Rainwater collection and storage in tanks – household or community level using roof and runoff management and ponds.	There may be fewer rainy days and longer drought periods. Rainfall events may be more intense	More storage may be required to bridge low rainfall periods. Danger of damage and contamination from flooding	Build in redundancy for potential reduced rainfall and longer dry seasons Ensure protection against flooding
Reticulated schemes from small rivers, springs and dams	Pumped schemes to villages and small towns based on small dams or river abstraction	Changed seasonality of runoff, peak flows and sediment load	Lower and less certain flows. Possible increased sedimentation Dams may be filled with sediment –possibility of failure	Design to a higher capacity. Build in mechanisms for dealing with increased sedimentation Conjunctive use of surface and groundwater to increase adaptability
Shallow family wells	Wells less than 10 m deep – dug by hand and often unlined	More intense rainfall, longer dry season	Increased contamination of sources More likely that sources will fail	Should generally not be promoted in isolation as improved water supplies, but can relieve pressure on them Ensure HHs and communities have a safe and reliable alternative
Improved hand dug wells	Hand dug wells often > 10 m deep lined with concrete and capped at the surface	More intense rainfall, longer dry season	Increased risk of contamination More likely that sources will fail	Case out shallow layers and runoff Hand dug wells should be tested at the peak of a normal dry season, sited in productive parts of the aquifer, and deep enough to intersect groundwater below 10 m. Elevate well head and hand pump for flood protection

Technology	Description	Climate risks	Possible impacts	Responses - adaptation
Protected spring supplies	Perennial springs where the source is protected and piped to a standpipe	Longer dry season – more intense rainfall	Possibility of contamination – particularly in urban or peri-urban settings Springs may be less reliable in longer dry seasons	More thorough investigation of seasonal spring flow and contamination pressures in catchment. Build in greater redundancy – develop further
Boreholes	Boreholes, 50-100 m deep, with hand-pump mechanism to abstract water	Longer dry season – more intense rainfall	Higher demand in extended dry seasons may cause source failure, and in some cases depletion of resource. High demand can lead to mechanical failure. Risk of supply contamination from very shallow layers during intense rainfall events	To improve reliability, ensure boreholes are sited in most productive part of aquifer. Improve hand pump maintenance, particularly dry season. Ensure shallow layers are cased out to prevent contamination
Large piped schemes from large dams and rivers	Capital intensive schemes for large towns and cities	Increased demand in cities. Changes in runoff and sedimentation affect storage	Larger storage should be able to cope with climate fluctuations Large increase in demand may lead to failure	Big storage is more resilient, but increasing demand and reliability issues are a concern. Consider conjunctive use, supply backup and designing for higher demand at outset
Use of water-efficient fixtures and appliances	Educating users, metering individual homes (water meters) implementing volumetric pricing	Longer dry seasons.	More economical use water may be required to bridge low rainfall periods. Water conservation.	Ensure efficient and economical use of water resources in the case of water scarcity.

Technology	Description	Climate risks	Possible impacts	Responses - adaptation
Increase groundwater recharge	Increasing groundwater recharge through conservation and recharge ponds (reservoirs) and contour ditches, rain water harvesting or other measures.	Longer dry season, source depletion	Higher demand in extended dry seasons may cause source failure, and in some cases depletion of resource.	Sustaining the sources in the long run; decreased vulnerability to water scarcity and longer drought periods.

Community Awareness Program

Target of WSP is health of people. Community participation is vital for successful WSP. Community should be fully aware of all activities of WSP and its consequences. Community needs to participate in the following activities of WSP:

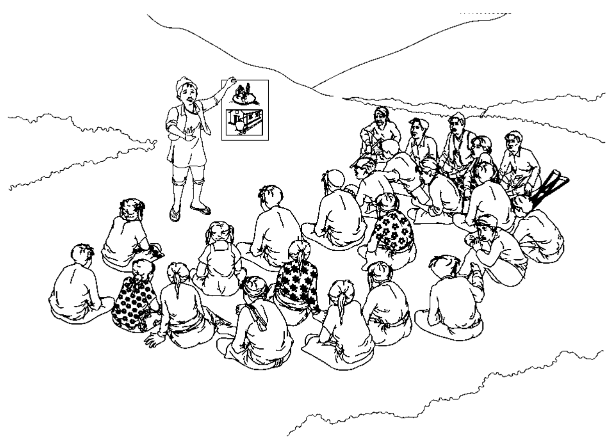


Figure 13: Community awareness program on WSP

- Selection of WSP team
- Hazard identification and control
- Source protection and conservation
- Safe use of water at household's level

Ultimate success of WSP is validated by user's satisfaction. Users sometimes become satisfied from water qualities because they are unaware of health and water quality relationships. In such case people need to be aware of health and WQ relationships. Sometimes people are not satisfied with WQ of supplied water and adopt alternate treatment at home which leads to ineffectiveness of investment made in WSP. In such case, the community needs to know about WSP activities. Hence, community awareness is needed for people to know about health education, Water Safety Plan and their roles. Climate change and adaptation to its adverse impacts, in terms of source conservation will be another important aspect in community awareness.

Community awareness activities can be organized in following ways:

- Community wide mass campaign through mass meetings and rallies
- Cluster wise meeting
- Cluster wise group training
- School wise training
- Linking WSP with health workers
- Through information boards
- Consumers survey in some intervals through sample surveys and focus group discussions
- Linking WSP with total sanitation.

Community can choose some or all of above methodologies or come out with their own innovative and creative ideas.

4

Part

Model WSP for Various Technology

Model WSP: Point Source (Spring) Protection

A spring is a place on the earth's surface where groundwater emerges naturally. The water source of most springs is rainfall that seeps into the ground uphill from the spring outlet. Spring water moves downhill through soil or cracks in rock until it is forced out of the ground by natural pressure. The amount, or yield, of available water form springs may vary with the time of year and rainfall.

While springs may seem like an ideal water supply, they need to be selected with care, developed properly, and tested periodically for contamination. Springs may not be a good choice for water supply if the uphill area from where where the water collects is used for industry, agriculture, or other potential sources of pollution.

Springs can be categorized into two types. Concentrated springs occur along hillsides at points where groundwater emerges naturally from openings in rock. These are the easiest springs to develop and protect from contamination.

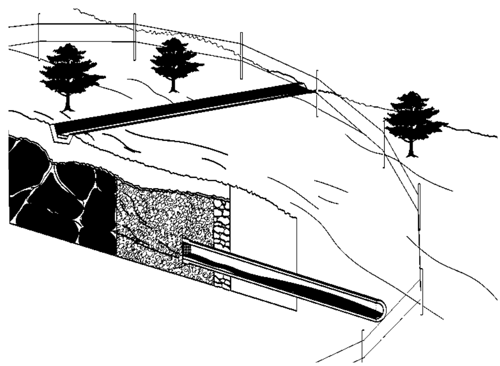


Figure 14: Point Source Protection

Proper development for concentrated springs consists of intercepting water underground in its natural flow path before it reaches the land surface. Seepage springs occur where groundwater "seeps" from the soil over large areas. The development process for seepage springs consists of intercepting flowing groundwater over a wide area underground and channeling it to a collection point. Because seepage springs collect water over large areas, they are more difficult to protect from surface water contamination than concentrated springs.

Springs are susceptible to contamination by surface water, especially during rainstorms. Contamination sources include livestock, wildlife, crop fields, forestry activities, septic systems, and fuel tanks located upslope from the spring outlet. Changes in color, taste, odor, or flow rate indicate possible contamination by surface water. Springs protection involves following measures: Divert all surface water away from the spring as far as possible. Construct a U-shaped surface drainage diversion ditch or an earth berm at least 50 feet uphill from the spring to divert any surface runoff away from the spring. Be careful not to dig deep enough to uncover flowing groundwater. Prevent pounding in the diversion ditch. Construct an earth berm adjacent to the spring or a second U-shaped diversion ditch lined with concrete tile for added protection. Fence an area at least 20 meter feet in all directions around the spring box to prevent contamination by animals and people who are unaware of the spring's location. Avoid heavy vehicle traffic over the uphill water bearing layer to prevent compaction that may reduce water flow. In case of prolonged drought periods it is important to support recharge of groundwater in uphill to prevent potential source depletion and also at the same taking into account the potential contamination aspects.

Verification of water safety plan can be done by visiting two times a year and by testing quality parameters once a year focusing E-Coli.

Model WSP: Spring Protection						
NO	**Hazards**	**Risk**	**Control**	**Monitoring When**	**Monitoring Who**	**Corrective action**
1	Contamination recharge from backfill area or recharge pond used to avoid delectation	5	Area fenced, Grass cover, diversion in ditch in good condition and no surface water uphill, avoid contamination form recharge pond to avoid contamination	Monthly	Operator	Repair fencing, surface drain, and rehab protective measure.
2	Contamination in spring box	4	Spring box or retaining wall in poor condition and inundation from waste water	Monthly	Operator	Repair wall and cover and clear ditch.
3	Surface water pools in up hills cause rapid recharge of contamination	4	No surface water, solid waste and wastewater available in upstream and Excreta management	Annual	Operator	Drain surface water and improve excreta and waste management in upstream area
4	Contaminated drawn from shallow aquifer due to connection	4	No evidence of water drawn from shallow aquifer	Monthly	Operator	Set intake deeper or provide treatment
5	Ingress of animal faeces	5	Set back distance to control animal husbandry and good fencing	Monthly	Operator	Remove animal shed from upstream of relocate to safe distance, correct fencing
6	Leaching of microbial contamination due poor sanitation	4	Provide adequate set back or remove sources of contamination	Monthly	Operator	Move contamination source or improve sanitary condition
7	Leaching of chemical in to intake	3	No source of chemical or set back distance	Annually	Operator	Move or reduce pollution level

Model WSP: Rain Water Harvesting

A rainwater harvesting system consists of three basic elements: collection area, conveyance system, and storage facilities. The collection area in most cases is the roof of a house or a building. The effective roof area and the material used in constructing the roof influence efficiency of collection and water quality.

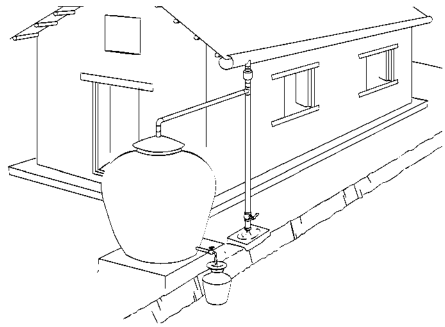


Figure 15: Roof RWH

A conveyance system usually consists of gutters or pipes that deliver rainwater falling on the rooftop to cisterns or other storage vessels. Both drain pipes and roof surfaces should be constructed of chemically inert materials such as wood, plastic, aluminum, or fiberglass, in order to avoid adverse effects on water quality.

The water ultimately is stored in a storage tank or cistern, which should also be constructed of an inert material. Reinforced concrete, fiberglass, or stainless steel is suitable materials. Storage tanks may be constructed as part of the building, or may be built as a separate unit located some distance away from the building.

Rainwater harvesting systems require few skills and little supervision to operate. Major concerns are the prevention of contamination of the tank during construction and while it is being replenished during rainfall. Contamination of the water supply as a result of contact with certain materials can be avoided by the use of proper materials during construction of the system. The main sources of external contamination are pollution from the air, bird and animal droppings, and insects. Bacterial contamination may be minimized by keeping roof surfaces and drains clean but cannot be completely eliminated. If the water is to be used for drinking purposes, filtration and chlorination or disinfection by other means is necessary. The following maintenance guidelines should be considered in the operation of rainwater harvesting systems:

- A procedure for eliminating the "foul flush" after a long dry spell deserves particular attention. The first part of each rainfall should be diverted (up to 10 minutes) from the storage tank since this is most likely to contain undesirable materials which have accumulated on the roof and other surfaces between rainfalls.
- The storage tank should be checked and cleaned periodically; thorough scrubbing of the inner walls and floors. Their design should allow this. Cleaning procedures consist of Use of a chlorine solution recommended for cleaning, followed by thorough rinsing.
- Care should be taken to keep rainfall collection surfaces covered, to reduce the likelihood of frogs, lizards, mosquitoes, and other pests using the cistern as breeding ground. Residents may prefer to take care of preventing such problems rather than taking corrective actions.
- Gutters and downpipes need to be inspected periodically and cleaned carefully. Periodic maintenance must also be carried out on any pumps used to lift water to selected areas in the house or building.

Verification of water safety plan can be done by visiting two times a year and by testing quality parameters once a year focusing E-Coli.

Model WSP: Rain Water Harvesting						
NO	Hazards	Risk	Control	Monitoring When	Monitoring Who	Corrective action
1	Roof not cleaned properly of faecal material found	4	Cleaning of roof and gutter	Before rainfall	Owner/ Operator	Clean roof regularly
2	Tree overhanging over collection tank	3	Tree branches do not overhang the roof and tank	Annual	Owner/ Operator	Trim trees
3	Animal and bird entering the tank	3	All opening on tank free from animal and bird entry	Annual	Owner/ Operator	Install and repair inspection cover and vents mesh
4	Tank dirty and accumulation of sediment	4	Tank cleaned regularly and disinfected annually	Annual	Owner/ Operator	Clean tank regularly and disinfect.
5	First flush of water enter tank	5	First flush diversion in place and used properly	Before raining	Owner/ Operator	Install first flush system and train users.

Model WSP: Rain Water Harvesting						
NO	**Hazards**	**Risk**	**Control**	**Monitoring When**	**Monitoring Who**	**Corrective action**
6	Unhygienic withdraw of water	5	Install tap or other sanitary means for withdraw	Monthly	Owner/ Operator	Move contamination source or improve sanitary condition
7	Leaching of chemical in to intake	3	No source of chemical or set back distance	At installation	Owner/ Operator	Install tap at least 5 cm above base of tank
8	Leakage or cracks on tank	2	Free from leakage and cracks	Annual	Owner/ Operator	Sanitary inspection
9	Water not filtered	2	Filter installed and maintained	Annual	Owner/ Operator	Install and clean filter
10	Leaching of chemical form roof(pb, As)		Material of roof approved	At installation	Owner/ Operator	Material tested or approved

Model WSP: Point Source: Shallow Tube Well

Shallow well hand pump technology works under suction mode. A suction pump draws water form shallow depth by creating vacuum in the suction pipes. The suction hand pump can practically draw water from a depth of 7.5 meter form ground level. If water table is below the limit suction pump deep set hand pump are used which can abstracts water from up to 30 meter deep from ground level.

Ground water is generally safe but it is likely to be contaminated if contaminated water ingress from the borehole. Some time aquifer may have a link with contaminated layer of water.

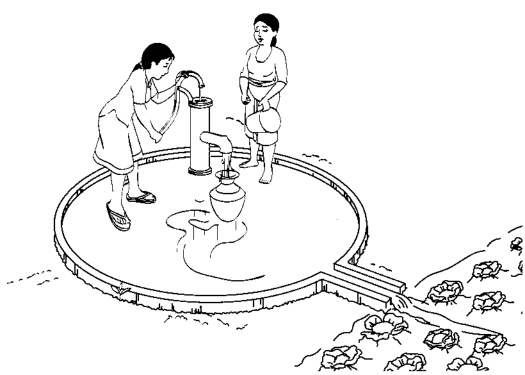


Figure 16: WSP of Shallow Tube Well

Contamination can be avoided by constructing apron around borehole head, ensuring that there is no ingress of contaminated water, avoiding open defecation or chemical pollution. If chemical occur naturally in the aquifer it can be avoided by shifting to alternate source or by treatment.

Verification: Verification of the tube well will be done by WSP team by sanitary inspection and WQ testing. Comprehensive analysis of chemical qualities of water should have been taken prior to commissioning. If this was not performed water must be tested during first verification for the range of chemical parameters. Specific parameters should be tested for likely chemicals.

Model WSP: Sallow Tube Well						
NO	**Hazards**	**Risk**	**Control**	**Monitoring When**	**Monitoring Who**	**Corrective action**
1	Ingress of contaminated water to bore well	4	One meter apron around well head, lining and drain in place	Monthly	Owner/ Operator	Extend apron, lining and clean drain
2	Bore hole inundated with contaminated water	4	Good drainage around wetland	Annual	Owner/ Operator	Repair and clean ditches
3	Contamination form priming water	4	Use clean water for priming	Annual	Owner/ Operator	Avoid hand pump needing priming
4	Contaminated water drawn in to aquifer	5	Pumping regime do not induce leaching	Monthly	Owner/ Operator	Set intake deeper or provide treatment
5	Naturally occurring chemicals	3	WQ assessment indicate acceptance	Before Construction	Owner/ Operator	Use alternate source of or treatment of water
6	Leaching of chemical in to ground water	4	No source of chemical within set back distance	Monthly	Owner/ Operator	Move pollution source or reduce pollution level
7	Faecal contamination due to open defecation	5	Open Defecation Community with sanitary toilets	Annual	Community	Inspect distance of toilet form tube well and maintain ODF

WSP in point source: Dug Well

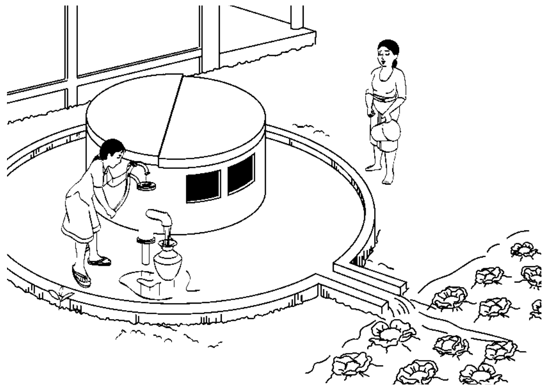


Figure 17: WSP of Hand Dug Well

Dug well are commonly used sources in rural area. It consists of 20 to 30 feet deep well lined with brick or stone wall. Modern wells are lined with concrete rings and go even deeper up to 100 feet. Well water is abstracted with bucket and rope with pulley arrangement. Modern wells are fitted with hand pump or motor pump. Wells are likely to be contaminated by ingress of contaminant from surrounding, by bucket, by engross of surface water or waste water around well head or leaching of chemicals in ground waters. In Terai where arsenic is being problem in shallow well dug well are found to be alternate source. Dug wells are more likely to be contaminated by faecal materials. For safety of well water, the well needs proper lining, raised head with cover, proper drain around, and sanitary way of abstraction. Pollution source in the surrounded should removed, open defection should be banned and area should be declared as protected zone. If E-Coli are found well should be disinfected with chlorine and pot chlorination should be applied for continuous safety or people need to use alternate treatment for drinking water at home

Verification of the water safety plan can be one by observing and testing water on monthly basis. Well should be cleaned once a year and E-Coli tested.

WSP Model: Dug Well						
NO	**Hazards**	**Risk**	**Control**	**Monitoring When**	**Monitoring Who**	**Corrective action**
1	Ingress of contaminated surface water directly in to well	3	Proper well head with cover, apron and drainage in place	Monthly	Operator	Provide cover, clean drain

WSP Model: Dug Well						
NO	**Hazards**	**Risk**	**Control**	**Monitoring When**	**Monitoring Who**	**Corrective action**
2	Ingress of contaminants due to poor construction and drainage lining	4	Lining in good condition with no sign of weep holes.	Seasonal	Operator	Improve well lining
3	Animal damage allow contamination	3	Fencing in place	Monthly	Operator	Repair fencing
4	Contamination introduced by buckets	4	Install and maintain other means for water abstraction	Monthly	Operator	Install and maintain other means for water abstraction
5	Well head area is inundated with contaminated surface water	3	Diversion ditches surrounding dug l in place	Weekly	Operator	Repair and clear ditches
6	Leaching of microbial contamination in aquifer	5	No latrine and solid waste within set back distance	Monthly	Operator	Move pollution source and follow sanitary design
7	Naturally occurring chemicals	5	WQ assessment indicate acceptance	Before Construction	Owner/ Operator	Use alternate source of or treatment of water
8	Leaching of chemical in to ground water	5	No source of chemical within set back distance	Monthly	Owner/ Operator	Move pollution source or reduce pollution level

Model WSP: Mechanized Borehole

Deep tube wells below the suction limit are drawn water using mechanical pumps. Centrifugal and submersible pumps are in use. Generally aquifer located at depth are free from contamination unless contaminated from naturally occurring chemicals like Iron, Manganese, Ammonia, Sulphide, Arsenic etc. Deep aquifer is generally found to be free from Arsenic in Terai.

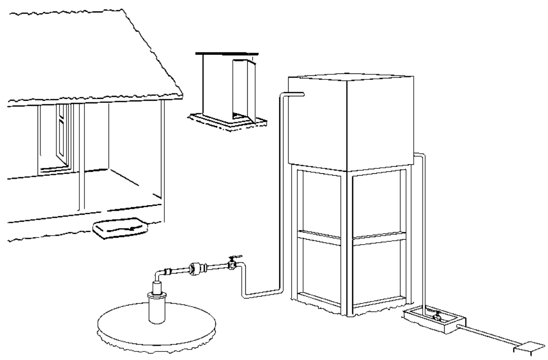


Figure 18: WSP of Deep Bore Hole

Ground water is generally safe but it is likely to be contaminated if contaminated water ingress form borehole. Some time aquifer may have link with contaminated layer of water. Contamination can be avoided by constructing apron around borehole head, ensuring prevention of ingress of contaminated water, avoiding open defecation or chemical pollution. If chemical occurs naturally in the aquifer that can be avoided by shifting to an alternate source or by treatment. The chemicals found in deep aquifer in ground water of Nepal are Iron, Manganese, Ammonia, Hardness etc. Most common is iron.

Verification: Verification of the tube well will be done by WSP team by sanitary inspection and WQ testing. Comprehensive analysis of chemical qualities of water should have been taken prior to commissioning. If this was not performed, water must be tested during the first verification for the range of chemical parameters. Specific parameters should be tested for likely chemicals.

Model WSP: Deep tube well with pumping						
NO	Hazards	Risk	Control	Monitoring When	Monitoring Who	Corrective action
1	Ingress of contaminated water to bore well	3	One meter apron around well head, lining and drain in place	Monthly	Operator	Extend apron, lining and clean drain
2	Bore hole inundated with contaminated water	3	Good drainage around wetland	Monthly	Operator	Repair and clean ditches
3	Ingress of contaminant due to poor construction and damage to lining	4	Proper well head completion. Top five meter annulus sealed and rising mains in good condition	Monthly	Operator	Insert seal around annulus and replace corroded rising mains.

Model WSP: Deep tube well with pumping						
NO	**Hazards**	**Risk**	**Control**	**Monitoring When**	**Monitoring Who**	**Corrective action**
4	Contaminated shallow water drawn in to aquifer	5	No evidence of induced leakage and shallow water drawn	Monthly	Operator	Set intake deeper, treatment
5	Rapid recharge causing connection to surface	4	Rapid recharge does not occur or cannot reach intake	Monthly	Operator	Set intake at greater depth
5	Naturally occurring chemicals	5	WQ assessment indicate acceptance	Before Construction	Operator	Use alternate source of or treatment of water
6	Leaching of chemical in to ground water	5	No source of chemical within set back distance	Monthly	Operator	Move pollution source or reduce pollution level
7	Pumping leads to increased leaching of contaminants	3	Leaching of contaminants within predicted range	Monthly	Operator	Modify pumping regime treatment
8	Pumping increase safe zone distance	3	Protection zone include draw down on GW flow	Monthly	Operator	Extend protection zone
9	Backflow form pipe to well	4	Back flow preventer installed	Daily	Operator	Back flow preventer installed
10	Failure in disinfection process	5	Ct value adequate and FRC produced	Daily	Operator	Repair disinfection unit
11	Leaching of pollution like chemical pesticide from land		Pollution controlled	Monthly	Environmental expert or agency	Maintain pollution control within protected zone
12	Pollution from hospitals and industries		Effective disposal methods and leaching prevented	Monthly	Environmental expert or agency	Ensure all industrial waste properly contained and treated

Model WSP: Treatment System

In some cases the source of water is so contaminated that it is not possible to be protected by the community. In such situation treatment plants are installed. Types of systems depend on the type and extent of contamination. Conventional online treatment system used in Nepal is sedimentation, roughing filter, slow sand filter and chlorination for disinfection. A treatment plant itself is a control to remove excessive contaminants. But if it is not properly operated contaminants enter the water supply. Hence, a treatment plant is also a hazard. This needs to be operated following standard process and with continuous monitoring for process and WQ testing. Generally treatment plants are designed to treat all kinds of contaminants. But some treatment plants may not be able to treat all contaminants to the required extent. For example if SSF are cleaned it may not be able to remove bacteria. In such cases, disinfection has to be used. Hence, functioning of the treatment plant has to be validated in its operation process.

Treatment System						
NO	**Hazards**	**Risk**	**Control**	**Monitoring When**	**Monitoring Who**	**Corrective action**
Sedimentation						
1	Excess turbidity beyond capacity of sedimentation tank	5	Stop flow when there is excessive turbidity	Monthly	Operator	Train plant operator, Provide intake filter
2	Excess flow which reduces efficiency of tank and carries more turbidity to outlet due increased velocity	4	Flow controlled beyond design flow	Monthly	Operator	Install weir with overflow system
3	Excessive deposition of settled solids leading to decreased settlement depth.	4	Tank cleaned regularly	Annual	Operator	Prepare routine based on practice or observation or flow height in weir.

Treatment System						
NO	**Hazards**	**Risk**	**Control**	**Monitoring When**	**Monitoring Who**	**Corrective action**
Roughing filter						
4	Excess turbidity beyond capacity of roughing filter	4	Flow controlled as per design flow	Monthly	Operator	Provide weir with water level or control in previous units
5	Over flow or water above bed	5	No water flow seen on bed surface.	Weekly	Operator	Backwash filter bed before water level comes to top or clean filter material if backwash need frequently
6	Bypass of untreated water form faulty drain pipe of uneven distribution of water in plant	5	No bypass caused within bed	Monthly	Operator	Avoid bypassing through drain and provide compartments for flow distribution. Install observation wells.
Slow Sand Filter						
7	Excess turbidity reduce bed functioning and time	3	Control maximum turbidity below 50.	Annually	Operator	Control function of previous units
8	Excess flow cause decreased efficiency	4	Flow controlled within design flow	Monthly	Operator	Install inflow or out flow control
9	Direct fall of inflow cause crack of bed allowing bypass of contaminant		Ensure flow speed and make sure that there is no cracks	Monthly	Operator	Reduce flow speed using inlet basin.
10	Excessive algae may cause bed function		Ensure optimum algae in bed	Monthly	Operator	Remove excess algae periodically
11	Bacteria may not be removed in initial stage of bed ripening		Make sure bacteria is fully removed before passing water to supply or use chlorine	Monthly	Operator	Check bacteria periodically and compensate with chlorine. Have chlorination unit.
12	Excess skin may reduce water flow		Make sure that bed is cleaned when overflow starts	Monthly	Operator	Make provision for periodic clean using appropriate tools.

Model WSP: Lift and Distribution

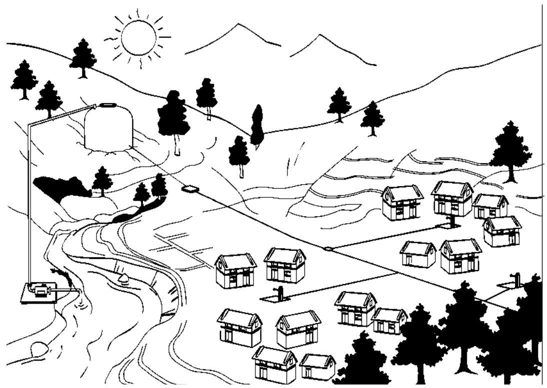


Figure 19: WSP of Surface Water Lift and Distribution System

Distribution system is the pipe networks controlled by valves for flow of water from the source or treatment system to the community. In the gravity system, pressure is gained from gravity flow and in the pumping system pressure is created by mechanical pumps directly or through overhead pumps. Principally distribution system should be neutral in terms of contaminants. However, if there are leakages combined with low pressure and pipes passing from contaminated area, additional contaminates may enter the system.

A lift system involves pumping of water from the source to the tank located in upper land so that water can flow by gravity to the community. Source protection and maintenance of the pump is necessary for safety of water at source. It is important to make sure that excess runoff water and potential landslides do not damage the structures.

Verification of the water safety plan can be done by visiting two times a year and by testing quality parameters once a year focusing E-Coli.

Distribution pipe system						
NO	Hazards	Risk	Control	Monitoring When	Monitoring Who	Corrective action
1	Water entering distribution is contaminated	5	Source WSP adhered	Monthly	Operator	Source protection and chlorination
2	Microbial contamination at storage tank by bird and animal	4	Tank is animal and bird proof	Monthly	Operator	Prevent access to bird and rodent, cut overhang branches and provide fences
3	Ingress of contaminated water form cracks	4	Tank structure with no cracks and drainage in good condition	Annual	Operator	Repair cracks, flush tank and maintain drainage
4	Contamination enters distribution system at valves	4	Valve maintained with adequate drainage	Monthly	Operator	Repair valve and drain
5	Ingress of contaminants form soil form combined leakage and drop in pressure	5	No leakage on lines	Weekly	Operator	Leakage control program
6	Ingress of contaminant during repair.	5	Hygienic code of practice followed	Monthly	Operator	Training provided
7	Bio-films develops due to high Air of Contact	3	Minimize bio film formation	Annually	Operator	Treatment, maintain steady flow or chlorination
8	Contamination due to cross connection with sewer pipe.	4	Cross connection avoided or leakage controlled	Monthly	Operator	Repair leakage and increase hydrostatic pressure
9	Excessive pressure may draw contaminants form source and cause leakage	3	Pressure maintained and operated properly	Weekly	Operator	Operate using SOP

Model WSP: Mini overhead system

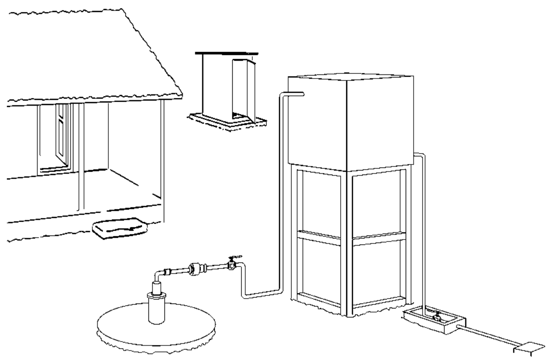


Figure 20: WSP of Mini-overhead Tank System

In Terai Nepal, there are many small communities residing in a cluster. They are traditionally using due well, hand pump as water source at community or private level. A community nearby urban area has installed a community water supply system. Traditional systems are now found to be contaminated either by bacteriological contaminant or by arsenic. About 1.8% of the terai tube well are found to be arsenic contamination level above acceptable limit of national standard (50 ppb). Generally, aquifer at deeper level, about 100 meters, are found to be free from arsenic.

This mini overhead system is emerging as an alternate system for Terai communities. This consists of water abstraction from dug well or deep boring. Solar system is found to be more reliable than elective motor due to unreliability of electricity and needing more maintenance and operation cost. Overhead towers are made up to ten meters made of RCC or steel. Tanks of capacity from 8 m3 to 25 m3 depending on population are installed.

Potential hazards in this kind of systems are contamination of ground water due to local pollution, contamination in reservoir and distribution system and during transportation and use at house hold level. Verification of the water safety plan can be one by observing and testing water on monthly basis. Wells should be cleaned once a year and E-Coli tested.

Model WSP: Mini Overhead System						
NO	**Hazards**	**Risk**	**Control**	**Monitoring When**	**Monitoring Who**	**Corrective action**
1	Ingress of contaminated surface water directly in to well	3	Proper well head with cover, apron and drainage in place	Monthly	Operator	Provide cover, clean drain
2	Ingress of contaminants due to poor construction and drainage lining	4	Lining in good condition with no sign of weep holes.	Seasonal	Operator	Improve well lining
3	Animal damage allow contamination	3	Fencing in place	Monthly	Operator	Repair fencing
4	Leaching of microbial contamination in aquifer	5	No latrine and solid waste within set back distance	Monthly	Operator	Move pollution source and follow sanitary design
5	Naturally occurring chemicals	5	WQ assessment indicate acceptance	Before Construction	Owner/ Operator	Use alternate source of or treatment of water
6	Leaching of chemical in to ground water	5	No source of chemical within set back distance	Monthly	Owner/ Operator	Move pollution source or reduce pollution level

5 Part

Annexes

Chlorine Dosing

Dose of Bleaching power with 25% effectiveness		
Basic Dose of Chlorine, mg/l	**Dose of Chlorine for 1000 Liter of water**	**Dose of Bleaching Powder for 1000 Liter of water**
0.1	100 mg = 0.1 g	400 mg = 0.4 g
0.2	200 mg = 0.2 g	800 mg = 0.8 g
0.3	300 mg = 0.3 g	1200 mg = 1.2 g
0.4	400 mg = 0.4 g	1600 mg = 1.6 g
0.5	500 mg = 0.5 g	2000 mg = 2.0 g
1.0	1000 mg = 1.0 g	4000 mg = 4.0 g
1.5	1500 mg = 1.5 g	6000 mg = 6.0 g
2.0	2000 mg = 2.0 g	8000 mg = 8.0 g
2.5	2500 mg = 2.5 g	10000 mg =10.0 g
3.0	3000 mg = 3.0 g	12000 mg = 12.0g

Chlorine is one of the commonly used disinfectants. If the source water is contaminated with bacteria and which could not be removed by treatment then chlorine is applied to protect health from diarrheal diseases. Some time, some amount of chlorine is also applied to check further contamination in the distribution line. Initially, we do not know the actual requirement of chlorine dose. We do some tests for chlorine demand to find out the required dosing in order to achieve the expected concentration of Free Residual Chlorine (FRC). If we find that FRC is below or above the expected concentration, then we can adjust by increasing or decreasing the basic dose. Our target is to achieve the FRC within the level of 0.1-0.2 mg/l (National standard as well as WHO guideline value).

Recording WQ test

System Name and Location:

Measuring Technicians: Flow rate:

Location	Parameters	Test result							
Time/day									
Raw water (Intake)	Temp(0C)								
	pH								
	Turbidity(NTU)								
	E-Coli								
Treated water or after Tank	Turbidity(NTU)								
	pH								
	Chlorine(mg/l)								
	FRC(mg/l)								
	E- Coli								
Tap Water	FRC(mg/l)								
	E-Coli								

Water Quality Surveillance

(1) Project information:

Name of System: Project code:

Service area: Population served:

Name of source and Type:

Type of System:

(2) Water Safety Plan Status:

Key WSP activities	Status (Yes/No)	Remarks
Water Safety Plan Team formed and in action		
Project analyzed and Hazards identified from source to distribution system		
Hazard controlled and validated		
Monitoring plan in place and Water Quality monitored on routine basis		
Users satisfaction assessed		
WSP document prepared		

Over all status of WSP: Working Need improvements Not in place:

Water Quality status: Safe Un Safe Not tested

(3) Status of water related disease:

Number death caused by diarrhea: Number of cases of diarrhea:

Common water related diseases in the service area:

Information sources:

(4) Observations:

(5) Recommendations for projects management/ water Safety Plan Team:

Learning test

SN	Question	Answers
1	Why is WSP needed? What are main principles of WSP? Who is responsible to apply WSP?	
2	Why WSP team is required? Who are the key members and what are the key tasks?	
3	What is content of community map? How conservation, protection and vulnerable area identified?	
4	What are the key hazards and controls? Why and how controls are verified?	
5	What is an improvement plan? How it is different from controls?	
6	What are the key elements of Monitoring plan? How is WSP verified internally and externally? What should service provider do if supplied water is not safe for some reason?	
7	What is the key question for user's satisfaction survey? How will it be used?	
8	What are the contents of WSP document? How is it updated? How does user's survey help for review?	
9	How much bleaching powder is needed for WS system supplying water for 3000 population @ 60 lpcd and consuming 0.5 mg/l of chlorine?	
10	What is safe water zone and how it is declared?	

Notes

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