A GUIDE TO SANITATION SAFETY PLANNING IN THE PHILIPPINES

STEP-BY-STEP RISK MANAGEMENT FOR SAFE REUSE AND DISPOSAL OF WASTEWATER, GREYWATER, AND EXCRETA

ASIAN DEVELOPMENT BANK

A GUIDE TO SANITATION SAFETY PLANNING IN THE PHILIPPINES

STEP-BY-STEP RISK MANAGEMENT FOR SAFE REUSE AND DISPOSAL OF WASTEWATER, GREYWATER, AND EXCRETA

ASIAN DEVELOPMENT BANK

6 ADB Avenue, Mandaluyong City, 1550 Metro Manila, Philippines
Tel +63 2 632 4444; Fax +63 2 636 2444
www.adb.org

Printed in the Philippines.

ISBN 978-92-9257-635-6 (Print), 978-92-9257-636-3 (e-ISBN)
Publication Stock No. TIM168478-2

Cataloging-In-Publication Data

Asian Development Bank
A guide for sanitation safety planning in the Philippines: Step-by-step risk management for safe reuse and disposal of wastewater, greywater, and excreta.
Mandaluyong City, Philippines: Asian Development Bank, 2016.

1. Sanitation safety planning. 2. Philippines. 3. Sanitation. 4. Health. I. Asian Development Bank.

Notes:
In this publication, "$" refers to US dollars.
Corrigenda to ADB publications may be found at http://www.adb.org/publications/corrigenda

CONTENTS

TABLES

FIGURES

TIPS AND LESSONS LEARNED

BOX

ACKNOWLEDGMENTS

A Guide to Sanitation Safety Planning in the Philippines was prepared by a team led by Stella Tansengco-Schapero (senior finance specialist, Urban Development and Water Division [SEUW] of the Southeast Asia Department [SERD]); with team members D. Jackson (consultant), J.A. Estiva (consultant), and J.M. Lim (consultant). Guidance and support were provided by Tatiana Gallego-Lizon (director, SEUW/SERD), Satoshi Ishii (senior urban development specialist, SEUW/SERD), and Javier Coloma Bretons (urban development specialist [water supply and sanitation], SEUW/SERD). The team wishes to thank the Department of External Relations; Pia Corrina Reyes, water resources officer, Sector Advisory Service Cluster of the Sustainable Development and Climate Change Department; and Michael John Lacambacal (operations assistant, SEUW/SERD) for their support in preparing and editing the guide.

The team wishes to acknowledge the contributions to the guide by many people, including the following core members of the technical working group: B. Magtibay, World Health Organization Philippines; F. Arellano and K. Catangcatang, Maynilad Water Services, Inc.; A. Baylosis and M.V. Signo, Baliwag Water District; J.R. De Dios and M.S. Anarna, Department of Health; A.R. Almario (consultant); and M.C. Ebarvia (consultant). Other members of the multistakeholder group included the following: Baliwag Water District and Maynilad Water Services, Inc.; Department of Health; Department of Environment and Natural Resources, Environment Management Bureau; Department of Agriculture; Department of Public Works and Highways; Dumaguete City Water District; local governments of Baliuag, Quezon City, and San Fernando; MAPECON Philippines, Inc.; Metropolitan Waterworks and Sewerage System; Philippine Society of Sanitary Engineers; Philippine Association of Water Districts; San Jose del Monte, Bulacan Water District; and World Health Organization.

ABBREVIATIONS

ADB	Asian Development Bank
AO	Administrative Order
BOD5	5-day biochemical oxygen demand
BWD	Baliwag Water District
COD	chemical oxygen demand
DA	Department of Agriculture
DENR	Department of Environment and Natural Resources
DOH	Department of Health
EMB	Environmental Management Bureau
ESH	environment, safety, and health
FOG	fats, oil, and grease
LGU	local government unit
MBAS	methylene blue-active substance
MENRO	Municipal Environment and Natural Resources Office
MEO	Municipal Engineering Office
mg/l	milligram per liter
MHO	Municipal Health Office
MPN	most probable number
MWSI	Maynilad Water Services, Inc.
NPC	National Power Corporation
PCO	Pollution Control Officer
PCU	platinum-cobalt unit
PPE	personal protective equipment
SMH	sewer manhole
SOP	standard operating procedure
SpTP	septage treatment plant
SSD	Sewerage and Sanitation Division
SSP	sanitation safety planning
VTU	vacuum truck unit
VWRF	Veterans Water Reclamation Facility
WHO	World Health Organization
WMD	Wastewater Management Division
WSP	water safety plan

INTRODUCTION AND USE OF THE GUIDE

1. INTRODUCTION

1.1. SANITATION SAFETY PLANNING

Sanitation aims to prevent human contact with the potential hazards posed by wastes such as wastewater, greywater, and excreta, including physical, microbiological, biological, or chemical agents of diseases. An understanding of the health risks posed by sanitation systems and how to best control these risks should underpin sanitation investments and their management. It is important for operators of sanitation systems to look beyond operating their facilities to ensure that no one in the sanitation chain (i.e., workers, farmers who use the treated wastewater, consumers who buy end products from the farmers, and nearby communities) is exposed to hazards related to wastewater, greywater, and excreta.

Sanitation safety planning (SSP) will help an operator of a sanitation system maximize the health benefits and minimize the health risks of the system. The Sanitation Safety Planning Manual published by the World Health Organization (WHO) in 2015 provides practical step-by-step guidance in the implementation of the 2006 WHO Guidelines for Safe Use of Wastewater, Excreta, and Greywater.[1] The manual is targeted at health authorities and regulators, local authorities, wastewater utility managers, sanitation enterprises and farmers, community-based organizations, farmers associations, and nongovernment organizations (NGOs).

SSP is a preventive risk management approach that identifies potential risks that may arise during the operation of a sanitation system, including waste collection, transportation and conveyance, treatment, disposal, and reuse. After the highest priority risks have been identified, an incremental improvement plan establishes control measures to ensure that no one in the sanitation chain is exposed to the hazards related to wastewater, greywater, and excreta. The 2015 WHO SSP manual provides examples of SSP documents developed in India, Peru, the Philippines, Portugal, Uganda, and Viet Nam.

1 World Health Organization. 2015. Sanitation Safety Planning Manual. Geneva. http://www.who.int/water_sanitation_health/publications/ssp-manual/en/

1.2. SANITATION SAFETY PLANNING PILOTS IN THE PHILIPPINES

The Asian Development Bank (ADB) is committed to increase sanitation investments to expand coverage of sanitation, hygiene, and wastewater management in its developing member countries through its Water Operational Plan (WOP) 2011–2020, supported by the Water Financing Program. The WOP priority thrusts are: (i) expanded wastewater management and reuse, (ii) expanded knowledge and capacity development using technology and innovation more directly, and (iii) enhanced partnerships with the private sector. SSP aims to address the challenges brought about by the impact on public health of scarce sanitation facilities or improper use of such facilities, as well as inadequate containment, treatment, and handling of wastewater, greywater, and excreta. Improper disposal of human wastes also contributes to the degradation of the environment and water resources.

The ADB Water Financing Partnership Facility (WFPF) mobilizes additional financial and knowledge resources from various development partners to support the implementation of its Water Financing Program. At the request of the WHO Country Office in the Philippines, WFPF supported a pilot demonstration activity to assist two water service providers, Baliwag Water District (BWD) and Maynilad Water Services, Inc. (MWSI), which operate sanitation systems, to undertake SSP and prepare their own SSP incremental improvement plans for their sanitation systems.

BWD is a medium-sized water utility serving almost 30,000 connections across all 27 barangays (villages) of the Municipality of Baliwag in Bulacan Province. BWD operates a septage treatment plant (BWD-SpTP) in Baliwag and has a water safety plan (WSP). MWSI is the concessionaire for the west zone of Metro Manila, serving more than one million connections. MWSI has much experience in wastewater management and completed the first WSP in the Philippines. For this SSP pilot, MWSI focused on its Veterans Water Reclamation Facility (MWSI-VWRF) in Project 7, Quezon City.

These pilot demonstration activities are the first SSP pilots in the Philippines. The SSP incremental improvement plans are expected to enhance the operation of the sanitation systems and support the implementation of the WSPs of these utilities. The SSP pilots in the Philippines provided information to the 2015 WHO SSP Manual.

A national steering committee on SSP was formed with ADB, WHO, and the Philippine Department of Health (DOH), and workshops were conducted for national partners from June 2014 to July 2015. The pilot demonstration activity outputs were an SSP incremental improvement plan for each utility and an SSP guide for operators of sanitation systems in the Philippines, including for the development of SSP incremental improvement plans. These will support DOH's operational guidelines governing domestic sludge and septage as part of the implementing rules and regulations of the Sanitation Code of the Philippines. The outputs will also enhance septage and wastewater management projects in the Philippines as well as promote compliance with the Clean Water Act and the water quality standards of the Department of Environment and Natural Resources (DENR).

It is expected that the SSP experience of BWD and MWSI will encourage other utilities that operate sanitation facilities in the Philippines to undertake SSP and develop their own SSP incremental improvement plans.

2. USE OF THE GUIDE

This guide is based on the following reference documents:

- 2006 WHO Guidelines for Safe Use of Wastewater, Excreta and Greywater;
- 2015 WHO SSP manual; and
- The SSP documents of the pilot utilities, BWD and MWSI.

Consistent with the six-step sanitation safety planning in the 2015 WHO SSP manual, the guide is divided into six steps:

Step 1 Prepare for Sanitation Safety Planning
Step 2 Describe the Sanitation System
Step 3 Identify Hazards and Assess Existing Controls and Exposure Risk
Step 4 Develop an Incremental Improvement Plan
Step 5 Monitor Control Measures and Verify Performance
Step 6 Develop Supporting Programs and Reviewing Plans

This guide seeks to simplify the SSP process, using examples and matrices developed for the SSP pilots in the Philippines.

THE SIX SANITATION SAFETY PLANNING STEPS

1. STEP 1: PREPARE FOR SANITATION SAFETY PLANNING

1.1. SET THE SANITATION SAFETY PLANNING OBJECTIVE

The overall objective of SSP should be related to promoting improved public health outcomes. Operators will have different reasons for an SSP initiative.

The objectives of the two operators included in the pilot demonstration activity are shown in the Box. The objective of MWSI is provided as Example A. The MWSI SSP specifically focuses on its Veterans Water Reclamation Facility in Project 7, Quezon City (MWSI-VWRF), a facility that collects wastewater through its sewer network, accepts septage, and discharges its effluent into a nearby creek. Example B summarizes the objectives of BWD, which operates a septage treatment plant in Baliwag, Bulacan (BWD-SpTP). Reclaimed water from BWD's SpTP is used to irrigate crops, water the lawn in the SpTP compound, and clean equipment. The sludge cakes and biosolids from the SpTP are currently used as soil conditioner and fertilizer.

1.2. DEFINE SANITATION SAFETY PLANNING SYSTEM BOUNDARY AND IDENTIFY LEAD ORGANIZATION

The questions listed in Table 1.1 will help an operator define its SSP system boundary by enumerating its key system components/activities and identifying the lead organization for the SSP process and key stakeholders to involve for each component/activity.

1.2.1. Sanitation Safety Planning System Boundary

The specific SSP objectives will define the system boundary or limit, and a clear delineation is important to achieve these objectives. To define the system boundary, criteria such as the following can be used (WHO 2015, p. 10):

- scope of operations of a sanitation facility or business,
- administrative boundaries,
- sanitation catchment area,
- area where waste products are used, and
- protection of specific exposure groups.

Certain safety objectives in the SSP may not appear to have a clear boundary initially, but this may be defined during the SSP process. A good example is food safety of products from farms that use reclaimed water for irrigation, and biosolids as fertilizer and/or soil conditioner.

Box: Examples of Sanitation Safety Planning Objectives

Example A: A Combined Sewage and Septage Facility (Maynilad Water Services, Inc.-Veterans Water Reclamation Facility [MWSI-VWRF])

The principal objective of sanitation safety planning (SSP) by MWSI is to mitigate risks to health of exposed workers, users, and the community during collection, transport, treatment, and disposal of wastewater, and during maintenance activities of the facility.

Example B: A Septage Facility (Baliwag Water District septage treatment plant [BWD-SpTP])

The principal objective of BWD in undertaking SSP is to ensure public health while implementing its septage management program. Specifically, the SSP seeks to safeguard the health of

- all groups exposed to activities related to septage processing, including septic tank desludging, transportation and treatment; and disposal of effluent, sludge cakes, and other waste generated;
- downstream farmers who use treated effluent for irrigation, and sludge cakes for fertilizer or soil conditioner; and
- consumers of produce from farms that use treated effluent and sludge cakes.

Sources: Baliwag Water DIstrict and Maynilad Water Services, Inc.

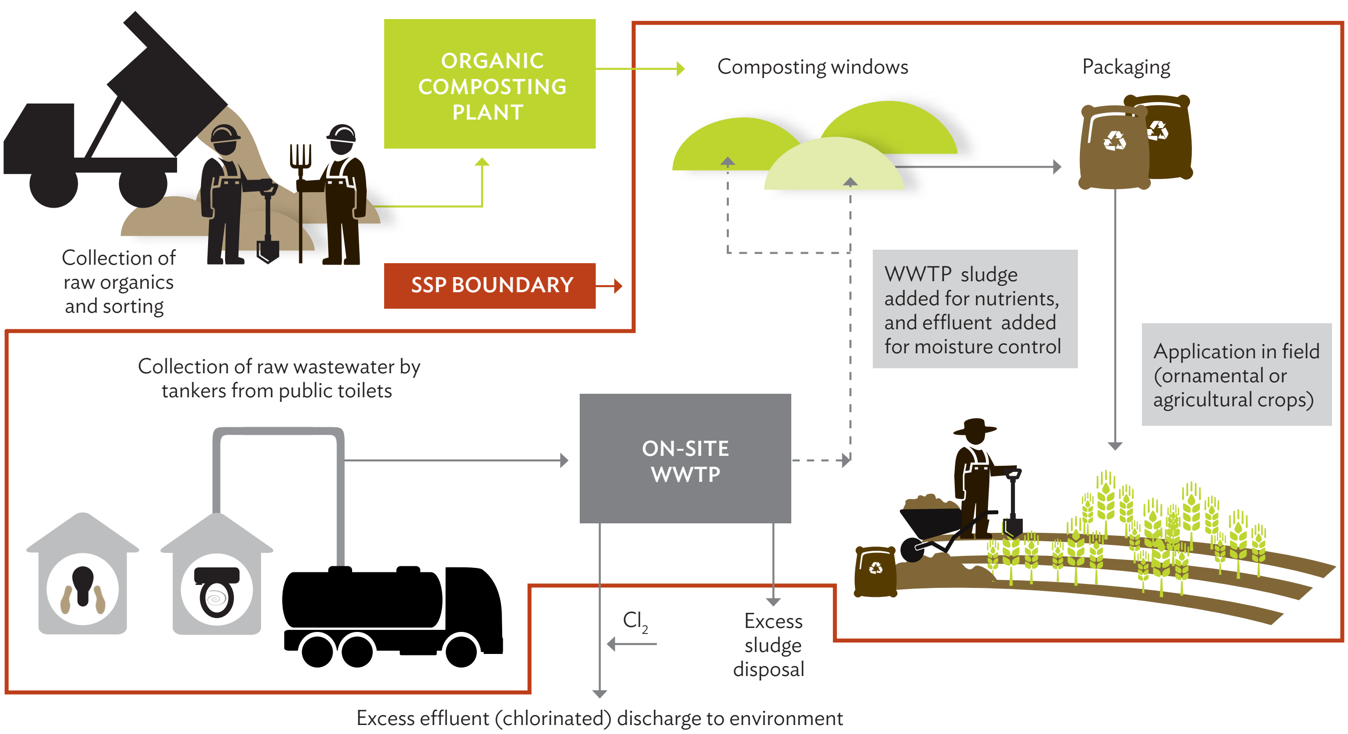
Three examples follow, based on the specific SSP objectives of these operators. The system boundary for the SSP of the operator of a wastewater treatment plant in Viet Nam is illustrated in Figure 1.1.

Table 1.1: Key Questions for Defining Sanitation Safety Planning System Boundary and Identifying Lead Organization

Components/Activities		Who Are the Key Stakeholders?
Question	**Answer**	
1. What is the scope of operation of the sanitation business (septage, sewerage, solid waste, etc.)? What is the extent of the area of operation? For septage collection, who are at risk along the transport route (from the septic tanks to the treatment plant)?		
2. How is wastewater generated by the facility treated (e.g., mechanized, natural systems) and disposed of (e.g., irrigation canal, natural body of water such as rivers and lakes, temporary holding tanks)? Are there downstream users of the treated effluent? If yes, who are they and what is the wastewater used for (e.g., irrigate rice farms, water lawns, wash vacuum trucks)?		
3. How is sludge treated and disposed of (e.g., composting, drying, incineration, landfill, used on land)?		
4. How are biosolids or sludge cakes generated by the facility used? Are they used as soil conditioner? Are they used to produce fertilizer (e.g., using vermicomposting)? Are they used as fertilizer to grow vegetables and other crops?; if so, what vegetables and crops? Any other uses (e.g., forestry and mine reclamation)?		

Source: Modified from World Health Organization. 2015. *Sanitation Safety Planning: Manual for Safe Use and Disposal of Wastewater, Greywater and Excreta*. Geneva. (www.who.int)

Figure 1.1: Sanitation Safety Planning System Boundary of a Wastewater Treatment Plant in Viet Nam



SSP = sanitation safety planning, WWTP = wastewater treatment plant.
Source: Adapted from WHO (2015, p. 34).

Figure 1.2 shows the system boundary for the MWSI combined sewage and septage facility in Project 7, Quezon City (MWSI-VWRF), for which the boundary includes areas both inside and outside the sewer network, but whose septage is treated at the facility. MWSI divided the SSP system into four areas: (A) sewered areas, (B) unsewered areas, (C) the Veterans Water Reclamation Facility itself (MWSI-VWRF), and (D) waste and end products. The first three areas fall within the scope of MWSI's business operation. The fourth area, waste and end products, involves MWSI and a third-party contractor, MAPECON, which processes MWSI's sludge into fertilizer.

- Area A (sewered areas) includes the collection of wastewater through sewer lines connected to the MWSI-VWRF, and the repair and maintenance of the sewer network. The solid waste taken from the sewage treatment is not included in the SSP system boundary for lack of information. A map shows the geographic limits of the sewered area of MWSI-VWRF.
- Area B (unsewered areas) includes the septage collection system using vacuum truck units (VTUs), and the repair and maintenance of VTUs.
- Area C includes the combined sewage and septage treatment plant (MWSI-VWRF).
- Area D (waste and end products) includes the processing facility of MAPECON, which processes MWSI sludge into fertilizer. The users of the fertilizer from MAPECON are not included within the system boundary.

BWD defined its SSP system boundary as its septage collection area (as illustrated in Figure 1.3), which covers all 27 barangays (villages) in the Municipality of Baliwag. The system components comprise the septage collection area, transport routes, components of the BWD-SpTP (i.e., equipment, tanks, water reuse facility, power/water supply, building, laboratory, and open spaces), farms that receive the treated effluent through an irrigation canal, the farmers' cooperative nearby that processes sludge cakes into fertilizer through vermicomposting, and a small nursery/garden that uses dried sludge as soil conditioner. The SSP system boundary does not include the septic tanks, leach field, internal house drains, and municipal drainage into which the effluent of individual septic tanks is discharged.

1.2.2. Lead Organization for Sanitation Safety Planning

The choice of the lead organization in the SSP process depends on the system boundary and the objectives of the SSP. The lead organization will take responsibility for ensuring that all the sanitation steps within the boundary are covered, even if it is not responsible for all the steps.

Table 1.2 provides examples based on analyses by the pilot operators. Example A shows the six system components/activities identified by MWSI within its system boundary. The first five are undertaken by MWSI and the sixth by a third-party contractor. Example B summarizes the five system components and the corresponding lead organization(s) for the BWD-SpTP based on its SSP objectives and system boundary. The first two components are within the scope of BWD operations; the remaining three relate to waste and end products and are outside its operations. Including these components in the SSP is consistent with the BWD SSP objective of ensuring public health while implementing its septage management program.

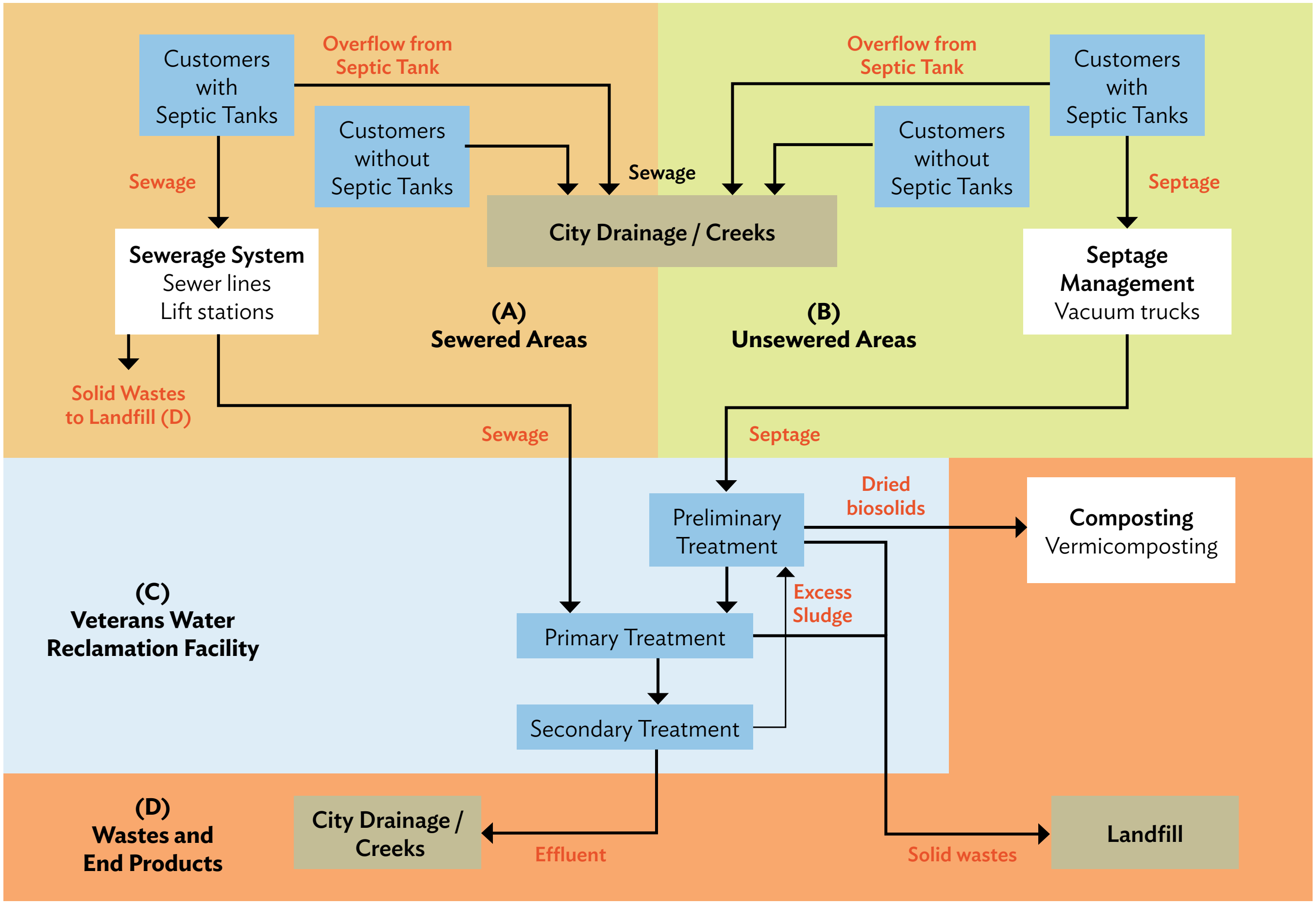
1.3. ASSEMBLE THE SANITATION SAFETY PLANNING TEAM

1.3.1. Stakeholder Analysis and Selecting Experts for the Sanitation Safety Planning Team

For SSP, stakeholders are people or institutions within the sanitation chain, including those directly involved with the operation of the sanitation system. The stakeholder analysis should be thorough to identify all relevant stakeholders and members of the SSP team and to ensure that all the SSP components and activities outside the areas of expertise of the lead organization are covered.

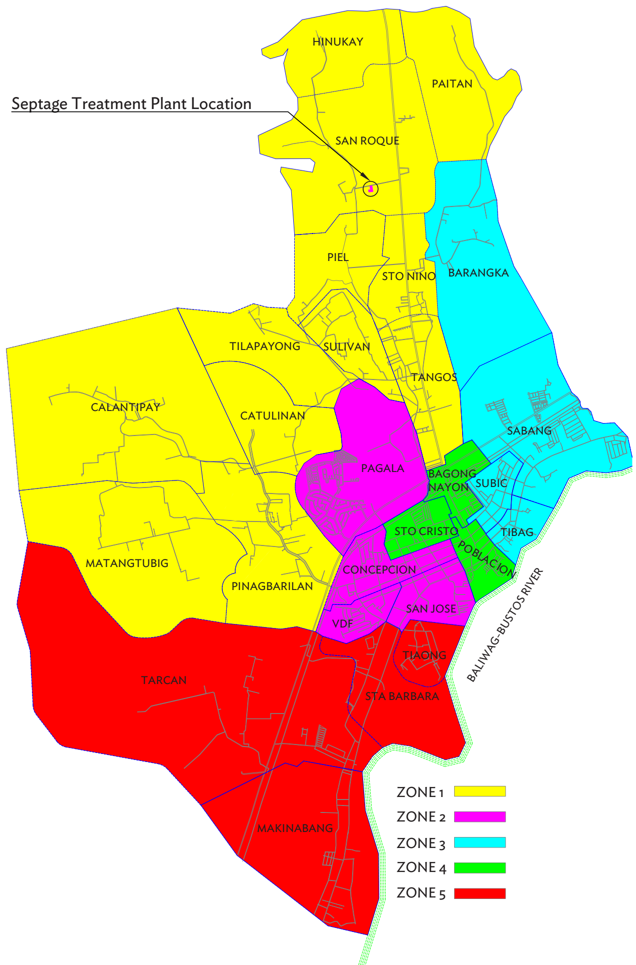
The SSP team should be able to define the system, identify hazards and hazardous events, and understand how the risks can be controlled. It is important that team members should include people with a mix of health and technical skills. It is preferable to engage as SSP team members many stakeholders who are actively involved.

Figure 1.2: Sanitation Safety Planning System Boundary of a Combined Sewage and Septage Facility (MWSI-VWRF) and Map of the Sewered Area



CST = communal septic tank , MWSI = Maynilad Water Services, Inc., SSP = sanitation safety planning, VWRF=Veterans Water Reclamation Facility.
Source: Maynilad Water Services, Inc.

Figure 1.3: Sanitation Safety Planning System Boundary of a Septage Facility (BWD-SpTP)



Septage Collection Area for BWD

BWD=Baliwag Water District, SpTP = septage treatment plant, SSP = sanitation safety planning.
Source: Baliwag Water District.

Table 1.2: Examples of Components and Lead Organizations for Sanitation Safety Planning

Table 1.2, Example A: A Combined Sewage and Septage Facility (MWSI-VWRF)

Components/Activities		Key Stakeholders Involved
1.	Collection of sewage through the sewer lines	SSP team (MWSI)
2.	Collection of septage through VTUs	SSP team (MWSI)
3.	Treatment of sewage and septage at the treatment plant	SSP team (MWSI)
4.	Repair and maintenance of sewer network	SSP team (MWSI)
5.	Repair and maintenance of VTUs	SSP team (MWSI)
6.	Processing of biosolids	SSP team (third-party contractor)

Table 1.2, Example B: A Septage Facility (BWD-SpTP)

Components/Activities	Lead Organization
1. Septage collection area and the transport route: every household septic tank in the franchise area is to be desludged by BWD; transport route of the vacuum trucks carrying the collected septage.	SSP team (BWD) along with its third-party contractor (desludgers, operators, and fleet management)
2. BWD-SpTP area: all treatment plant components, including equipment, tanks, water reuse facility, power/water supply, building, laboratory, and open spaces.	
3. Farmers in 7,200 m^2 lot adjacent to the eastern part of BWD's SpTP, who receive the treated effluent through the irrigation canal	SSP team (BWD)
4. The farmers' cooperative that uses sludge cakes for processing as fertilizers using vermicomposting.	SSP team (BWD)
5. A small nursery/garden maintained by Mr. Rodolfo German of NPC, Norzagaray, who uses dried sludge as soil conditioner.	SSP team (BWD)

BWD = Baliwag Water District, MWSI = Maynilad Water Services, Inc., m^2 = square meter, NPC = National Power Corporation, SSP = sanitation safety planning, SpTP = septage treatment plant, VTU = vacuum truck unit, VWRF = Veterans Water Reclamation Facility.
Sources: Baliwag Water District and Maynilad Water Services, Inc.

When identifying members of the SSP team and assigning responsibilities, the following should be taken into consideration (WHO 2015, p. 12):

- Are organizations (or stakeholders) for all steps of the sanitation chain represented?
- Are members with day-to-day technical operational skills included?
- Does at least one member have an understanding of management systems and emergency procedures?
- Do members have the authority to implement recommendations stemming from the SSP?
- How will the work be organized? Will the activities be regular or periodic?
- Can the SSP team activities be done as part of regular activities?
- How will specific stakeholders not represented on the SSP team be engaged?
- How will documentation be organized?
- What external technical support can be brought in to support the SSP team?

Figure 1.4 shows how the pilot utilities structured their SSP teams. As Example A shows, the MWSI SSP team was organized into four groups covering the four areas in its SSP system boundary. The unsewered area (without septic tank) group was responsible for monitoring households within its sewer network/Project 7 area that have no sewer connections or septic tanks. The representative from the Quezon City government led this group because sanitation for these households falls within the jurisdiction of the local government. The unsewered area (with septic tank) group was responsible for the desludging, transport, treatment of sewer and sewage, and processing of biosolids. The sewer area group was responsible for the monitoring and maintenance of the sewer network. The quality monitoring group was responsible for monitoring the quality of effluent and compliance with regulations.

Example B shows that the BWD SSP team was divided into two: a core team and a multistakeholder group. The core team was responsible for the development, implementation, and monitoring of the SSP. The multistakeholders were important to identify hazards and help achieve the health risk reduction measures of the SSP.

Figure 1.4: Examples of Sanitation Safety Planning Team Structures

Figure 1.4, Example A: A Combined Sewage and Septage Facility (MWSI-VWRF)

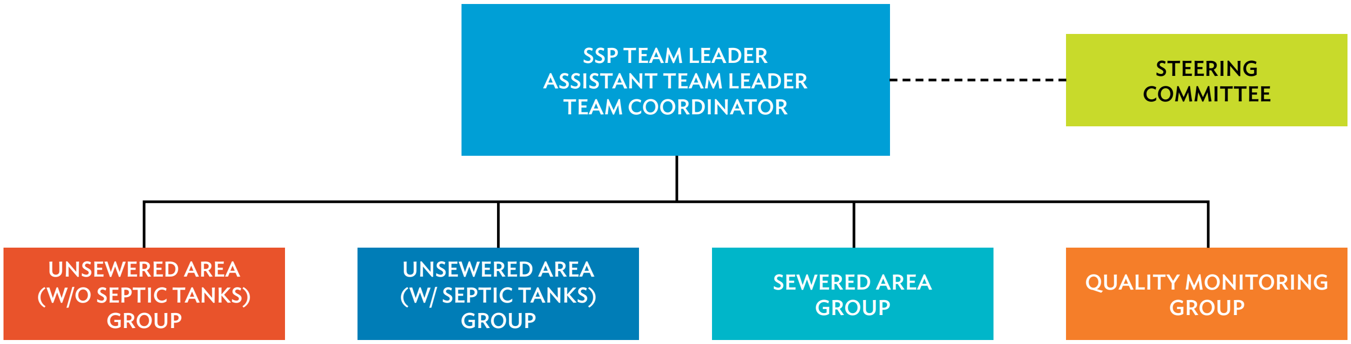
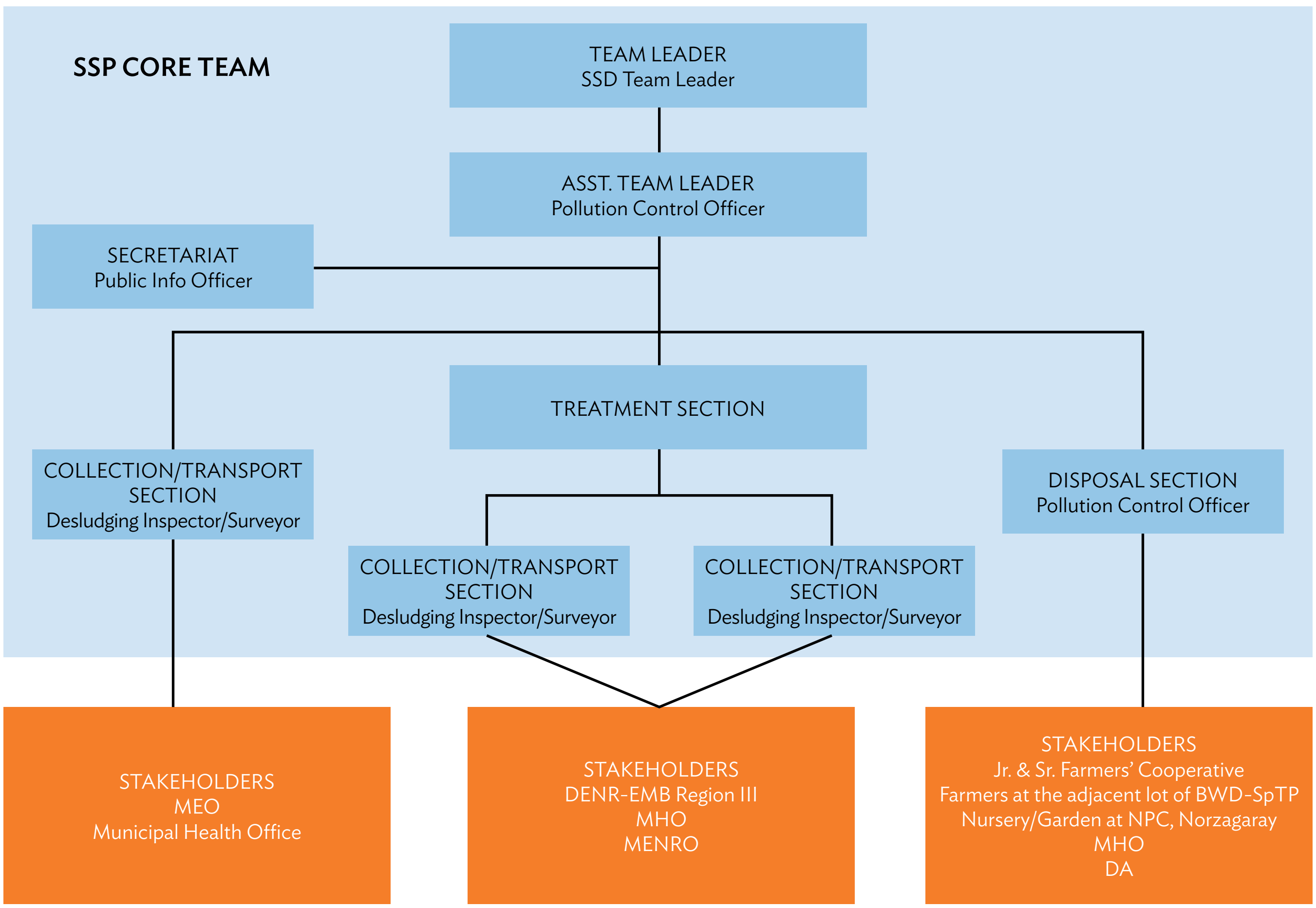


Figure 1.4, Example B: A Septage Facility (BWD-SpTP)



BWD-SpTP = Baliwag Water District-septage treatment plant, DA = Department of Agriculture, DENR-EMB = Department of Environment and Natural Resources-Environmental Management Bureau, MEO = Municipal Engineering Office, MENRO = Municipal Environment and Natural Resources Officer, MHO = Municipal Health Office, MWSI = Maynilad Water Services, Inc., NPC = National Power Corporation, SSD = Sewerage and Sanitation Division, SSP = sanitation safety planning, VWRF = Veterans Water Reclamation Facility.
Sources: Baliwag Water District and Maynilad Water Services, Inc.

1.3.2. Team Leader

The SSP team must appoint a team leader to drive and focus the SSP effort. The team leader must have the authority and organizational and interpersonal skills to ensure that the SSP can be implemented. The team leader may consider opportunities for external assistance in situations where the skills required are not available locally, including partnering arrangements with other organizations, national or international assistance programs and training resources, and consultants (PAHO undated, p. 18–19).

For the MWSI SSP, a senior assistant vice president of the Corporate Quality, Environment, Safety, and Health Division was appointed the team leader to ensure focus among various MWSI department heads, the third-party contractor, and representatives of Quezon City government agencies.

For BWD, the head of the Sewerage and Sanitation Division was appointed the SSP team leader and led the core team.

1.3.3 Team Members and their Responsibilities

The responsibilities of all SSP team members should be clearly defined and assigned from the start and documented. For large teams, it is often useful to form a group to describe key activities relating to the SSP, including those members who are responsible for implementing each of the activities (PAHO undated, p. 19).

Table 1.3 shows how the two pilot operators structured their SSP teams. The MWSI team was composed of MWSI staff, a Quezon City Health Office representative, and the third-party contractor that processes the biosolids. A team leader, assistant team leader, and a coordinator led the team. The job titles of the members of the team and the organizations they represented are also detailed, to emphasize the technical expertise required from the team. The SSP team members from MWSI were heads of the departments that are involved in the daily operations of the MWSI's sanitation systems. Representatives from Quezon City government and the MWSI third-party contractor brought in skills and expertise that complemented those of MWSI personnel. The team was responsible for the development, review, and subsequent revision of the SSP documents. A National Steering Committee served as advisers to the team leader, assistant team leader, and coordinator.

For BWD, the members were from BWD Sewerage and Sanitation Division, BWD Public Information Office, and the third-party contractor responsible for desludging, fleet management, and operating the BWD-SpTP. The multistakeholders facilitated data gathering and coordination among BWD, local government, national government line agencies, and the private sector. The multistakeholder group was composed of representatives from (i) the local government of Baliwag, (ii) DENR, (iii) farmers who use the reclaimed water for irrigation, (iv) a cooperative that uses the sludge cakes for vermicomposting, and (v) a farmer who uses the sludge cakes as a soil conditioner. The expertise of the multistakeholder group complemented that of the core team. BWD also convened a project coordination group composed of consultants from government and donor agencies as an external reviewer of SSP. This group guided the SSP team on development, review, and audit of the SSP.

Table 1.3: Examples of Sanitation Safety Planning Teams

Table 1.3, Example A: A Combined Sewage and Septage Facility (MWSI-VWRF)

Team Leader and Members	Job Title/Organization
Sanitary Safety Planning Team Leader	Head, Corporate Quality, Environment, Safety, and Health Division
Assistant Team Leader	Head, Wastewater Management Division
Team Coordinator	Head, Planning, Development, Implementation, and Certification
Unsewered Area (without Septic Tanks) Group	Sanitary Inspector, Quezon City–Health City Office
Unsewered Area (with Septic Tanks) Group	Head, Septage Management
	Head, Technical and Administrative Services
	Officer, Information and Resource Management
	Representative of MAPECON, the third-party contractor for biosolids processing
Sewered Area Group	Head, Sewer Network Management
	Head, Sewer Network Maintenance
	Officer, Project Development and Monitoring
Quality Monitoring Group	Officer, Process Control and Monitoring
	Officer, Planning, Development, Implementation, and Certification
	Head, Environmental Research and Assessment Unit
	Safety Officer
	Head, Process Control Laboratory

Source: Maynilad Water Services, Inc.

Table 1.3, Example B: A Septage Facility (BWD-SpTP)

Core Team:	
Team Leader, Members, and Responsibilities	**Job Title/Organization**
Team Leader, SSP Lead the team Call regular meetings of the SSP team Take responsibility of all SSP work from development to implementation and sustainability of the SSP Initiate revisit and possible revisions/improvement of the SSP	Head, Sewerage and Sanitation Division, BWD
Assistant Team Leader, SSP Overall in charge of monitoring of major activities in the septage treatment plant Monitor the disposal of dried sludge cake, solid waste, hazardous waste, FOG, and other residual wastes.	Engineer B/ Pollution Control Officer, BWD
Document Specialist/ Secretariat Serve as liaison of the SSP core team with the multistakeholders Record/document the process of development of the SSP Prepare the minutes of the meetings of the SSP team	Public Information Officer/CP-C, BWD
On-site Desludging Personnel Monitor the septage collection from the septic tank of the households Monitor the handling and transport of the collected septage to the treatment plant	Surveyor, BWD
Plant Supervisor Supervise the day-to-day operation of the SpTP Provide needed data on operations (i.e., volume treated, chemicals used, hours of operations, etc.)	Plant Supervisor, BWD
Chemist Monitor the quality of effluent that shall be reused in landscaping, and cleaning of machinery at the SpTP Monitor quality of the sludge cake Ensure compliance with government standards	Chemist, BWD

Table 1.3, Example B continued

Multistakeholders Group:	
Responsibility	**Job Title/Organization**
Provide assistance on the awareness campaign on the standard design of septic tanks and the importance of desludging the septic tanks on a regular basis	Municipal Engineer Office, Baliwag
Provide data and latest study/findings of health-related matters relevant to the operation of the sanitation systems Enlighten the community on the importance of having desludging service and the health hazards posed by overflowing septic tanks Update SSP team on new regulations that may be developed in relation to the safe use of collection, handling, transport, and disposal of excreta, wastewater, and greywater	Municipal Health Office, Baliwag
Provide feedback on the quality of effluent of BWD-SpTP Review and check Self-Monitoring Reports and Compliance Monitoring Reports of BWD-SpTP Update SSP team on latest national standards for effluent regulations	Department of Environment and Natural Resources-Environmental Management Bureau Region 3
Provide details on processing of sludge cakes and if possible on quality/ volume of fertilizers/soil conditioners produced from sludge cakes Provide information on how to use products Identify end-users of compost/fertilizers	Jr. & Sr. Farmers' Cooperative
Provide details on the types of crops grown per season/period Provide information as to when the crops will be harvested and where the produce will be sold	Farmers at the adjacent lot
Provide details on the types of crops grown using sludge cakes Provide information on who will be the consumers of the crops grown using sludge cakes	Small garden at National Power Corporation, Norzagaray

BWD = Baliwag Water District; CP-C = clerk processor C; FOG = fats, oil, and grease; MWSI = Maynilad Water Services, Inc.; SpTP = septage treatment plant; SSD = Sewerage and Sanitation Division; SSP = sanitation safety planning; VWRF = Veteran's Water Reclamation Facility.
Note: MAPECON is a pest-management company designated by Manila Water Services, Inc. as a third-party contractor responsible to handle, transport, and process biosolids.
Sources: Baliwag Water District and Maynilad Water Services, Inc.

Tips and Lessons Learned: Step 1 – Prepare for Sanitation Safety Planning

For both Maynilad Water Services, Inc. (MWSI) and Baliwag Water District (BWD), preparing for sanitation safety planning (SSP) was a challenge. SSP is a new concept worldwide and the two utilities piloted the concept in the Philippines. Few utilities and stakeholders have meaningful SSP experience. In addition, unlike a water safety plan, with which both pilot utilities have experience, SSP varies based on the objectives and definition of the system boundary. SSP considers different groups at risk for microbiological, physical, and chemical hazards. In addition, there is usually no clear regulatory framework with roles and responsibilities that are shared over different sectors. Such a framework is not yet evolving due to limited investment in sanitation systems. Workshops were conducted to guide the MWSI and BWD teams through the SSP process.

2. STEP 2: DESCRIBE THE SANITATION SYSTEM

The SSP team must be able to generate a complete description of the sanitation system within the system boundary identified. The SSP team must understand all parts of the sanitation system in order to provide support for the process after the risk assessment.

To have a better understanding of the sanitation system, the SSP team must conduct a site inspection to enable accurate mapping of the sanitation system and to collect information needed for the SSP. The site inspection will include all the sites within the system boundary.

Photographic documentation of the parts of the sanitation system during site inspection is necessary to identify and track hazards and hazardous events in the system, and to justify the need for improvement or upgrading of the facilities. This will also be essential to create the schematic and flow diagram of the sanitation system.

2.1. MAP THE SYSTEM

A system map is a visual representation of the sanitation system components within and outside the system boundary. Since each sanitation system is unique, it is important that the system description and its visual representation/system map be specific. The system map should accurately and clearly depict the path of all waste fractions from generation to disposal.

In developing the system map, the following should be considered (WHO 2015, p. 26):

- Include all sources of waste, both point and nonpoint sources, such as runoff.
- Account for all used and disposed parts of the waste stream (e.g., use or disposal for crops, fish or animals, soils, surface water or groundwater, and air).
- Identify all significant existing potential barriers (e.g., detention ponds, septic tanks).
- Include flow rates where known.
- Include the capacity or design loading of components where known (e.g., treatment plant flow or loading limits, transfer system capacities).
- Include drinking water sources where this is relevant to, or could be affected by, the sanitation system.

The method of mapping and visual representation will depend on the scale and complexity of the system as well as the details required to clearly present the system components. A system flow diagram, process flow diagram, simplified schematics, and geographic maps are some of the methods that can be used to represent the system components.

Figure 2.1A shows the MWSI system map. MWSI used a flow diagram to show the processes for its combined sewage and septage treatment streams. It also included a flow diagram for system subcomponents in order to highlight the four areas identified within its SSP system boundary (as detailed in Section 1.2.1, p. 5). The use of subcomponents allowed MWSI to elaborate on the activities of each area.

- Area A (sewered area) is detailed in the subcomponent on “Sewer Network Maintenance Activities” (Fig. 2.1B).
- Area B (unsewered area) is detailed in the subcomponent on “Fleet Maintenance” (Fig. 2.1C).
- Area C (VWRF area) is integrated in the system map where a snapshot of the entire process is presented; it also shows the treatment process for combined sewage and septage at MWSI-VWRF (Fig. 2.1A).
- Area D (waste and end product area) is detailed by the subcomponent on “Vermiculture Composting at MAPECON” (Fig. 2.1D).

Figure 2.2 shows the system map of BWD’s septage management system, presented as a process flow diagram. The flow diagram tracks the path of all fractions of waste through the system and the processes involved. A clear boundary shows the delineation of processes that are included within the system boundary, and those processes that are excluded in the system boundary. The system map also shows the processes that are within the sphere of BWD’s business operations (shaded light green for clarity).

Figure 2.1: Sanitation Safety Planning System Map of a Combined Sewage and Septage Facility (MWSI-VWRF)

Figure 2.1A. System Map: Sewage/Septage Processing

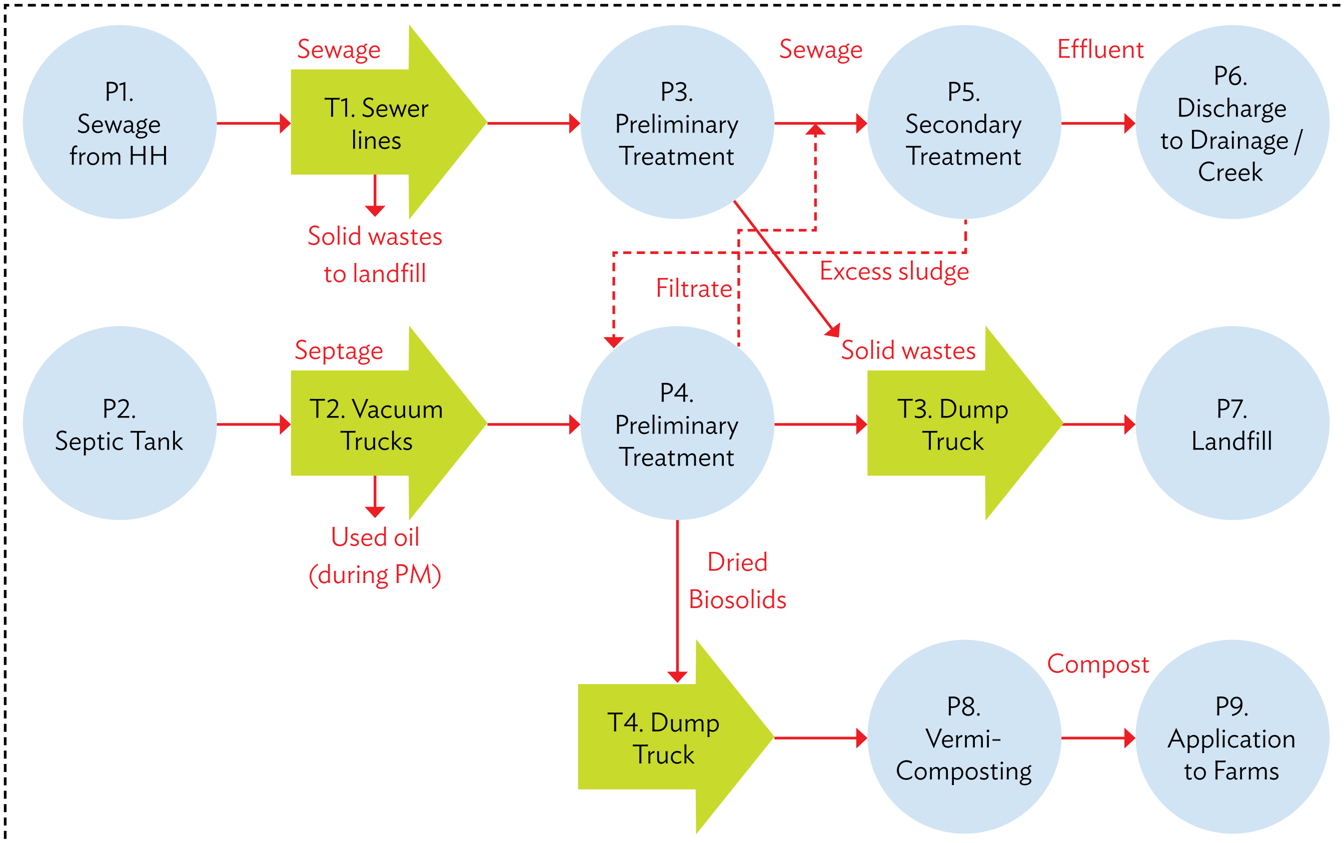


Figure 2.1B. Subcomponent: Sewer Network Maintenance Activities

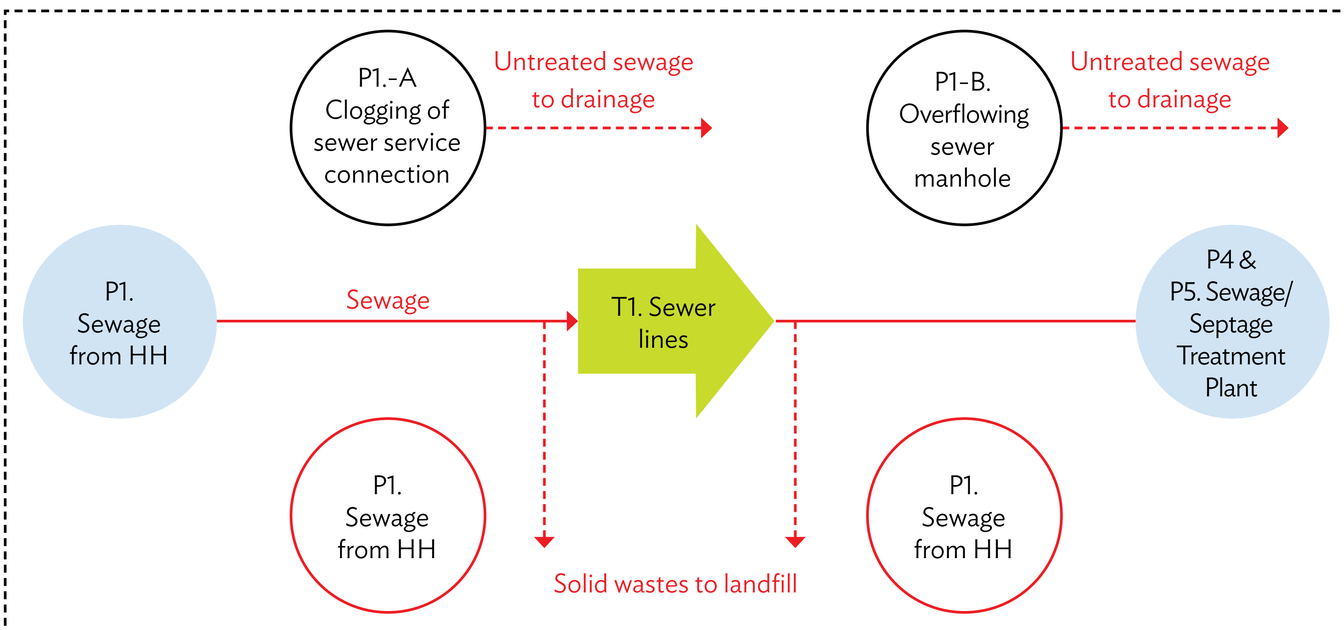


Figure 2.1C. Subcomponent: Fleet Maintenance

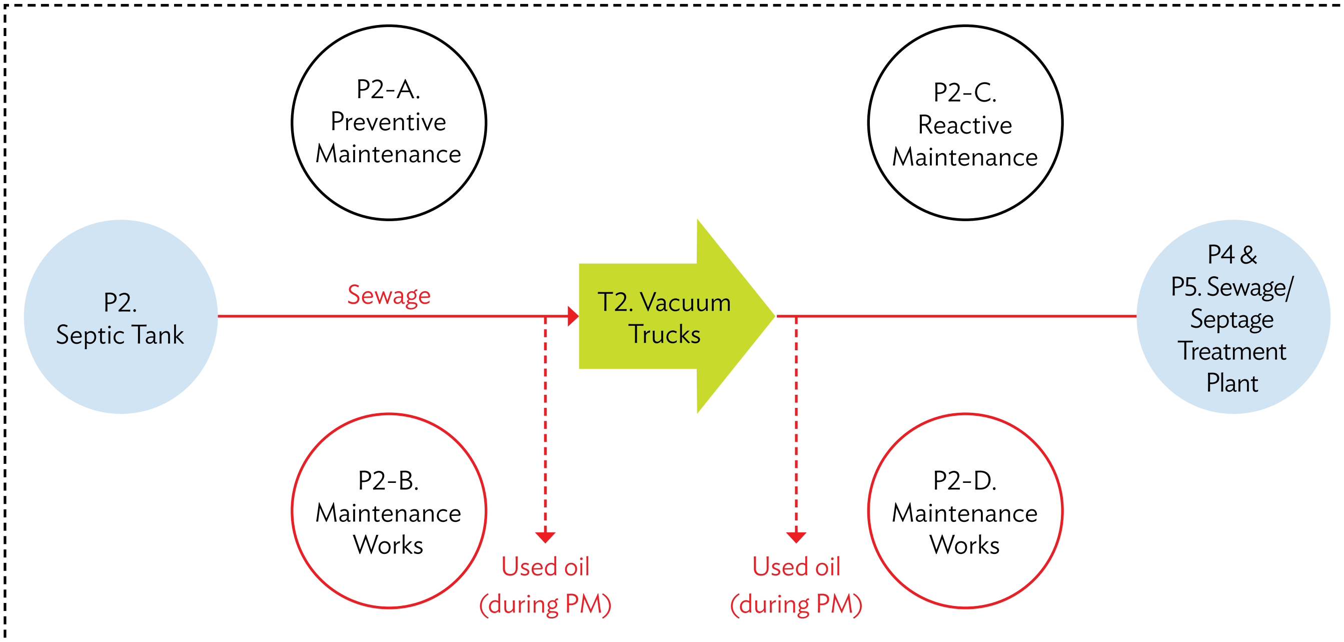
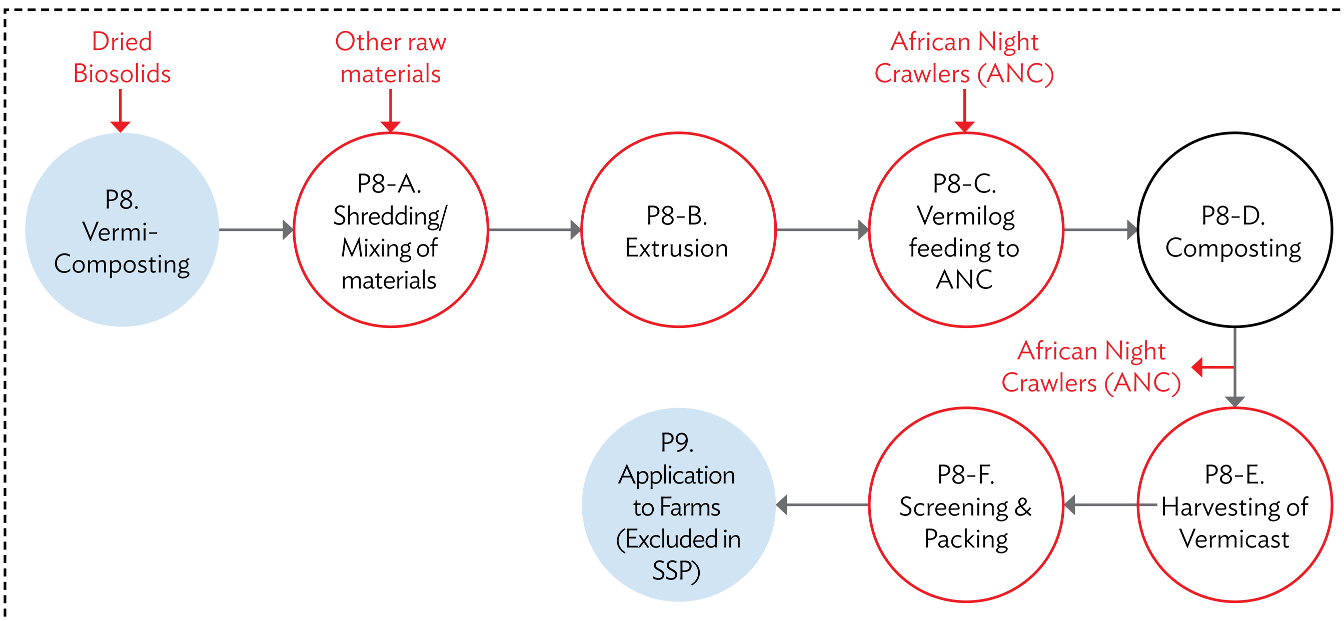
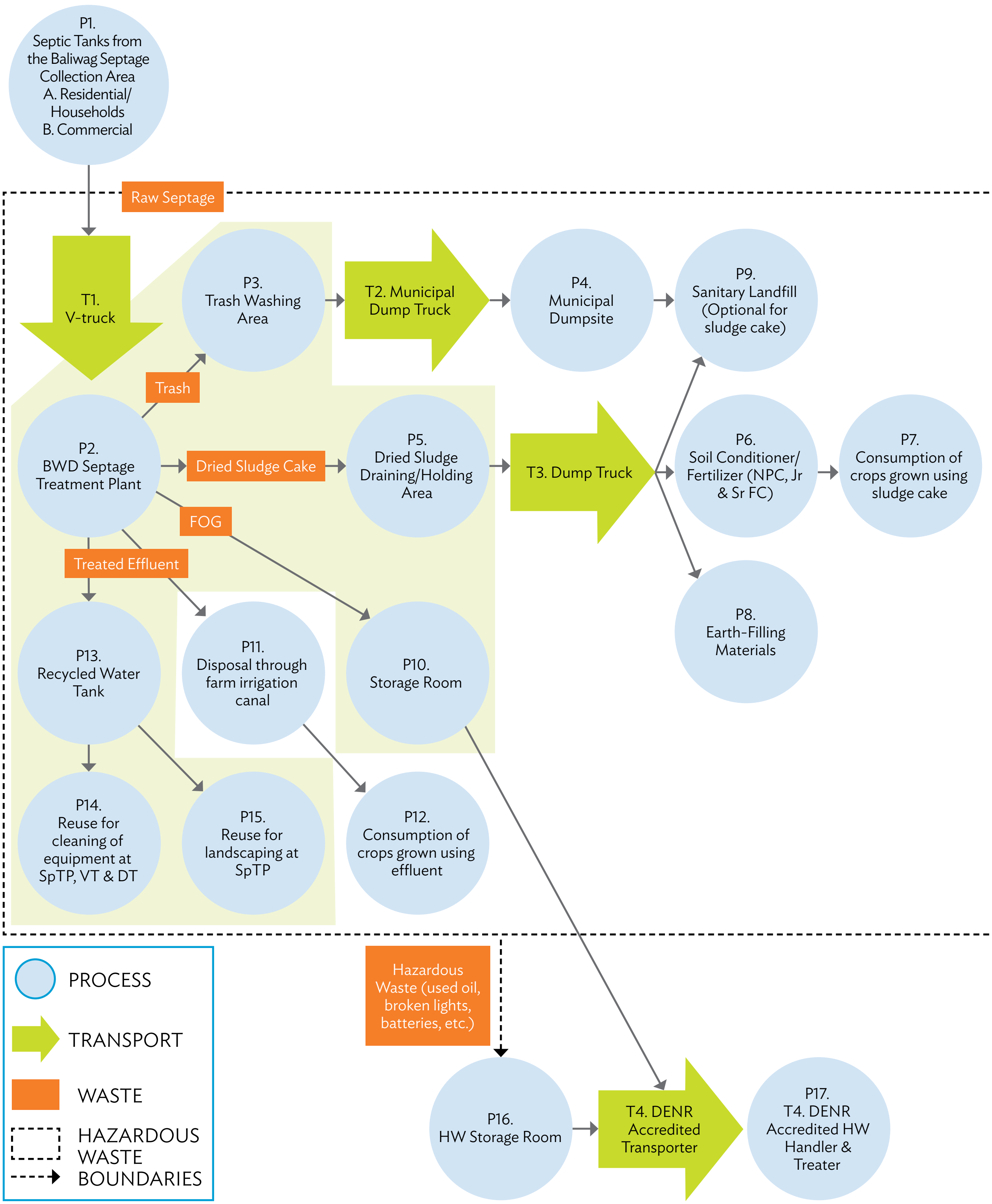


Figure 2.1D. Subcomponent: Vermiculture Composting at MAPECON



HH = households, MWSI = Manila Water Services, Inc., SSP = sanitation safety planning, VWRF = Veterans Water Reclamation Facility.
Note: MAPECON is a pest-management company designated by Manila Water Services, Inc. as a third-party contractor responsible to handle, transport, and process biosolids.
Source: Maynilad Water Services, Inc.

Figure 2.2: Sanitation Safety Planning System Map of a Septage Facility (BWD-SpTP)



BWD = Baliwag Water District; DENR = Department of Environment and Natural Resources; DT = dump truck; FOG = fats, oil, and grease; HW = hazardous waste; MWSI = Maynilad Water Services, Inc.; NPC = National Power Corporation; SpTP = septage treatment plant; SSP = sanitation safety planning; VT = vacuum truck.
Source: Baliwag Water District.

2.2 DESCRIBE THE SANITATION STEPS

The system map should clearly show the sanitation steps within the system boundary and must follow the path of all fractions of the waste, from the point of generation to use or disposal. At each step, the SSP team should record available quantitative information about the waste streams (e.g., flow rate, design capacity) of each treatment element. It is also important to understand the variability of the system. Detailing each sanitation step within the system boundary will help the SSP team comprehensively identify potential hazards and hazardous events in the system.

2.3. CHARACTERIZE THE WASTE FRACTIONS

The system map should clearly establish the path of different waste fractions through the system and the composition of the waste generated. When characterizing waste fractions, the following factors must be considered (WHO 2015, p. 27):

- The source(s) of the waste.
- The main composition of the waste in terms of liquid and solid fractions.
- The potential for accidentally mixed components of the waste that may pose risk.
- The likely concentration of physical and chemical pollutants and pathogenic microorganisms of the waste.

Table 2.1 provides a template for waste characterization and identification of potential health hazards for a sewage or septage treatment plant. The various biological, chemical, and physical hazards related to the wastes generated by the system are discussed further in the next section.

Table 2.1: Template for Waste Characterization and Potential Health Hazards for a Combined Sewage and Septage Facility

Components	Biological Hazards					Chemical Hazards		Physical Hazards		
	Viruses	Bacteria	Protozoa	Helminths	Vector-related disease	Toxic chemicals	Heavy metals	Sharp objects	Inorganic material	Malodors
Note: Put a checkmark (✓) if the hazard is most likely present for each component.										
A. Sewage or Septage Components										
Diluted Excreta										
Urine (human)										
Trash										
Fats, Oil, and Grease										
B. End Products (after treatment)										
Septage Treatment Plant Effluent										
Sludge Cake										
Hazardous Wastes										
Biosolids (compost, vermicompost/ worm castings)										

Source: Modified from World Health Organization. 2015. *Sanitation Safety Planning: Manual for Safe Use and Disposal of Wastewater, Greywater and Excreta*. Geneva. (www.who.int)

2.3.1 Biological Hazards

Biological hazards are caused by opportunistic pathogens such as bacteria, viruses, protozoans, and helminths. It is important that potential biological hazards of biosolids be characterized. The presence and frequency of different helminthic infections are context specific. As the species and concentration of helminth eggs in waste influence the design of control measures, it is important to determine which helminth species are endemic in the study area.

Table 2.2 shows the typical survival time of pathogens in freshwater, sewage, crops, and soil at temperatures of 20°C–30°C. The pathogens survive even under extreme conditions. Helminths, for example, will survive for many days in soil. They may also survive during the composting process. Platyhelminth eggs have been found to survive composting. The specific pathogens identified should be continuously monitored.

Vectors are living organisms that can transmit infectious diseases between humans or from animals to humans. Stagnant parts of drainage systems, treatment ponds, and stored waste may serve as breeding sites for insect vectors.

2.3.2 Chemical Hazards

Chemical contaminants in waste often pose considerable health risks and are difficult to control and eliminate. Toxic chemicals and heavy metals persist and may accumulate in water bodies, solids, and animals.

Table 2.2: Typical Pathogen Survival Times at 20°C–30°C

Pathogen	Survival Time (days)		
	Freshwater and Sewage	Crops	Soil
Viruses[a]			
Enteroviruses[b]	<120 but usually <50	<60 but usually <15	<100 but usually <20
Bacteria			
Fecal coliforms[a,c]	<60 but usually <30	<30 but usually <15	<70 but usually <20
Salmonella spp.[a]	<60 but usually <30	<30 but usually <15	<70 but usually <20
Shigella spp.[a]	<30 but usually <10	<10 but usually <5	---
Vibrio cholerae[d]	<30 but usually <10	<5 but usually <2	<20 but usually <10
Protozoa			
Entamoeba histolytica cysts	<30 but usually <15	<10 but usually <2	<20 but usually <10
Helminths			
Ascaris lumbricoides eggs	Many months	<60 but usually <30	Many months

Notes: a In seawater, viral survival is less and bacterial survival is very much less, than in freshwater.
b Includes polio, echo, and coxsackie viruses.
c Fecal coliform is not a pathogen but is often used as an indicator organism.
d *V. cholerae* survival in aqueous environments is a subject of current uncertainty.
Sources: Adapted from R.G. Feachem, D.J. Bradley, H. Garelick, and D.D. Mara. 1983. *Sanitation and Disease-Health Aspects of Excreta and Wastewater Management*. Chichester: John Wiley & Sons; USEPA. 2004. *Guidelines for Water Reuse.* EPA/625/R-04/108. Washington, DC: Municipal Support Division, Office of Wastewater Management.

Insecticides and pesticides are common toxic chemicals. Results of heavy metal analyses (see Table 2.5) show heavy metals found at MWSI-VWRF.

For agricultural irrigation using reclaimed water, the important chemical constituents to monitor are salinity, sodium, trace elements, excessive chlorine residual, and nutrients (USEPA 2004, p. 22). Salinity is the most important parameter in determining the suitability of treated effluent/reclaimed water for use because the tolerance for salinity of crops varies. Sodium salts accumulate in the soil and affect the infiltration of water into the soil. The unavailability of soil water affects the growth of the plants (Tanji 1990). Soil dispersion and structural breakdown could be contributed by excessive sodium in irrigation water (when sodium exceeds calcium by more than a 3:1 ratio). The finer soil particles will fill many smaller pore spaces, seal the surface, and greatly reduce water infiltration rates. In contrast with the destabilizing effect of sodium, calcium and magnesium act as stabilizing ions.

2.3.3 Physical Hazards

Physical hazards include sharp objects mixed in different waste streams and the potential contamination of wastes with inorganic material and malodors.

2.3.4 Identifying and Monitoring Hazards at Maynilad Water Services, Inc.

The following tables summarize the information collated for MWSI-VWRF:

- waste characterization (Table 2.3);
- microbial analysis (Table 2.4);
- analysis of heavy metals (Table 2.5); and
- influent stream characteristics showing the values for sewage, septage stream, and influent to secondary treatment (Table 2.6).

Table 2.3: Waste Characterization and Potential Health Hazards for a Combined Sewage and Septage Facility (MWSI-VWRF)

Component	Biological Hazards					Chemical Hazards		Physical Hazards		
	Viruses	Bacteria	Protozoa	Helminths	Vector-related disease	Toxic chemicals	Heavy metals	Sharp objects	Inorganic material	Malodors
Septage and Sewage										
Diluted Excreta	✓	✓	✓	✓					✓	✓
Urine (human)	✓	✓	✓	✓						✓
Solid Waste	✓	✓	✓	✓	✓			✓	✓	✓
Fats, Oil, and Grease (domestic)	✓	✓	✓	✓					✓	✓
End Products (after treatment)										
Effluent	✓	✓	✓	✓						
Biosolids	✓	✓	✓	✓	✓		✓		✓	✓
Hazardous Wastes						✓	✓	✓	✓	

MWSI = Maynilad Water Services, Inc., VWRF = Veterans Water Reclamation Facility.
Source: Maynilad Water Services, Inc.

2.3.5 Identifying and Monitoring Hazards in Baliwag Water District

Table 2.7 shows the results of waste characterization in terms of the general presence of biological, chemical, and physical hazards for the BWD septage only facility (BWD-SpTP). Table 2.8 shows the influent characteristics of septage, filtrate (influent to sequencing batch reactor), and effluent for reuse of BWD-SpTP.

Table 2.4: Microbial Analysis for a Combined Sewage and Septage Facility (MWSI-VWRF)

Raw Sewage	Count/ml
Nematodes	2
Rotifers	8
Paramecium	3
Algal plankton	
Centritractus	1
Algae	
Ankistrodermus	1
Cyttarocylis	8
Ceratium	10
Ascaris ova	3
Effluent	**Count/ml**
Rotifers	
Asplancha sieboldi	7
Algae	
Gomphosphaeria	9
Hydrodictyon	2
Phormidium	1

ml = milliliter, MWSI = Manila Water Services, Inc.,
VWRF = Veterans Water Reclamation Facility.
Source: Maynilad Water Services, Inc.

Table 2.5: Analysis of Heavy Metals for a Combined Sewage and Septage Facility (MWSI-VWRF)

Heavy Metals	Raw Sewage (mg/l)	Effluent (mg/l)
Arsenic	<0.001	<0.001
Cadmium	0.008	0.001
Hexavalent Chromium	0.005	<0.005
Lead	0.01	0.007
Total Mercury	<0.0001	<0.0001
Cyanide	0.002	<0.001

ml = milliliter, MWSI = Manila Water Services, Inc.,
VWRF = Veterans Water Reclamation Facility.
Source: Maynilad Water Services, Inc.

Table 2.6: Influent Stream Characteristics in relation to Legal Requirements of a Combined Sewage and Septage Facility (MWSI-VWRF)

Parameter	Sewage	Septage	Influent to Secondary Treatment	DENR AO No. 35: Class C Limits
Biochemical Oxygen Demand (BOD), mg/l	250–500	5,000–8,000	450	50
Chemical Oxygen Demand (COD), mg/l	350–1,000	15,000–20,000	1,500	100
Total Suspended Solids (TSS), mg/l	200–500	10,000–40,000	200	70
Fats, Oil, and Grease, mg/l	100–200	1,000–1,500	50	5
pH	5–9	6.5–8.5	6.5–8.5	6.5–9.0
Color, PCU	200	-	-	100
Total Coliform, MPN/100 ml	>16,000	-	-	<10,000
Moisture Content	n/a	95%–98%	n/a	n/a

DENR AO = Department of Environment and Natural Resources Administrative Order, MPN = most probable number, PCU = platinum-cobalt unit, mg/l = milligram per liter, MWSI = Maynilad Water Services, Inc., VWRF = Veterans Water Reclamation Facility.
Source: Maynilad Water Services, Inc.

Table 2.7: Waste Characterization and Potential Health Hazards for a Septage Facility (BWD-SpTP)

A. Septage Components	Biological Hazards					Chemical Hazards		Physical Hazards		
	Viruses	Bacteria	Protozoa	Helminths	Vector-related disease	Toxic chemicals	Heavy metals	Sharp objects	Inorganic material	Malodors
A. Septage Components										
Diluted Excreta	✓	✓	✓	✓					✓	✓
Urine (human)	✓	✓	✓	✓						✓
Solid Waste	✓	✓	✓	✓	✓			✓	✓	✓
Fats, Oil, and Grease (domestic)	✓	✓	✓	✓					✓	✓
B. End Products (after treatment)										
SpTP Effluent	✓	✓	✓	✓						
Sludge Cake	✓	✓	✓	✓	✓		✓		✓	✓
Hazardous Wastes						✓	✓	✓	✓	

BWD = Baliwag Water District, SpTP = septage treatment plant.
Source: Baliwag Water District.

Table 2.8: Results of the Physico-Chemical Analysis of Raw Septage, Filtrate, and Effluent Stream of a Septage Facility (BWD-SpTP)

Parameter	Raw Septage Characteristics	Filtrate (Influent to SBR)	Effluent (for Reuse)	Target Efficiency
pH	7.84	7.76	7.37	
Color, PCU	12,500	1,000	65	
Cumulative Reduction		92%	99.5%	≥90%
Chemical Oxygen Demand (COD), mg/l	5,579	228	69	
Cumulative Reduction		96%	99%	≥60%
Biochemical Oxygen Demand(BOD), mg/l	700	121	7.7	
Cumulative Reduction		82%	99%	≥90%
Total Suspended Solids (TSS), mg/l	18,200	1,972	7	
Cumulative Reduction		89%	99.9%	≥90%
Fats, Oil, and Grease, mg/l	477	63	3.3	
Cumulative Reduction		87%	99%	≥90%
E. coli	No available data			
Cumulative Reduction				
Helminth eggs	No available data			
Cumulative Reduction				

BWD = Baliwag Water District, mg/l = milligram per liter, PCU = platinum-cobalt unit, SBR = sequencing batch reactor, SpTP = septage treatment plant.
Note: Cumulative reduction is calculated across the treatment systems.
Source: Baliwag Water District.

2.4. VALIDATE THE SYSTEM DESCRIPTION

It is important to validate the system description to ensure that the information gathered is complete and accurate. System validation should provide evidence of the stated system characteristics and performance. This can be done by field investigations such as sanitary inspections and surveillance, focus group discussions, key informant interviews, and collection of samples for laboratory testing.

2.5. GATHER COMPLIANCE AND CONTEXTUAL INFORMATION

Controlling and managing system risks are closely linked to quality standards, monitoring system management and performance, demographic aspects and land-use patterns, as well as climate change and seasonal conditions. Therefore, it is very important to collect all available information on these parameters.

2.5.1. Quality Standards, Certification, and Audit Requirements

The SSP team should collect sufficient data on relevant quality standards, certification and audit requirements, and other legal and regulatory aspects concerning control of system elements and waste, as summarized in Tables 2.9–2.11, including the following (WHO 2015, p. 27):

- relevant laws relating to public health and the environment;
- regulations on effluent disposal and discharges and odor regulations;
- specifications on planning related to spatial planning of urban areas, vulnerable environmental areas, and agricultural or pasture land, as well as restrictions;
- specific national regulations related to agricultural products;
- specific national guidelines for preparedness or disaster planning;
- regulations related to quality monitoring, surveillance, and system auditing (not financial); and
- certification requirements for agricultural end products.

Table 2.9: Quality Standards of Waste Generated by a Combined Septage and Sewage Plant

Waste	Existing Laws and Guidelines	Parameters
Effluent	DENR Administrative Order 35 – Effluent Regulations of 1990 Effluent Standards: Conventional and other Pollutants in Inland Waters (Category I and II and in Inland Waters Class C)	BOD5 at 20°C – 50 mg/l Total Suspended Solids – 70 mg/l Oil and Grease – 5.0 mg/l Total Coliforms – 10,000 MPN/100 ml Surfactants (MBAS) – 5.0 mg/l Phenol Substances as Phenols – 0.1 mg/l
	DENR Administrative Order 35 - Effluent Regulations of 1990 Effluent Standards: Toxic and Other Deleterious Substances (Category I and II and in Inland Waters Class C)	Arsenic - 0.2 mg/l Cadmium – 0.05 mg/l Chromium hexavalent – 0.1 mg/l Cyanide – 0.2 mg/l Lead – 0.3 mg/l Mercury (total) – 0.005 mg/l PCBs – 0.003 mg/l Formaldehyde – 1.0 mg/l
Biosolids	WHO Guidelines for the Safe Use of Wastewater, Excreta, and Greywater Volume I Policy and Regulatory Aspects	Recommended minimum verification monitoring of microbial performance targets for wastewater and excreta in agriculture: ≤1 helminth egg per liter for restricted and unrestricted irrigation ≤10,000 *E. coli* per 100 ml for unrestricted irrigation to leaf crops ≤100,000 *E. coli* per 100 ml for unrestricted irrigation to high growing crops

BOD5 = 5-day biochemical oxygen demand, COD = chemical oxygen demand, DENR = Department of Environment and Natural Resources, WHO = World Health Organization, MBAS = methylene blue-active substance, mg/l = milligram per liter, ml = milliliter, MPN = most probable number, PCB = polychlorinated biphenyl, PCU = platinum-cobalt unit.
Sources: DENR and WHO.

MWSI-VWRF discharges its effluent into a creek. Consequently, it needs permits from DENR and Laguna Lake Development Authority (LLDA). Table 2.10 shows the legal requirements of the DENR LLDA.

Table 2.10: Legal Requirements for a Combined Sewage and Septage Facility (MWSI-VWRF)

Agency	Requirement	Specifics/Details
DENR-EMB	PD1586[a] ECC/ CNC	CNC-0610-16-011 issued on 16 October 2006
	RA6969[b] Hazardous Waste ID	HW#GR-13-74-1313 (Am) issued on 30 January 2014
	RA 8749[c] Permit to Operate	1-400kW POA No.14-POA-C-137404-0968 (R) valid until 30 March 2019
	DAO 2014-02[d] Accredited PCO	Reynaldo C. Angeles
LLDA	BR 408 S2011[e] LLDA Clearance	LLDA Clearance No.PC-25b-012-003 25 issued on 11 July 2013
	RA9275[f] Discharge Permit[g]	DP application submitted on 8 August 2013 (updated on 24 October 2014)
	Accredited PCO Annual Consumption Report	Reynaldo C. Angeles Latest report submitted was on 30 January 2015

a PD1586 or the Presidential Decree No. 1586 defines the framework for the implementation of Environmental Impact Assessment as the mechanism to reconcile the impacts of development projects on society and the physical environment. For the purpose of this order, the Veterans Water Reclamation Facility has been issued a Certificate of Non-Coverage (CNC) on 16 October 2006 by the Environmental Management Bureau that certifies that the project is not covered by the Environmental Impact Statement (EIS) system.
b RA6969, or Republic Act No. 6969, is an Act that covers the importation, manufacturing, processing, handling storage, transportation, sale, distribution, use, and disposal of all unregulated chemical substances and mixtures in the Philippines, including the entry, even in transit as well as the keeping or storage and disposal of hazardous and nuclear wastes into the country for whatever purpose. For the VWRF, materials being disposed of are used light bulbs, used vehicle batteries, used oil, and ink cartridges.
c RA 8749, or Republic Act No. 8749, is an Act providing for a Comprehensive Air Pollution Control Policy and since the VWRF has a 400 kW generator in place, a Permit to Operate is required in this facility.
d DAO 2014-02, or Department of Environment and Natural Resources Administrative Order 2014-02, also known as the revised guideline for PCO accreditation, states that all establishments requiring a Pollution Control Officer (PCO) shall submit a Self-Monitoring Report (SMR), which provides information on the establishment's environmental compliance and overall environmental performance. For this facility, Mr. Reynaldo C. Angeles of Wastewater Management Division is the appointed PCO and is in charge of the accomplishment of SMR.
e BR 408 S2011, or Board Resolution 408 Series of 2011, expressly provides that a clearance must be issued for all approved proposed plans, programs, and projects unless the proposals will contribute to the unmanageable pollution of the Laguna Lake waters or will bring about the ecological imbalance of the region. With this an LLDA Clearance was issued to the VWRF on 11 July 2013.
f RA 9275, or Republic Act No. 9275 also known as the Philippine Clean Water Act of 2004, prohibits the discharging, depositing or causing to be deposited material of any kind directly or indirectly into the water bodies or along the water margins of any surface water. In order for a facility to be allowed to discharge into a particular water body, a compliance schedule and monitoring requirement shall be the legal authorization from DENR in the form of Discharge Permit.
g MWSI operates a 400 kW generator and as a result, MWSI must comply with RA 9136 (Electric Power Industry Reform Act of 2001), its IRR (Implementing Rules and Regulations), and related resolutions of the Energy Regulatory Commission (ERC).

CNC = certificate of noncoverage, DENR = Department of Environment and Natural Resources, DP = discharge permit, ECC = environmental compliance certificate, EMB = Environmental Management Bureau, HW = hazardous waste, ID = identification, kW = kilowatt, LLDA = Laguna Lake Development Authority, MWSI = Manila Water Services, Inc., PCO = pollution control officer, PD = Presidential Decree, VWRF = Veterans Water Reclamation Facility.
Source: Maynilad Water Services, Inc.

For its SpTP, BWD must comply with DENR and WHO standards. It is also required to undertake a toxicity characteristic leaching procedure for fats, oil, and grease and sludge cakes disposed of in landfill or garbage sites. Table 2.11 shows the legal requirements with which BWD must comply.

2.5.2. System Management and Performance

The SSP team should obtain the following information (WHO 2015, p. 28):

- Data on monitoring and surveillance of the system
- Frequency of documentation
- If faults and/or deviations were followed-up
- Epidemiological data on the groups of people involved
- Types and amount of products

2.5.3. Demographics and Land-use Patterns

The SSP should also include a brief review and description of land-use and sociocultural aspects such as:

- location and population of human settlements, especially informal ones;
- special activities that could have an impact on sanitation and wastewater production;
- special equity considerations concerning ethnicity, religion, or specific communities or groups of users; and
- other land uses such as industry, commerce, livestock, and recreation.

Table 2.11: Legal Requirements for a Septage Facility (BWD-SpTP)

Waste	Existing Laws/Guidelines	Parameters (mg/kg)
Dewatered Septage - Sludge Cake Processed Sludge Cake as Soil Conditioner/ Fertilizer/ Vermicompost	WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater Volume I, Policy and Regulatory Aspects	Maximum tolerable soil concentrations of various toxic chemicals based on human health protection: Arsenic 8 Cadmium 4 Chromium n/a Copper n/a Mercury 7 Lead 84 Silver 3 Nickel 107 Barium 302 Selenium 6 Additional parameters include: Antimony 36 Beryllium 0.2 Boron 1.7 Fluorine 635 Molybdenum 0.6 Thallium 0.3 Vanadium 47

BWD = Baliwag Water District, WHO = World Health Organization, mg/kg = milligram per kilogram, SpTP = septage treatment plant.
Source: Baliwag Water District.

2.5.4 Known or Suspected Changes relating to Weather and Other Seasonal Conditions

Changes related to weather or other seasonal conditions should be identified, especially those linked to rainfall and temperature variations. The following are aspects that may be considered (WHO 2015, p. 28):

- Mean variability of the load to the treatment plant over the year
- Seasonal variation of use due to type of crops and harvest
- Additional inflow areas during heavy rainfall and implications on treatment steps, e.g., combined sewer flow (stormwater and sewer together)
- Changes in usage patterns in time of water scarcity

Tips and Lessons Learned: Step 2 – Describe the Sanitation System

Step 1 is key for Step 2. A good team composition and leadership, and a clear delineation of the system boundary are essential to a good sanitation system description. Both Baliwag Water District (BWD) and Maynilad Water Services, Inc. (MWSI) have included technical staff to map and characterize the sanitation system.

The system map should show the flow of waste fractions in every sanitation step within the system boundary. BWD and MWSI teams used flow diagram techniques to show the waste fractions along the sanitation chain and to delineate what is included within the system boundary.

Other stakeholders in the BWD and MWSI sanitation safety planning teams are essential in mapping and completing the compliance and contextual information of sanitation steps outside the business operation of the utilities—sludge composting, vermicomposting, and water reclamation are generally outside the business operations of BWD and MWSI.

3. STEP 3: IDENTIFY HAZARDS AND ASSESS EXISTING CONTROLS AND EXPOSURE RISK

3.1. IDENTIFY HAZARDS AND HAZARDOUS EVENTS

Risk assessment starts with the identification of hazards and hazardous events at each point of exposure for all the sources of waste generation.

The SSP team should identify the following hazardous events:

- **Hazardous Events Associated with the Normal Operation of the System.** These hazards include the possibility of defective infrastructure, system overloads, lack of timely maintenance, operator error, involuntary contact by operators with hazardous waste, excessive emissions of gas and smells, excessive accumulation of waste, etc.
- **Hazardous Events due to System Failure or Accident.** Failures or accidents are highly likely to occur during the operation of the system, often caused by events not connected with the operation itself, such as electricity blackouts, accidental spillages of hazardous waste, treatment failure, and equipment breakdown.
- **Hazardous Events related to Seasonal or Climatic Factors.** Hazards can also be due to failures or accidents generated by seasonal and climate changes such as flood or drought, seasonal changes in the behavior of the system, and change in quality of the influent due to heavy rainfall.
- **Indirect Hazards or Hazardous Events.** Some hazards can affect people who are not directly involved in the sanitation chain. These hazards include vermin, vector proliferation, and effects of waste discharges into rivers, aquifers, irrigation canals and fields, and on downstream communities.

To identify the risk and potential events related to the end products, it is important to map out the areas where end products are used or disposed of. The present land use of disposal areas, their proximity to population centers/urban areas, and the land-use pattern in the vicinity should be determined. This is to quantify the risk, characterize the possible events, and prepare mitigation/control measures. In addition to land-use characteristics, the physical properties of disposal areas should be determined.

End products for the pilot utilities include sludge cake (used for composting, vermicomposting, etc.) and treated effluent/reclaimed water. It is essential to characterize the end products for the purpose of identifying the hazards. For example, the biosolids produced from sludge from BWD and MWSI are used as fertilizers.

For MWSI, a third-party contractor collects the sludge and treats the waste using vermicomposting only. The two processes used to "dispose" of the sludge generated at the BWD-SpTP are composting and vermicomposting. The amount of sludge that can be composted depends on the soil properties, temperature, and other factors of the disposal site. While composting (traditional) can occur at high temperatures (above 75°C), vermicomposting is done at lower temperatures (below 35°C). Both composting and vermicomposting processes depend on certain "loading capacity," the former from soil, and the latter from "worms" that produce the castings.

One important concern is the contamination of aquifers and groundwater from the hazards of end products. The pathogens may survive the composting and vermicomposting process and contaminate the water resources. As noted earlier, typical pathogens may survive in soil for many days. The pathogens may migrate to water and/or crops if end products are used to grow them. In assessing the risk, it is necessary to determine the location of water resources. This could be done using available engineering data, traditional knowledge, mapping methods, etc. In the absence of data, use of geological maps can help locate aquifers and groundwater.

Some hazards are not evident under ordinary circumstances but could have a progressive impact on the health of those involved or on the environment within and outside the sanitation system. Examples of such hazards are soil quality deterioration, soil salinity, eutrophication of water sources, and bioaccumulation of toxic compounds in irrigated products.

3.2. IDENTIFY EXPOSURE GROUPS AND EXPOSURE ROUTES

After the identification of all hazards, the groups associated with every hazard should be identified and categorized. The hazards and exposed groups are linked together through a transmission and exposure routes. This step requires the identification of exposure groups along with transmission and exposure routes.

3.2.1. Exposure Groups

The risk assessment aims to identify groups of people that may be exposed to particular hazards. This step enables the prioritization of exposure groups and control measures in the risk assessment. The SSP team should classify all groups of people that may be exposed to each hazard identified. The exposure groups can then be added into the system map. They are categorized as shown in Table 3.1.

The SSP team should further categorize exposure groups, as follows (PAHO, undated, p. 36):

- **Who?** An accurate definition of those who could be at risk of exposure.
- **How many?** An estimate of the number of individuals in each group who could be exposed directly or indirectly.
- **Where?** A definition of the place(s) where the exposure may occur within the sanitation system.

Table 3.2 provides a template for groups that may be exposed for a septage management operation.

Table 3.1: Exposure Group Categories

Symbol	Short Name	Short Description
W	Waste Handlers	Persons who operate, maintain, monitor, clean, and empty the sanitation components
F	Farm Workers	Persons who irrigate their crops with the waste products (effluent and sludge cake)
U	Utility Workers	Persons who use the effluent for landscaping and gardening
L	Local Community	Persons who live near or downstream from the sanitation system or farm where the material is used and who may be passively affected
C	Consumers	Anyone who consumes or uses the sanitation products (e.g., crops or compost)

Source: Modified from World Health Organization. 2015. Sanitation *Safety Planning: Manual for Safe Use and Disposal of Wastewater, Greywater and Excreta*. Geneva. (www.who.int)

Table 3.2: Exposure Groups for a Septage Management System Operator

Symbol	Exposure Group	Exposure Subcategory	No.
W	W1 (Desludging Aides)	Those who open septic tanks	
	W2 (Vacuum Truck Operators)	Those who collect and transfer raw septage	
	W3 (SpTP operators)	Those who operate an SpTP	
	W4 (Chemist, Pollution Control Officer, Division Manager, Plant Supervisor)	Those who monitor operations	
	W5 (Municipal Garbage Collectors)	Those who collect and receive the washed trash in an SpTP	
	W6 (Accredited Hazardous Waste Treaters)	Those who collect and receive the hazardous waste generated in an SpTP	
F	F1	Farmers who use sludge cakes as soil conditioner	
	F2	Farmers who use sludge cakes for vermiculture	
	F3	Farmers who use effluent to grow crops	
U	U1*	Those who use the effluent for landscaping and gardening	
L	L1	Those who live in households that use sludge cakes as earth filler	
	L2	Those who live adjacent to an SpTP	
	L3	Those who live adjacent to farms using effluent	
	L4	Those who live in households where a septic tank will be desludged	
	L5	Those who visit and observe SpTP operations	
	L6	Local community along possible spillage accident area	
	L7	Local community that could be affected by contamination of aquifer, groundwater, and other resources	
C	C1	Those who consume crops grown with sludge cakes as soil conditioner by F1 farmers	
	C2	Those who consume crops grown in compost by F2 farmers	
	C3	Those who consume products irrigated with effluent by F3 farmers	

SpTP = septage treatment plant.
*U1 persons are utility workers who use treated effluent for landscaping and gardening. For instance, the Baliwag Water District SpTP is reusing its treated effluent to maintain its lawn and garden; U1 persons are utility workers responsible for this task.
Source: Modified from World Health Organization. 2015. *Sanitation Safety Planning: Manual for Safe Use and Disposal of Wastewater, Greywater and Excreta*. Geneva. (www.who.int)

3.2.2. Exposure and Transmission Routes

Transmission routes of pathogens can be through direct contact exposure (primary) to the contaminated wastewater or through external exposure (secondary) by consuming products that have used contaminated wastewater or by vectors such as mosquitoes and flies. Transmission can also occur through the air, as with inhalation of aerosols and contaminated particles. Table 3.3 shows the common exposure routes to consider in the SSP process. Additional exposure and transmission routes may be identified in the future if additional data and analysis are available.

3.3. IDENTIFY AND ASSESS EXISTING CONTROL MEASURES

Control measures are any actions and activities that can be used to prevent or eliminate sanitation-related hazards, or to reduce these to an acceptable level. For each hazardous event identified, existing control measures must be identified and their effectiveness validated in order to mitigate the risk of that event. Control measures can be evaluated by considering their potential (i.e., assuming they work well at all times) and actual (actual operating practices) performance.

Table 3.3: Common Exposure Routes and Transmission

Exposure and Transmission Route	Description
Ingestion after contact with wastewater and excreta	Transfer of excreta (urine and/or feces) through direct contact to the mouth from the hands or items in contact with the mouth, including ingestion of contaminated soil via contact with hands (e.g., farmers or children)
Ingestion of contaminated groundwater and surface water	Ingestion of water drawn from a ground or a surface source, which is contaminated from wastewater or excreta and sludge, including unintentional ingestion of recreational waters by swimmers and bathers
Consumption of contaminated produce (vegetables)	Consumption of plants (e.g., lettuce) that have been grown on land irrigated or fertilized with a sanitation product
Dermal contact with excreta and wastewater	Infection where a pathogen (e.g., hookworms) enters through the skin via the feet or other exposed body part following contact with wastewater, excreta, open defecation, contents of leaking sanitation components or during operation (e.g., pit emptying)
Vector borne by flies and mosquitoes	Transmission routes include the mechanical transfer of excreta by flies to a person or food items, and bites from a mosquito or other biting insect, which could be carrying a disease
Inhalation of aerosols and particles	The inhalation of micro droplets of water and particles (which may not be noticeable) emanating or resulting from a sanitation technology, which may carry a pathogen dose

Source: Modified from World Health Organization. 2015. *Sanitation Safety Planning: Manual for Safe Use and Disposal of Wastewater, Greywater and Excreta*. Geneva. (www.who.int)

3.4. ASSESS AND PRIORITIZE THE EXPOSURE RISK

The health of the identified exposure groups can be at risk because of the hazards to which they are exposed. The risks can be serious, moderate, or potentially insignificant. Therefore, in this stage of the development of the plan, the SSP team should establish the risks associated with each hazard and then prioritize the most serious ones.

Depending on the scale and complexity of the sanitation system, the SSP team may decide to carry out a descriptive assessment of the risks or a more rigorous semiquantitative risk assessment, using a probability and severity matrix to determine the level of risk. The following descriptions differentiate the two methods.

3.4.1. Descriptive Risk Assessment

The descriptive risk assessment method involves using the opinion and judgment of the SSP team to assess the hazards at each stage of the process and to determine whether these are under control (WHO 2015, p. 44). All the hazards identified should be reviewed for each exposure group and the risk categorized as high, medium, low, or uncertain. The SSP team can create its own definitions. Table 3.4 shows the risk category descriptions suggested by WHO (2015).

3.4.2. Semiquantitative Risk Assessment

In semiquantitative risk assessment, a risk matrix is used to arrive at a risk category or score. The SSP team should assign a likelihood and severity to each identified hazardous event. The following formula is used to compute risk:

Risk = Likelihood x Severity (Consequences)

Table 3.5 shows how the risk ratings are established and used to evaluate quantitatively the hazards in the system.

Table 3.4: World Health Organization-Suggested Risk Category and Priority Descriptions

Priority	Description
High	It is possible that the event results in injuries, acute and/or chronic illness, or loss of life. Actions need to be taken to minimize the risk.
Moderate	It is possible that the event results in moderate health effects (e.g., fever, headache, diarrhea, small injuries) or unease (e.g., noise, malodors). Once the high-priority risks are controlled, actions need to be taken to minimize the risk.
Low	No health effects anticipated. No action is needed at this time. The risk should be revisited in the future as part of the review process.
Unknown	Further data are needed to categorize the risk. Some action should be taken to reduce risk while more data are gathered.

Source: Modified from World Health Organization. 2015. *Sanitation Safety Planning: Manual for Safe Use and Disposal of Wastewater, Greywater and Excreta*. Geneva. (www.who.int)

Table 3.5: Risk Assessment Matrix

Risk Rating		Severity (S)				
		Insignificant	Minor	Moderate	Major	Catastrophic
		Rating 1	Rating 2	Rating 4	Rating 8	Rating 16
LIKELIHOOD (L)	Very Unlikely **Rating 1**	1	2	4	8	16
	Unlikely **Rating 2**	2	4	8	16	32
	Possible **Rating 3**	3	6	12	24	48
	Likely **Rating 4**	4	8	16	32	64
	Almost Certain **Rating 5**	5	10	20	40	80

Risk Score R = (L) x (S)	<6	6–12	13–32	>32
Risk Level	Low	Medium	High	Very High

L = likelihood, R = risk, S = severity.
Source: Modified from World Health Organization. 2015. *Sanitation Safety Planning: Manual for Safe Use and Disposal of Wastewater, Greywater and Excreta*. Geneva. (www.who.int)

Table 3.6 summarizes the definitions of the likelihood and severity in the risk assessment matrix suggested by WHO. The SSP team should then summarize the highest risks.

Table 3.7 shows the risk assessment for the MWSI combined sewage and septage facility. The levels of risks were determined and rated. The risk assessment included maintenance of the sewer network, desludging and transportation of septage, fleet maintenance (VTUs), operation of VWRF, transportation of the sludge cake to a vermicomposting site of a third-party contractor, and processing and harvesting of biosolids. The use of biosolids is not included in the risk assessment as it is outside the system boundary.

Table 3.6: World Health Organization-Suggested Descriptions of Likelihood and Severity in the Risk Assessment Matrix

Type	Score	Description
Likelihood		
Very Unlikely	1	Has not happened in the past and is highly improbable it will happen in the next 12 months (or another reasonable period)
Unlikely	2	Has not happened in the past, but may occur in exceptional circumstances in the next 12 months (or another reasonable period)
Possible	3	May have happened in the past and/or may occur under regular circumstances in the next 12 months (or another reasonable period)
Likely	4	Has been observed in the past and/or is likely to occur in the next 12 months (or another reasonable period)
Almost Certain	5	Has often been observed in the past and/or will almost certainly occur in most circumstances in the next 12 months (or another reasonable period)
Severity		
Insignificant	1	Hazard or hazardous event resulting in no or negligible health effects compared with background levels
Minor	2	Hazard or hazardous event potentially resulting in minor health effects (e.g., temporary symptoms like irritation, nausea, and headache)
Moderate	4	Hazard or hazardous event potentially resulting in self-limiting health effects or minor illness (e.g., acute diarrhea, vomiting, upper respiratory tract infection, and minor trauma)
Major	8	Hazard or hazardous event potentially resulting in illness or injury (e.g., malaria, schistosomiasis, food-borne trematodiases, chronic diarrhea, chronic respiratory problems, neurological disorders, and bone fracture); and/or may lead to legal complaints and concern; and/or major regulatory noncompliance
Catastrophic	16	Hazard or hazardous event potentially resulting in serious illness or injury, or even loss of life (e.g., severe poisoning, loss of extremities, severe burns, and drowning); and/or will lead to major investigation by regulator with prosecution likely

Source: Modified from World Health Organization. 2015. *Sanitation Safety Planning: Manual for Safe Use and Disposal of Wastewater, Greywater and Excreta*. Geneva. (www.who.int)

Table 3.7: Excerpts from Hazard Identification and Risk Assessment for a Combined Sewage and Septage Facility (MWSI-VWRF) (Treatment of Sewage and Septage, and Processing of Biosolids)

No.	Sanitation Step	Hazard Identification			Existing Controls	Risk Assessment					
		Hazard Exposure Event	Hazard Type	Exposure Route	Description of Existing Control	Validation of Control	Exposure Group	Likelihood	Severity	Score	Risk rating
1	P1-D Unclogging of sewer manholes (SMH) and sewer lines	Exposure to raw sewage due to overflow of SMH caused by clogging of sewer line	Pathogen	Inadvertent ingestion	Covering mouth and nose with hand/cloth	Observation	U1	3	4	12	M
2			Helminth risks	Dermal contact	Footwear	Visual		3	2	6	M
3	P1-D Unclogging of sewer manholes and sewer lines	Exposure to raw sewage due to overflow of SMH caused by clogging of sewer line	Pathogen	Inadvertent ingestion	Safety mask	PPE issuance/ visual	W2	4	4	16	H
4			Helminth risks	Dermal contact	Safety boots and gloves	PPE issuance/ visual		4	2	8	M
5	P1-D Unclogging of sewer manholes and sewer lines	Exposure to raw sewage due to overflow of SMH caused by damaged sewer	Pathogen	Inadvertent ingestion	Covering mouth and nose with hand/cloth	Observation	U1	3	4	12	H
6			Helminth risks	Dermal contact	Footwear	Visual		3	2	6	M
91	P8-A Shredding/ mixing of materials	Exposure to biosolids during shredding	Helminth risks	Dermal contact	Gloves	Observation	U3	4	4	16	H
92			Pathogen	Inadvertent ingestion	N/A	Observation		4	4	16	H
93	P8-E Harvesting of vermicast	Exposure to biosolids during harvesting of the vermicast	Helminth risks	Dermal contact	Gloves	Observation	U3	4	4	16	H
94			Pathogen	Inadvertent ingestion	N/A	Observation		4	4	16	H

MWSI = Maynilad Water Services, Inc., N/A = not applicable, PPE = personal protective equipment, P1-D and P8 = sanitation steps (as shown in column 2), SMH = sewer manholes, VWRF = Veterans Water Reclamation Facility.
Notes: Common exposure routes are defined in Table 3.3; Exposure groups U1, U3, and W2 are defined in Table 3.4; Risk ratings refers to risk levels (R) that are defined in Table 3.5, with L = low risk, M = medium risk, and H = high risk; Likelihood and Severity are defined in Table 3.6.
Source: Maynilad Water Services, Inc.

Table 3.8 summarizes the risk assessment of the hazards with high-priority risks for BWD septage management operations. The BWD SSP team also used semiquantitative assessment in computing the risk ratings. The risks assessment included desludging and transportation of septage, operation of BWD's SpTP, transportation of the sludge to a nearby vermicomposting site, processing of biosolids, and use of reclaimed water and biosolids. Table 3.9 identifies the highest priority risks for BWD, and its SSP improvement plan was based on this prioritization.

Table 3.8: Excerpts from Hazard Identification and Risk Assessment for a Septage Facility (BWD-SpTP) (Treatment of Septage, Processing of Biosolids, and Use of Reclaimed Water and Biosolids)

Sanitation Step	Hazard Identification			Existing Control(s)	Risk Assessment Allowing for the existing control L = Likelihood, Se = Severity, Sc = Score, R = Risk Level						Comments Justifying Risk Assessment or Effectiveness of the Control
	Hazardous Exposure Event	Hazard Type	Exposure Route	Description of Existing Control	Validation of Control	Exposure Group	L	Se	Sc	R	
P1 Septic tank of BWD concession-aires	1. Exposure to raw Septage during opening of septic tank	1. Pathogens in raw septage 2. Malodors	1. Skin contact	Vaccination for hepatitis and anti-tetanus Strict implementa-tion of safety and hygiene practices Wearing of proper PPE	Routine inspection/ Inspection report Vaccination record Routine inspection/ Inspection report	W1	2	2	4	L	PPE is observed
			2. Inadvertent ingestion			W1	2	4	8	M	
			3. Inhalation			W1	3	2	6	M	
	2. Exposure to raw septage during desludging	1. Pathogens in raw septage 2. Malodors	1. Skin contact			W2	2	2	4	L	PPE is observed
			2. Inadvertent ingestion			W2	2	4	8	M	
			3. Inhalation			W2	3	2	6	M	
	3. Exposure to raw septage during opening and desludging of septic tank	1. Pathogens in raw septage 2. Malodors	Inhalation	Setting up of warning devices Post desludging clean-up	Routine inspection/ Inspection report	L4	3	2	6	M	Some individuals are observed near desludging area
T1 Transport of septage by VT	1. Exposure to raw septage due to spillage during vehicular accident	1. Pathogens in raw septage 2. Malodors	1. Skin contact	VT speed limit VT PM Adherence to LTO rules on road worthiness Cleanup procedure for spilled material	Visual and maintenance report	W2	2	2	4	L	Control measures at hand are strong
			2. Inadvertent ingestion			W2	2	4	8	M	
			3. Inhalation			W2, L6	3	2	6	M	
	2. Exposure to raw septage due to spillage during loose fittings	1. Pathogens in raw septage 2. Malodors	1. Skin contact	Regular mainten-ance of VTs Cleanup procedure for spilled material	Maintenance report Visual inspection/ Inspection report Training report	W2	3	2	6	M	Control measures at hand are strong
			2. Inadvertent ingestion			W2, L6	3	2	6	M	

BWD = Baliwag Water District, LTO = Land Transportation Office, PPE = personal protection equipment, P1 and T1 = sanitation steps (as shown in column 1), SpTP = septage treatment plant, VT = vacuum truck.

Notes: Common exposure routes are defined in Table 3.3; Exposure groups U1, U3, & W2 are defined in Table 3.4; Risk ratings refers to risk levels (R) defined in Table 3.5, with L = low risk, M = medium risk, and H = high risk; Likelihood and Severity are defined in Table 3.6.
Source: Baliwag Water District.

Table 3.9: Summary of Hazards with High Priority Risks for a Septage Facility (BWD-SpTP)

Sanitation Step	Hazardous Exposure Event	Hazard Type	Exposure Route	Exposure Group	Risk Score
P4 Disposal of trash by municipal trash collector	Exposure to treated trash due to contact during disposal	Pathogens in washed trash	Inadvertent ingestion	W5	16
P6 Sludge cake as farm soil conditioner	Exposure to sludge cake due to contact during application to farming activities	1. Pathogens in sludge cake 2. Malodors	Skin contact	F1, F2	20
P7 Consumption of crops harvested using sludge cake	Consumption of contaminated crops	Pathogens in sludge cake	Ingestion	C1, C2	20
P11 Disposal of effluent for farm irrigation	Exposure to effluent due to contact during farming activities	Pathogens in effluent	Skin contact	F3, L3	16

BWD = Baliwag Water District, SpTP = septage treatment plant.
Notes: P4, P6, P7, and P11 are sanitation steps. W5, F2, F2, C1, C2, F3, L3 are exposure groups as defined in Table 3.2. Risk scores were derived using Table 3.5.
Source: Baliwag Water District.

Tips and Lessons Learned: Step 3 – Identify Hazards and Assess Existing Controls and Exposure Risk

Identifying and mapping the sanitation steps within the system boundary are essential steps. Do a walk-through of the sanitation system using the system map. At every sanitation step, identify hazards, probable events, and exposure groups. Follow Tables 3.1–3.6 to complete this step.

This step allows you to review your existing controls and assess their adequacy. This comprehensive risk assessment process also allows you to rank the risks, some of which may have been identified in a partial assessment.

The risk prioritization will help to set your priorities in terms of "what to do first." Maynilad Water Services, Inc. and Baliwag Water District used the results of risk assessment to formulate their action plans, prioritizing only the risks with highest scores due to limited resources.

4. STEP 4: DEVELOP AND IMPLEMENT AN INCREMENTAL IMPROVEMENT PLAN

4.1. IDENTIFY NEW AND/OR IMPROVED CONTROL MEASURES

Taking into account the hazards identified and the levels of risk priority that these entail, new or improved control measures must be developed in order to improve risk management. The SSP team should take the following into account when evaluating different control measures (WHO 2015, p. 59):

- The potential for improving existing control(s)
- Cost of the control option relative to its likely effectiveness
- Most appropriate location in the sanitation chain to control the risk
- Technical effectiveness of proposed new control options
- Acceptability and reliability of the control in relation to local cultural and behavioral practices
- Responsibility for implementing, managing, and monitoring the proposed new controls
- Training, communication, consultation, and reporting needed to implement the proposed control measure.

4.2. DEVELOP AN INCREMENTAL IMPROVEMENT PLAN

Once the appropriate control measures are established, an improvement plan must be developed by the SSP team to decrease or eliminate the risks. Improvement plans can be capital works, operational measures, behavioral measures, or some combination of the three.

The person or agency responsible for every action must be identified in an improvement plan for it to be implemented and managed. The cost of the proposed control measures and when they are to be implemented must also be incorporated into the plan. The implementation of each measure should be prioritized based on the risk category for each hazard evaluated. The SSP team should monitor and record the implementation status of the improvement plan to ensure that every action is undertaken.

Table 4.1 summarizes the MWSI SSP improvement plan. The BWD SSP improvement plan is captured in Table 4.2. Both plans were based on the risk ratings, with hazards with high ratings prioritized. Not all hazards were addressed due to limited resources.

Tips and Lessons Learned: Step 4 – Develop and Implement an Incremental Improvement Plan

Step 3 (Identify Hazards and Assess Existing Controls and Exposure Risk) is critical for Step 4. The improvement plan aims to mitigate or eliminate the risks. It is important to determine the available resources that can be used to implement the improvement plan. Maynilad Water Services, Inc. prepared its improvement plan by addressing only hazards with a high risk rating. Baliwag Water District identified the highest priority risk and prepared its plan based on the rankings.

Table 4.1: Excerpts from the Sanitation Safety Planning Improvement Plan for Maynilad Water Services, Inc.–Veterans Water Reclamation Facility

No.	Hazardous Exposure Event	Improvement Action/s (new/improved control measure)	Priority (high, medium, low, unknown)	Responsible Agency/ Person	Estimated Cost	Status
Sewage Collection						
3	Exposure to raw sewage due to overflow of SMH caused by clogging of sewer line (pathogen)	Provide high quality PPE to protect personnel from direct contact with raw sewage (W2)	High	Logistics		Procured
5	Exposure to raw sewage due to overflow of SMH caused by damaged sewer line	Household owners are advised to keep distance from the sewer line; traffic cones to be used	High	WMD personnel		Procured
7	Exposure to raw sewage due to overflow of SMH caused by damaged sewer line (pathogen)	Provide high quality PPE to protect personnel from direct contact with raw sewage (W2)	High	Logistics		Procured
9	Exposure to raw sewage due to overflow of SMH caused by high rainfall	Conduct unclogging of SMH for reported incidences	High	WMD maintenance	None	For implementation
11	Exposure to raw sewage due to overflow of SMH caused by high rainfall (pathogen)	Provide high quality PPE to protect personnel from direct contact with raw sewage (W2)	High	Logistics		Procured

MWSI = Maynilad Water Services, Inc., PPE= personal protective equipment, SMH = sewer manhole, SSP = sanitary safety planning, VWRF = Veterans Water Reclamation Facility, W2 = exposure category for vacuum truck operator, WMD = Waste Management Division.
Source: Maynilad Water Services, Inc.

Table 4.2: Excerpts from the Sanitation Safety Planning Improvement Plan for Baliwag Water District–Septage Treatment Plant

Hazardous Exposure Event	Improvement Action	Priority	Effectiveness in Reducing the Risk	Responsible Person/ Agency	Estimated Cost	Status
Sanitation Step: P4. Disposal of Trash by Municipal Trash Collector						
Exposure to washed trash due to contact during disposal	Disinfection of trash (washing with disinfectant solution)	High – immediate implementation	No quantified data but will have important positive effects	BWD SSP team	~ P2,000 per month	For implementation
	Coordination with the LGU to provide the garbage collectors with proper tools and PPE	High – immediate implementation	No quantified data but will have important positive effects	BWD SSP team, MHO	Minimal	For coordination with the LGU

BWD = Baliwag Water District, LGU = local government unit, MHO = Municipal Health Office, PPE = personal protective equipment, SMP = septage management plan, SpTP = septage treatment plant, SSP = sanitary safety planning.
Source: Baliwag Water District.

5. STEP 5: MONITOR CONTROL MEASURES AND VERIFY PERFORMANCE

5.1. DEFINE AND IMPLEMENT OPERATIONAL MONITORING

Operational monitoring is the routine monitoring of parameters that can be measured quickly through rapid testing or simple observations and measures. It provides real-time feedback on whether the system is working properly; and if not, enumerates the necessary corrections that must be undertaken as quickly as possible.

In choosing monitoring points, the control of the highest risks must be prioritized. The following aspects should be identified for each monitoring point (WHO 2015, p. 71):

- parameter (measured or observed)
- method of monitoring
- frequency of monitoring
- who will monitor
- critical limit
- action when critical limit is exceeded

Sample operating monitoring plans are provided in this section. Table 5.1 shows the operating monitoring plan for MWSI for the collection of sewer, desludging and transport of septage, treatment of sewage and septage, and processing of biosolids. Table 5.2 shows a sample operational monitoring overview plan prepared by the BWD SSP team, summarizing the control measures that need to undergo detailed operational monitoring. Table 5.3 summarizes the BWD operational monitoring plan.

Table 5.1: Operational Monitoring Plan for Maynilad Water Services, Inc.–Veterans Water Reclamation Facility

Operational Monitoring Plan of Maynilad Water Services, Inc., for Monitoring Operational Procedure on Collection, Transport, Treatment of Raw Septage and Sewage, and Disposal of End Products/By-Products				
Operational Limit	**Operational Monitoring Control Measure: Compliance with Operational Procedures, Work Instructions, and ESH Guidelines**		**Corrective Action**	
100% Compliance with Operational Procedures, Work Instructions, and ESH Guidelines	What is monitored?	Practice and procedure	What action should be undertaken?	- Verbal reminder -Issuance of System Improvement Request (SIR) form
	How is it monitored?	Observation, inspection, and review of submitted accomplishment report		
	Where is it monitored?	On site	Who undertakes the action?	-On-site PCO -On-site Safety Officer -Plant Head/ Supervisor
	Who monitors it?	-On-site PCO -On-site Safety Officer -Desludging Officer -Plant Head/Supervisor	When should it be undertaken?	Within 1–3 days

ESH = environment, safety, and health, MWSI = Maynilad Water Services, Inc., PCO = Pollution Control Officer, VWRF = Veterans Water Reclamation Facility, WMD = Wastewater Management Division.
Source: Maynilad Water Services, Inc.

Table 5.2: Operational Monitoring Overview Plan for Baliwag Water District–Septage Treatment Plant

Sanitation Step	Control Measures to Have a Detailed Operational Monitoring Plan
P1 Septic Tank of BWD Concessionaires	
P1 1. Opening of septic tank	Wearing of proper PPE
	Strict implementation of safety and hygiene practices
	Technical procedures
P1 2. Desludging	Wearing of proper PPE
	Strict implementation of safety and hygiene practices
	Technical procedures
P2 Treatment of Raw Septage	
P2 A. Primary Treatment	Wearing of proper PPE
	Technical procedures
	Strict implementation of safety and hygiene practices
	Flow rate of septage unloading
P2 B. Secondary Treatment	Wearing of proper PPE
	Strict implementation of safety and hygiene practices
	Proper sampling device
	Inspection of machinery and other fittings

BWD = Baliwag Water District, PPE = personal protective equipment, SpTP = septage treatment plant.
Source: Baliwag Water District.

Table 5.3: Excerpts from the Sanitation Safety Planning Operational Monitoring Plan for Baliwag Water District–Septage Treatment Plant

BWD SSP Operational Monitoring Plan				
Operational Monitoring Plan for	**P1. Septic Tanks of BWD Concessionaire Monitoring of Wearing Proper PPEs and Compliance with SOP and Safety and Hygiene Practices During Opening of Septic Tanks**			
Operation Limit	What is monitored	Wearing of proper PPEs Compliance with SOP and safety and hygiene practices	Corrective Action when the Operational Limit is Not Met	
100% Compliance with Wearing of Proper PPEs, SOP, and Safety and Hygiene Practices			What Action is to be taken	Conduct cause investigation and take action as per identified cause, i.e., Refresher on SOP and safety and hygiene practices Verbal reminder
	How it is monitored	Random site inspection		
	Where it is monitored	On site	Who Takes The Action	PCO
	Who monitors it	PCO	When it is Taken	Within 1–2 days
	When it is monitored	Site Inspection at least once a week	Who Needs to be informed of the Action	Concerned personnel

BWD = Baliwag Water District, PPE = personal protective equipment, PCO = Pollution Control Officer, SOP = special operating procedure, SpTP = septage treatment plant, SSP = sanitary safety planning,
Source: Baliwag Water District.

5.2. VERIFY SYSTEM PERFORMANCE

The purpose of verification monitoring is to determine the compliance of the system design parameters and/or whether the system complies with the specified requirements. Verification monitoring must be carried out periodically to show that the system is working as designed. This type of monitoring generally requires more complicated forms of analysis than operational monitoring. As with operational monitoring parameters—in this case the method, frequency, entity responsible, critical limits, and corrective action—the critical limits that are exceeded must also be identified. However, there will be fewer verification monitoring points and they will focus on the end-points of the system such as effluent quality, microbial and chemical testing of produce and soil, and the health of exposed groups.

Sample verification monitoring plans are provided in this section. Tables 5.4 and 5.5 provide plans prepared for the septage and sewage treatment plant of MWSI and for the BWD septage treatment plant.

Table 5.4: Sanitation Safety Planning Verification Monitoring Plan for a Combined Sewage and Septage Facility (MWSI-VWRF)

Sanitation Step	SSP Verification Monitoring Plan				
	What	**Limit**	**When**	**Who**	**Method of Monitoring**
Effluent Discharge	Quality of effluent to be used for irrigation and reused for farming	DENR AO-35	Monthly	WMD – Process Control and Monitoring Unit	Sampling and testing
	Quality of end-product to undergo vermiculture	TCLP limit	Annually	Third-party service provider	
Sludge Cake Disposal	Quality of sludge cake to be disposed	TCLP limit	Annually	Third-party service provider	Sampling and testing
		Microbial Limit: Helminth eggs <1/g total solids *E. coli* <1,000 g/total solids	Quarterly	CQESH – Central Laboratory Department	

CQESH = corporate quality, environment, safety, and health; DENR AO = Department of Environment and Natural Resources Administrative Order; MWSI = Maynilad Water Services, Inc.; VWRF = Veterans Water Reclamation Facility; TCLP = toxicity characteristic leaching procedure; WMD = Wastewater Management Division.
Source: Maynilad Water Services, Inc.

Table 5.5: Sanitary Safety Planning Verification Monitoring Plan for a Septage Facility (BWD-SpTP)

<table>
<tr><th rowspan="2">Sanitation Step</th><th colspan="5">SSP Verification Monitoring Plan</th></tr>
<tr><th>What</th><th>Limit</th><th>When</th><th>Who</th><th>Method of Monitoring</th></tr>
<tr><td>Septage Collection, Treatment</td><td>Workers health status</td><td>No sanitation-related illnesses/ diseases</td><td>Yearly</td><td>BWD</td><td>Checking of Medical Report</td></tr>
<tr><td rowspan="6">Septage Treatment</td><td rowspan="6">Quality of treated water</td><td>pH 6.5–9.0
Color<150 PCU
Turbidity <2 NTU
Total suspended solids <70 mg/l
Free chlorine 0.05–0.10 mg/l</td><td>Daily</td><td rowspan="2">BWD</td><td rowspan="6">Sampling and testing</td></tr>
<tr><td>BOD, COD, settleable solids</td><td>Weekly</td></tr>
<tr><td>DENR AO-35
Conventional and other pollutants</td><td rowspan="2">Annually</td><td rowspan="4">BWD/ third-party laboratory</td></tr>
<tr><td>E.coli ≤10,000 MPN/100 ml)</td></tr>
<tr><td>DENR AO-35
Toxic and other deleterious substances</td><td>Annually</td></tr>
<tr><td>Helminth eggs ≤1/liter</td><td>Every 2 months</td></tr>
</table>

BOD = biochemical oxygen demand, BWD = Baliwag Water District, COD = chemical oxygen demand, DENR AO = Department of Environment and Natural Resources Administrative Order, mg/l = milligram per liter, MPN = most probable number, ml = milliliter, NTU = nephelometric turbidity unit, PCU = platinum-cobalt unit, SMP = sanitation management plan, SSP = sanitation safety planning, SpTP = septage treatment plant.
Source: Baliwag Water District.

5.3. AUDIT THE SYSTEM

Auditing ensures that the SSP is still having a positive outcome by checking the quality and effectiveness of the SSP process. It checks and evaluates whether the activities enumerated during the SSP are being carried out in practice and records are kept where required. Internal, regulatory, or independent auditors do the assessment.

The following questions should be considered when conducting an audit (WHO 2015, p. 78):

- Have all significant hazards and hazardous events been identified?
- Have appropriate control measures been included?
- Have appropriate operational monitoring procedures been established?
- Have appropriate operational or critical limits been defined?
- Have corrective actions been identified?
- Have appropriate verification monitoring procedures been established?
- Have those hazardous events with the most potential for problems to human health been identified and appropriate action taken?

Tips and Lessons Learned: Step 5 – Monitor Control Measures and Verify Performance

This step confirms that the sanitation system is performing as designed through the identification and continuous and periodic monitoring of the control measures. It is important that control measures are time bound; the responsible persons/units are identified; the critical limits (based on legal/statutory, applicable standards, guidelines, etc.) are known; and the acceptable methods (sampling, testing, etc.) are specified.

The choice of control measures for continuous operational monitoring and periodic verification monitoring is important, and so is the special operating procedure when the limits for control measures are exceeded.

Continuous operational monitoring control measures should be relatively easy to measure in order to provide quick real-time feedback, especially about components that exhibit the highest risk. Periodic verification monitoring control measures are relatively fewer and harder to obtain than operational monitoring control measures. Verification monitoring determines whether the system complies with design parameters and/or specific requirements. The focus is usually on the end products (reclaimed water, biosolids, etc.).

In addition to operational and verification monitoring, the SSP improvement plan should be reviewed/audited to assess its effectiveness. The review/auditing could be done by an internal auditor. It could also be done by an external regulatory or independent auditor. For example, BWD's plan will be audited by local and national government regulators.

6. STEP 6: DEVELOP SUPPORTING PROGRAMS AND REVIEW PLANS

6.1. DEVELOP SUPPORTING PROGRAMS AND IMPLEMENT MANAGEMENT PROCEDURES

6.1.1. Supporting Programs

Supporting programs reinforce SSP indirectly and are necessary for the proper operation of the control measures. A key aspect is communication of health issues with the stakeholders. Examples of supporting programs are (WHO 2015, p. 89):

- Training programs for staff
- Presentation of evidence and results to public and institutional stakeholders
- Awareness raising and training for key exposure groups to improve compliance for control measures that require behavior change
- Provision of incentives or penalties linked to compliance
- Routine maintenance programs
- Public awareness campaigns
- Research programs to support key knowledge or evidence gaps
- Tools for managing the actions of staff such as quality assurance systems
- Lobbying for an appropriate SSP enabling environment
- Engaging stakeholders in SSP

The supporting programs for MWSI are shown in Table 6.1. It also shows the groups responsible for the various programs. Excerpts from BWD supporting programs are provided in Table 6.2.

Table 6.1: Maynilad Water Services, Inc. Sanitation Safety Planning Supporting Programs

SSP Supporting Program	Group Responsible
Conduct of health forum for the employees on proper hygiene	Health Management Department (HR Division)
Yearly evaluation and accreditation of service providers (for treatment of biosolids)	Procurement Department (Logistics Division)
Review of existing environment, safety, and health–related operational procedures and work instructions	Corporate QESH Division
Training on emergency response, hazardous waste handling, and chemical handling	Environmental Management Department, Safety Department (Corporate QESH Division)
Annual review of the sanitation and sewerage system	Wastewater Management Division

HR = human resources; QESH = quality, environment, safety, and health; SSP = sanitation safety planning.
Source: Maynilad Water Services, Inc.

Table 6.2: Excerpts from Baliwag Water District Sanitation Safety Planning Supporting Programs

SSP Supporting Programs
Formulation and implementation of quality management system
Semiannual internal quality audit
Annual external audit by the Department of Health
Annual revisit/review of the sanitation system
Public information, education, and communication (health and environmental risks from using reclaimed water, sludge as soil conditioner, and biosolids from vermicomposting)
Training programs on emergency response; hazardous waste and chemical handling seminar
Training for microbial analysis
Survey of farmers' health status
Conduct of quarterly assembly meeting of the SSP team
Coordination with the Department of Agriculture regarding research to determine the maximum permissible limits for various soil and grass contaminants found in green spaces and agricultural areas, particularly heat-resistant coliforms and parasites.

SSP = sanitation safety planning.
Source: Baliwag Water District.

6.1.2. Management Procedures

Management procedures are written instructions that describe (i) the steps or actions to be taken during normal operating conditions, and (ii) corrective actions when operational monitoring parameters reach or breach operational limits. These are often called standard operating procedures (SOPs). Emergency management procedures can also be developed.

All systems require instructions on how to operate the system. If operational and emergency protocols are already in place but have no formal supporting document, the SSP team should recommend the development of manuals for management of the sanitation system. Such manuals are based on information and data acquired from documenting existing and best practices within the system. Examples of management procedures are (WHO 2015, p. 88):

- Operation and maintenance schedules
- Procedures for all aspects of treatment of the system (e.g., screening aeration, filtration, and chlorination)
- Operational monitoring procedures
- Procedures related to managing sanitation system inputs
- Schedules and procedures to monitor wastewater quality and reuse application, and statutory requirements.

Tips and Lessons Learned: Step 6 – Develop Supporting Programs and Review Plans

After undertaking Steps 1 through 5, the sanitation safety planning (SSP) team should have identified certain needs to strengthen the individual and organizational capabilities in order to achieve the objectives of the SSP. For instance, this may involve formulating standard operating procedures (SOPs), modifying certain SOPs, trainings, etc. Maynilad Water Services, Inc. and Baliwag Water District already have supporting programs on emergency response, information dissemination, etc.

SSP should be undertaken periodically, or as the need arises. Periodic review allows improvement, changes to SOPs, integration of new knowledge, etc. Documentation is a key ingredient in the review and update of SSP. It provides a record as to what transpired since then. The capacity and SOPs for documentation should be strengthened in preparation for the next cycle of SSP.

6.2. REVIEW AND UPDATE SANITATION SAFETY PLANNING OUTPUTS

The SSP team should review the SSP outputs regularly and systematically. Reviews should take into account any improvements made, changes in operating conditions, and any new evidence of health risks relating to the sanitation systems. In addition to periodic programmed reviews, the SSP should also be assessed under the following special circumstances (WHO 2015, p. 87):

- After an incident, emergency, or near accident
- After improvements or significant change in the system
- After an audit or evaluation to incorporate its findings and recommendations.

Tips and Lessons Learned: Duration, Cost, and Importance of Sanitation Safety Planning

The lead organization should allow 3–6 months to complete the sanitation safety planning (SSP). The process took Maynilad Water Services, Inc. and Baliwag Water District 6 months on an intermittent basis. The support provided for the two SSP pilots cost $50,000, arguably a reasonable cost considering the widespread benefits.

In the SSP process, hazards and risks are identified. Control measures are identified and incorporated in the improvement. Before any occurrence of hazardous events, the problem has long been identified and controlled, preventing any catastrophic problem for the public in the future.

REFERENCES AND RELATED LITERATURE

American Public Health Association, American Water Works Association, and Water Environment Federation. 1992. *Standard Methods for the Examination of Water and Wastewater. 18th Edition*. Washington, DC: American Public Health Association.

American Water Works Association, CaliforniaNevada Section. 1997. *Guidelines for the Onsite Retrofit of Facilities using Disinfected Tertiary Recycled Water*.

Barnett, H., and A.W. Ormiston. 2007. *Manual for On-site Wastewater Design and Management: Technical Report to Support Policy Development*. Report No: 2007/EXT/778. Horizons Regional Council, Palmerston North, New Zealand.

Bartram, J., L. Corrales, A. Davison, D. Deere, D. Drury, B. Gordon, G. Howard, A. Rinehold, and M. Stevens. 2009. *Water Safety Plan Manual: Step-by-step Risk Management for Drinking-water Suppliers*. Geneva: World Health Organization.

Blakemore, R.J. 1995. *The Use of Earthworm for Bioconversion of Sewage Sludge and Municipal Waste: a Synopsis of Relevant Literature*. Canberra: ACT Department of Urban Services Waste Department.

Dyer, S.D., C. Peng , D. C. McAvoy, N. J. Fendinger, P. Masscheleyn, L. V. Castillo, and J. M. U. Lim. 2003. The Influence of Untreated Wastewater to Aquatic Communities in the Balatuin River, the Philippines. *Chemosphere*. 52. pp. 43–53. (www.elsevier.com/locate/chemosphere)

Grand Traverse County. 2006. *Septage Treatment Facility Operating Plan*. Traverse City, MI.

Magtibay, B. 2006. Philippine Regulations on Sanitation and Wastewater Systems. *Biosphere Environment and Health System Series*. Volume 2. (www.itnphil.org.ph)

Mahvi, A.H. 2008. Sequencing Batch Reactor: A Promising Technology in Wastewater Treatment. Iran. *J. Environ. Health Sci. Eng*. 5 (2). pp. 79–90.

Maynilad Water Services, Inc. 2006. *Project Description/Initial Environmental Examination: Project 7 Sewage and Septage Treatment Plant, St. Anthony Village, Project 7, Quezon City*. (E1288, v 9).

Metcalf and Eddy, Inc. 1991. *Wastewater Engineering; Treatment, Disposal and Reuse. Third Edition*. Revised by G. Tchobanoglous and F.L. Burton. New York: McGraw-Hill, Inc.

New Hampshire Department of Environmental Services. 2006. *Septage Hauling in New Hampshire. Environmental Fact Sheet.WD-WEB-11*. Concord, New Hampshire. (http://www.des.nh.gov)

New York City. *New York City's Wastewater Treatment System*. Department of Environmental Protection, New York. (Undated).

New York City. *NYC Green Infrastructure Plan: A Sustainable Strategy for Clean Waterways*. New York. (Undated).

Nova Scotia Environment and Labour. 2006. *Guidelines for the Handling, Treatment and Disposal of Septage*. Halifax, Nova Scotia.

Pan American Health Organization (PAHO). *Sanitation Safety Plan Manual: Risk Management Guide for the Safe Use of Domestic Wastewater in Latin America.* (Undated). (http://www.bvsde.paho.org/documentosdigitales/bvsde/texcom/sct/052378.pdf)

Shahmansouri, M.R., H. Pourmoghadas, A.R. Parvaresh, and H. Alidadi. 2005. Heavy Metals Bioaccumulation by Iranian and Australian Earthworms (*Eisenia fetida*) in the Sewage Sludge Vermicomposting. *Iranian J. Env. Health Sci. Eng.* 2(1). pp. 28–32.

Shalavi, M. 2006. Vermicomposting of Faecal Matter as a Component of Source Control Sanitation. Dem promotionsausschuss der Technischen Universitat Hamburg-HarburgzurErlangung des akademischen Grades Doktor-Ingenieurvorgelegte Dissertation.

Sinha, R.K, S. Herat, GokulBharambe, and A. Brahambhatt. 2009. *Vermistabilization of Sewage Sludge (Biosolids) by Earthworms: Converting a Potential Biohazard destined for Landfill Disposal into a Pathogen-free, Nutritive and Safe Biofertilizer for Farms*. (http://wmr.sagepub.com)

Swanson, R.L., M. L. Bortman, T. P. O'Connor, and H. M. Stanford. 2004. Science, Policy and the Management of Sewage Materials: The New York City Experience. *Marine Pollution Bulletin*. 49. pp. 679–687.

Tanji, K.K. 1990. Nature and Extent of Agricultural Salinity. InAgricultural Salinity Assessment and Management, edited by K.K. Tanji. *ASCE Manual and Reports on Engineering Practices*. 71. pp. 1–41.

United States Department of Defense. 1997. *Wastewater Treatment System Design Augmenting Handbook* (MIL-HDBK-1005/16). Washington, DC.

United States Department of Labor, Occupation Safety and Health Administration (OSHA). *Occupational Safety and Health Standards (Part 1910)*. (www.osha.com)

United States Department of Labor, Occupation Safety and Health Administration (OSHA). *Safety and Health Regulations for Construction (Part 1926)*. (www.osha.com)

United States Environmental Protection Agency (EPA). 1983. *Process Design Manual for Land Application of Municipal Sludge*. EPA 625/1-83-016. Center for Environmental Research Information, Cincinnati, OH.

———. 1994. *Guide to Septage Treatment and Disposal*. (EPA/625/R-94/002). Washington, DC: Office of Research and Development.

———. 1995. *A Guide to the Biosolids Risk Assessment for the EPA*. (EPA/B32 -B-93-005). Washington, DC: Environmental Protection Agency, Office of Wastewater Management.

———. 2003.Technical Background Document for the Sewage Sludge Exposure and Hazard Screening Assessment. Office of Water.

———. 2004. *Guidelines for Water Reuse* (EPA/625/R-04/108). Washington, DC: Municipal Support Division Office of Wastewater Management Office of Water; US Agency for International Development; Technology Transfer and Support Division National Risk Management Research Laboratory Office of Research and Development.

———. Region VIII. *Biosolids Management Handbook* (Parts 1-4). Denver, CO.

Water Environment Foundation. 2014. *Nutrient Roadmap* (Version 1). Alexandria, VA. (www.wef.org)

World Health Organization (WHO) 2006. *Guidelines for the Safe Use of Wastewater, Excreta and Greywater: Policy and Regulatory Aspect* (Vol.1). Geneva.

———. 2006. *Guidelines for the Safe Use of Wastewater, Excreta and Greywater: Wastewater Use in Agriculture* (Vol.2). Geneva.

———. 2006. *Guidelines for the Safe Use of Wastewater, Excreta and Greywater: Wastewater and Excreta Use in Aquaculture* (Vol.3). Geneva.

———. 2006. *Guidelines for the Safe Use of Wastewater, Excreta and Greywater: Excreta and Greywater use in Agriculture* (Vol.4). Geneva.

———. 2015. *Sanitation Safety Planning: Manual for Safe Use and Disposal of Wastewater, Greywater and Excreta*. Geneva. (www.who.int)

A Guide to Sanitation Safety Planning in the Philippines
Step-by-step Risk Management for Safe Reuse and Disposal of Wastewater, Greywater, and Excreta

Sanitation safety planning is a preventive risk management approach that identifies potential risks that may arise during the operation of a sanitation system, including waste collection, transportation and conveyance, treatment, disposal, and reuse. After the highest priority risks have been identified, an incremental improvement plan establishes control measures to ensure that no one in the sanitation chain is exposed to the hazards related to wastewater, greywater, and excreta. This guide describes a six-step process for sanitation safety planning in the Philippines, based on the experiences of pilot projects by two water service providers, Baliwag Water District and Maynilad Water Services, Inc.

About the Asian Development Bank

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to a large share of the world's poor. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

ASIAN DEVELOPMENT BANK
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
www.adb.org