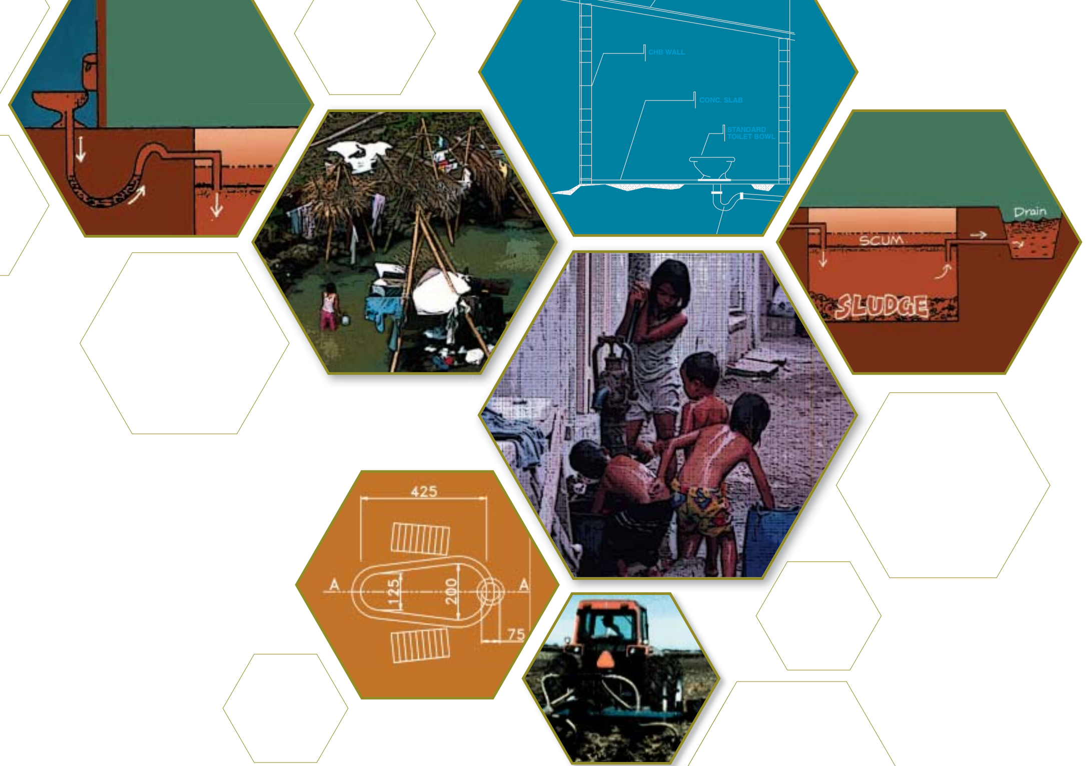

PHILIPPINES SANITATION SOURCEBOOK AND DECISION AID

ABBREVIATIONS

BOD – biochemical oxygen demand

C – Carbon
CHB – concrete hollow blocks
CI – cast iron
cm. – centimeter(s)
Conc. – concrete

DA – Department of Agriculture
DAO – Department Administrative Order
DENR – Department of Environment and Natural Resources
DN – nominal diameter
dia - diameter
DO – dissolved oxygen
DOH – Department of Health
DPWH – Department of Public Works and Highways

Ecosan – ecological sanitation
EIA – environmental impact assessment

$FeCl_3$ – Ferric chloride
ft. – foot/feet
F/M – food to microorganism

GI – galvanized iron

ha – hectare(s)
hp - horsepower

kg. – kilogram(s)
km. – kilometer(s)
LGU – local government unit
m. – meter(s)
mg/l – milligram(s) per liter
MLSS – mixed liquor suspended solids
MLVSS – mixed liquor volatile suspended solids
mm. – millimeter(s)
m^3 – cubic meter(s)

N – Nitrogen

P or Php – Philippine peso
PD – Presidential Decree
PVC – polyvinyl chloride
RBC – rotating biological contactor
RC – reinforced concrete

SBR – sequencing batch reactor
SOP – standard operating procedure
sq.m./m^2 – square meter(s)

TSS – total suspended solids

UASB – upflow anaerobic sludge blanket
UDDT – urine diversion dehydration toilet
US EPA – United States Environmental Protection Agency
UV – ultraviolet

°C – degrees Celsius
% – percent

FOREWORD

Inadequate sanitation threatens the sustainability of the Philippine environment and the health of Filipinos. Twenty-five Filipinos die of diarrhea everyday and sanitation-related epidemics have broken out over the last few years in low income communities. Water quality monitoring assessments show that pollution of water is a direct result of the lack of sanitation facilities. This results in over Php 67 billion in estimated annual losses to the economy in avoidable health care costs and losses in tourism and fisheries receipts.

The Philippines Clean Water Act (R.A 9275), passed last year, is a quintessential piece of legislation that was designed to address the interlinked problems of water quality, pollution prevention and control and sanitation. The law calls for a comprehensive and integrated approach to water management and overturns the prevailing policy that sanitation is merely a household responsibility. It directs national and local governments to work together in ensuring adequate provision of municipal sanitation systems. It calls for a strategic approach to planning and managing water resources within a basin, which includes the institution of systems and regulations related to wastewater management. It complements other laws and policies, such as the Sanitation Code (PD 856), already in place for many years.

One of the key sector limitations, however, is the gap in knowledge and experience among policy-makers and the handful of sanitation practitioners, both at national and local levels, on strategic sanitation planning and alternative options for sanitation, wastewater collection and treatment. Between the on-site combination of a toilet and septic tank system and the traditional sewerage and treatment systems, a vacuum of information exists on other options available and their relative performance. Information on the sanitation and wastewater management requirements of varying types of communities and user-enterprises is also lacking. These missing pieces of information are necessary to underpin strategic sanitation planning.

This Sanitation Sourcebook is a first attempt at addressing the gap in information about sanitation and wastewater management, as well as about the considerations related to planning for sanitation projects in different types of environment. It distills some of the core concepts of sanitation in a user-friendly format so that the book can serve as a practical reference to sanitation professionals and investment decision-makers, particularly the local governments.

In putting together this important reference, the Government of the Philippines has been supported by the Water and Sanitation Program – East Asia and the Pacific of the World Bank, the German Technical Cooperation Agency and the Government of Australia. Their support and guidance, along with those of the peer reviewers who have contributed professionally to this book, are much appreciated. We look forward to the application of the knowledge embodied in this book towards the improvement of sanitation throughout the country.

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FOREWORD

Sanitation presents one of the most significant service delivery challenges related to poverty alleviation and sustainable development in the Philippines. A review of the urban sewerage and sanitation sector through the Water Supply and Sanitation Performance Enhancement Project (WPEP) confirmed the prolonged lack of investment in the sector and the deteriorating quality of sewerage and on-site sanitation facilities throughout the Philippines. Except in parts of Metro Manila and a handful of cities, the lack of sewerage and other sanitation services leaves the population with few options for safe excreta and wastewater disposal.

High hygiene awareness among urban and rural residents, even among the poor, is not translated to effective demand or health-benefiting practices due in part to the sheer lack of options to improve their access to sanitation services. Financing conventional sanitation improvements is viewed by local governments and enterprise managers to be too expensive and beyond their reach.

Consequently, an overwhelming majority are excluded from service, while affluent and middle income urban residents depend on self-provided toilet and septic tank systems. Exclusive housing estates and other commercial establishments sometimes invest in independent sewerage and communal septic tank systems. But dependence on self-provision results in a reduction of the potential revenue base of sanitation service providers. In addition, the efficacy of such systems is not monitored well and, in many cases, offer only inadequate primary treatment of wastewater. The poor have even fewer options.

The Sanitation Sourcebook aims to stimulate effective demand for sanitation services by presenting tools for strategic decision-making around a wider range of more affordable sanitation options. It also hopes to stimulate informed investment decisions by local governments to ensure more sustainable outcomes. Thus, it features environment-friendly and affordable decentralized solutions.

Interest in sanitation and information on such solutions were demonstrated during the highly successful 1st International Symposium on Low-Cost Technology Options for Water Supply and Sanitation in Bohol in 2004. This event was also jointly organized by our agencies to ignite and facilitate dialogue among stakeholders, users and different donor organizations in the sector.

We, the international support agencies involved in the development of this Sourcebook are very pleased with the ownership of and inputs from the national government agencies that have worked with us on this project, as well as with the strong partnership among the various donors, sanitation professionals in the peer review panel and the Philippine Ecological Sanitation Network, and with the collaborating sanitation investment projects and organizations. Collaboration and partnership have been the mark of this project from its inception, and we hope that this will continue into the future

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This Sourcebook was developed and written through the collaboration of sanitation practitioners in the Philippines and abroad.

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The Sourcebook Project was supported by a team of communications specialists: Ms. Elenida Basug and Ms. Ma Cristina Francisco (EMB DENR), and Ms. Ana Esperanza Ong, Ms. Rosario Nolasco (Editor) and Mr. Yosa Yuliarsa (Water and Sanitation Program – East Asia and the Pacific). The photographs used in this Sourcebook were taken by Radoslaw Janicki, Caroline Van Den Berg, Ulrike LipKow and the staff of Radian Consulting, Inc. This book was designed by Gibug Studio, Jakarta, Indonesia.

The Sourcebook Project Team would like to acknowledge the participation of the local communities and enterprise collaborators interviewed for this Sourcebook, including the Philippine Hospital Association.

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INTRODUCTION

This Sourcebook presents basic concepts on sanitation to help project planners, enterprise managers, local executives and other members of the community assess their situation and make a judgment on appropriate sanitation interventions.

It responds to a need identified during a scoping study to present sanitation and wastewater concepts and technology in a comprehensive, yet simple way.

How to Use this Sourcebook

This Sourcebook is focused on information about low-cost sanitation technology options. Technology is not the only important aspect of a sanitation project. By focusing on this, the Sourcebook does not intend to downplay the role of hygiene and behavior change, nor the need for institutional frameworks that support sustainable financing, operation and management within sanitation projects. The narrow focus of the Sourcebook only seeks to fill a gap considering that there are excellent toolkits and guidebooks already available on broader topics of strategic sanitation and hygiene planning, programming and promotion. A list of these other resources will be found in Annex 3. We encourage readers to use these resources in conjunction with this Sourcebook.

The objective of this Sourcebook is to identify and discuss the factors that need to be considered when deciding on options for sanitation and wastewater technology. The Sourcebook aims to present a range of solutions and help decision-makers assess the various options based on informed choice. A secondary objective of the Sourcebook is expected to stimulate informed demand for sanitation.

The Sourcebook is mainly written for Philippine project planners, but may be useful to community organizers, service providers, sanitation project financiers, environmental and sanitation regulatory officers, other such practitioners, and to communities and users. During project preparation and implementation, readers are advised to seek advice from experts such as civil and environmental engineers, social scientists and finance specialists.

How the Sourcebook is Organized

Chapter 1 is an Introduction to Sanitation Systems. It discusses the objectives of sanitation, basic concepts and components of wastewater and different components of sanitation infrastructure. These concepts serve as basis for understanding the operating principles of different technologies. It helps answer the question, for example, of why pre-treatment is necessary in some cases and not in others. Chapter 1 ends by presenting options spanning the major components of sanitation infrastructure systems and shows their various combinations through a flow chart.

Chapter 2 sets out a decision-making framework to aid project planners assess different options. The chapter starts with a discussion of factors relevant to decision-making. Factors are classified as either restricting or influencing. Restricting variables are conditions that, when present, disallow the use of specific technologies. Influencing variables do not eliminate an option. However, they need to be considered in the design, construction and operation of a system, or they may affect the acceptability of an option to users or project proponents. Thus, influencing factors are distinguished between technical and demand factors. The discussions try to help planners understand why and in what way these factors are relevant and whenever possible, provide for their measure or standard, a description of their usual occurrence or suggest how they can be measured or determined. The factors are given index numbers that relate them to an item in a survey questionnaire or checklist that is proposed to be used as a tool for investigation. The instruments themselves appear in Annex 1.

The chapter then puts forward an iterative approach to decision-making, supported by a series of decision aids. The first step is a process of eliminating technologies that cannot be used because of physical conditions that exist in the project area. A table relates these variables to the technologies and uses the colors green, yellow and red to indicate 'go,' 'proceed with caution,' and 'stop.' This indicates whether the occurrence of a condition rules out an option. The end result of this is a list of potentially feasible options. The second step of the decision process is to compare technologies based on their performance against 13 factors considered to be the most relevant.

The Sourcebook does not put forward a scoring system and makes no final choices for project participants since priorities of stakeholders will vary from case to case.

Chapter 3 presents Typified Community and Enterprise profiles. The Chapter 'typifies' the physical and socio-economic conditions that define the sanitation situation and challenges in two kinds of communities and three enterprises. For this edition, the Sourcebook Project Team chose to feature the following: tenured low-income urban communities, peri-urban coastal communities, medium-sized beach resorts, municipal public markets and secondary hospitals. The source and characteristics of wastewater and critical factors observed to influence demand for sanitation services are described in these profiles.

Sanitation situations vary from place to place and it would be impossible to describe all peculiarities. By typifying situations, the Sourcebook does not intend to replace physical and socio-economic investigations that need to underpin project planning. Indeed its intention is to improve investigations by highlighting issues that might escape the consideration of project planners, users and enterprise owners, community leaders and local government staff who may not have working knowledge of sanitation systems and become entirely dependent or captive to the advice of external parties.

Instruments to aid socio-economic and technical investigations are found in Annex 1.

Chapter 4 is a compilation of 23 selected low-cost sanitation options presented in Sanitation Technology Sheets. It presents options under each component of sanitation infrastructure. The sheets feature the components, basic operating principles, application, efficiency, costs and advantages and disadvantages of the options.

There are four Annexes. The survey instruments for technical and socio-economic investigation are in Annex 1. Annex 2 is a list of organizations that provide information or assistance on sanitation. Annex 3 is a list of selected web-based resources on sanitation and hygiene promotion. A list of credit funding utilities for sanitation projects in the Philippines is shown in Annex 4.

The Glossary provides the definition of terms used in the Sourcebook, particularly technical terms.

Next Steps and Updating

This Sourcebook is the first attempt to provide basic and simplified information on sanitation. The intention is to test its applicability by dissemination to local governments and through various sanitation and financing institutions operating in the Philippines.

Comments and feedback are welcome for the improvement of any update edition. Feedback can be sent to the Water and Sanitation Program – East Asia and the Pacific through the Country Team Leader in the Philippines. Follow the contact links from this website: www.wsp.org

CHAPTER 1
INTRODUCTION TO SANITATION SYSTEMS

Sanitation refers to the hygienic and proper management, collection, disposal or reuse of human excreta (feces and urine) and community liquid wastes to safeguard the health of individuals and communities.

It is concerned with preventing diseases by hindering pathogens, or disease-causing organisms, found in excreta and wastewater from entering the environment and coming into contact with people and communities. This usually involves the construction of adequate collection and disposal or reuse facilities and the promotion of proper hygiene behavior so that facilities are effectively used at all times.

1.1 Objectives of Sanitation[1]

Sanitation (and hygiene promotion) programs have three primary objectives:

- Improving health conditions
- Promoting dignity of living or enhanced quality of life
- Protecting the environment

The combined positive effects of these conditions lead to wider economic benefits.

Health

Disease-causing organisms in human excreta may find their way into a host and cause diseases. This usually results in diarrhea. In the Philippines, the Department of Health (DOH) estimates that 93 Filipinos suffer from diarrhea every hour and 25 die from it every day. Diarrhea poses such a significant burden and yet it is easily preventable with proper sanitation and hygiene.

Pathogens are transmitted through a number of routes. These routes can be remembered with the acronym, **WASH**:

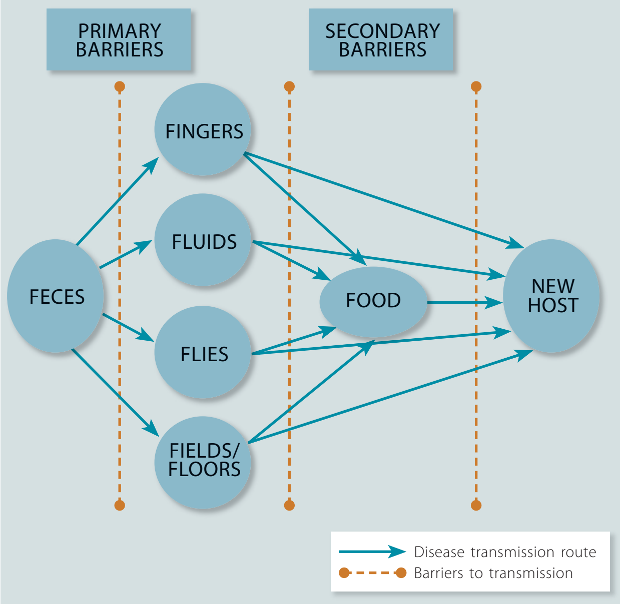
- contamination of **W**ater that we ingest
- spread by **A**nthropods or other insects
- contact (with our feet) through the **S**oil or floor
- contact through our **H**ands

The first three routes are blocked by constructing sanitation facilities that effectively separate excreta from human and animal (including insects) contact and secure against the contamination of drinking water and soils. The last route is barred by proper hygiene practices such as washing hands with soap after defecation or after cleaning up children post-defecation.

1 While this Sourcebook focuses on sanitation, it is important to note that in order to fully achieve these objectives, attention needs to be paid to hygiene, solid waste and drainage management.

The 'F-diagram' shown in the figure below illustrates these same routes as fingers, flies, fields/floor and fluids. The most effective way of reducing transmission of disease is to erect "primary barriers" which prevents pathogens from entering the environment. The "secondary barriers" are practices that prevent the contact or use of the contaminated 4Fs into the food or new host.

Figure 1-1
The F-Diagram



Source: Sanitation and Hygiene Promotion Programming Guidelines (2005), after Wagner and Lanoix

Quality of Life

Research has found that people value sanitation facilities, close to or at the home, more for the resulting privacy, convenience and improvement (sights and smell) of their immediate surroundings than for their health benefits. Personal and environmental cleanliness gives a sense of dignity to people, particularly women. School latrines have been proven to be an essential part of keeping teenage girls and young women at school and enabling them to complete their education.

Environmental Protection

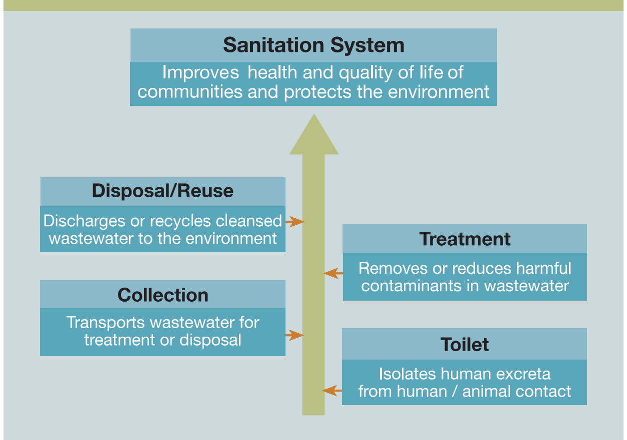
The indiscriminate disposal of wastewater into the environment also results in degradation of surface and groundwater resources. About half of the biological pollution unloaded to Philippine waters comes from untreated domestic wastewater. This depletes the waters of oxygen that is necessary to sustain aquatic life. Investment in sanitation and wastewater facilities can improve the quality of water bodies dramatically.

1.2 Components of Sanitation Infrastructure

Sanitation infrastructure systems generally have four components. These are: *toilet, collection, treatment* and *effluent/sludge disposal and reuse*.

Each or all components can be located *on-site*, meaning close to or at the source of waste generation. On-site systems usually serve a single or small group of households or enterprises. Complete on-site systems, where waste is collected, treated and disposed on-site, are called *decentralized systems*. Components or systems can also be located *off-site* or away from the source of waste generation. *Centralized systems* collect and treat large volumes of waste from households and establishments. The residual waste is then moved to areas located away from the communities.

Figure 1-2
Components of Sanitation Infrastructure



Toilet
The toilet consists of a waste receptacle (bowl) or squatting plate with or without a superstructure. To erect a toilet at home or in a public place is to assign a stationary area for urination and defecation. This prevents the practice of defecating in open areas, which results into a health hazard for the community. Toilets isolate human excreta to prevent direct or indirect transmission of diseases. Toilet bowls that allow the separate collection of urine and feces are called *urine diverting toilets*.

Collection and Conveyance
Collection and conveyance systems transport wastewater for treatment or disposal. Where systems cater to more than one household, the conveyance system receives wastes from many establishments and households. In more conventional systems, waste from the toilet is usually combined with waste from other parts of the house or establishment and carried away through a sewerage system. In emerging alternative systems, such as ecological sanitation systems, waste streams (urine, feces and kitchen/shower) are isolated and stored or conveyed separately.

The *sewerage system* consists of a pit/hole, receptacle vessel and pipe network. Pipe networks can be conventional or simplified. A *conventional sewer* system uses gravity (and sometimes, pumps) to convey wastewater through the network. Pipes must be laid in a continuous incline. The system involves deep trenches and high digging costs.

Simplified sewer (or small bore sewerage) systems operate similarly to their conventional counterpart, but pipe size is significantly reduced and laid in shallower trenches. This is made possible by adding a primary treatment step before conveyance, to separate solids and refine the wastewater that goes into the network. While conventional and simplified sewers transport wastewater only, *combined systems* transport household wastewater plus storm or rainwater. Storm drainage and canals are commonly used as combined systems.

Condominial sewerage, a variation of simplified sewerage, allows sewer pipes to pass through property lots rather than both sides of a street under conventional systems. The shorter grid of smaller and shallower feeder pipes running through the backyards allow shallower connections to the street sewers, effecting significant reductions in cost. In condominial sewerage, sewer pipes have to cross property lots. Property owners need to allow construction and maintenance of the infrastructure within their properties.

Wastewater can also be collected and transported for disposal by *cartage*, which consists of safe manual delivery, using pails, spades and carts. Delivery is also done by vacuum trucks or desludging equipment.

Treatment
Treatment is the process of removing liquid and solid waste, or reducing it to stable, non-polluting matter. A treatment plant is a medium, structure or equipment used for this purpose. The characteristics of wastewater will dictate the treatment process that will be required. There are various methods to address the different types of polluting elements present in wastewater. These elements and processes are discussed in Section 1.4.

Disposal or Reuse
The last component of sanitation infrastructure is

concerned with returning or releasing treated effluent and sludge to the environment. Care should be taken that doing so will not pose a hazard to people and the environment. Disposal can mean discharge to a water body (such as a river), application to land or to the soils, or even release to the atmosphere in the form of gas.

In terms of ecological sanitation, residual elements are not 'disposed' but reused. Wastewater can be safely reused in agriculture, landscape irrigation, aquaculture, and fire fighting. Sludge can be used in agriculture or dried for use as fertilizer. Before its reuse, the quality and safety of the waste should first be established. Incorrect application can cause harm.

1.3 Water-Reliant and Non-Water Reliant Sanitation Systems

In general, sanitation systems are either water-reliant or non-water reliant. *Water-reliant systems* employ water to flush and convey waste through the system and therefore, require a continuous supply of water. *Non-water reliant systems* are those that rely on dry storage and carriage that does not employ water for conveyance. Thus, carriage is usually conducted manually. It does not mean that liquid waste or even, clean water, is not received in the system. A small amount of water may be employed to clean components of a dry system, such as the sitting bowl. A vacuum flush toilet, such as those employed in airplanes, can thus be considered non-water reliant.

1.4 Polluting Components of Wastewater, Impact and Treatment

Wastewater is composed of different elements, some of which are harmful when discharged untreated, in large volumes or in high concentrations and cannot be processed naturally by the environment. The treatment process will differ according to the polluting element contained in the water.

The concentration of different polluting elements will have specific effects on the environment and on humans. The accumulation of solid particles in water results in turbidity or murkiness. Concentration of organic matter in water bodies causes depletion of oxygen and, ultimately, the inability to sustain aquatic life dependent on oxygen. Organic matter also releases foul odors resulting from decay. Nutrients encourage the growth of algae and could lead to eutrophication or excess plant growth, which also reduces the dissolved oxygen in water. Gases in wastewater, such as hydrogen sulfide and ammonia, could be toxic. The same is true for other pollutants such as metals, pesticides, and halogenated compounds. Micro-organisms can cause diseases.

Figure 1-3 illustrates the polluting components of wastewater, their potential impact if discharged untreated, and the applicable treatment process. Table 1-1 discusses this in more detail.

Figure 1-3
Polluting Components of Wastewater, Impact and Treatment

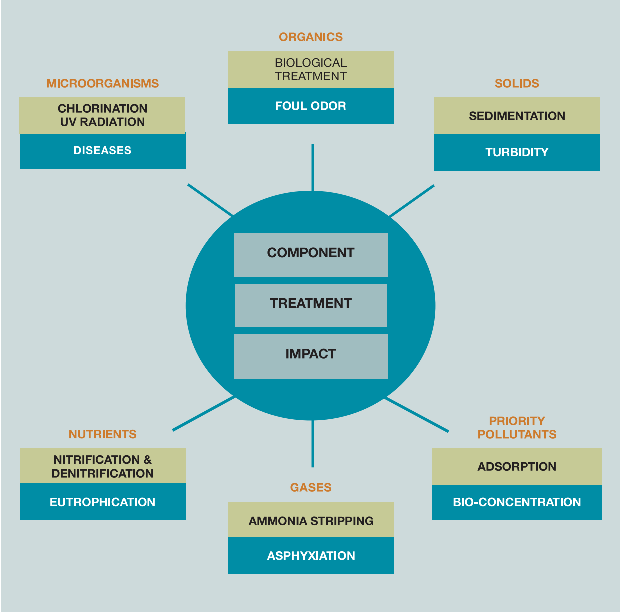


Table 1-1
Polluting Components of Wastewater, Impact and Treatment

POLLUTING COMPONENT		TREATMENT	ENVIRONMENTAL IMPACT (if not treated)
PHYSICAL FRACTION			
SOLIDS	1. Coarse solids, e.g. sand, gravel and large materials, e.g. sticks	Screening, grit removal, comminution	Non-removal of coarse solids may cause damage to pumps, thus impairing the treatment process.
	2. Settleable solids	Sedimentation tanks (septic tanks and clarifiers)	Increase the turbidity of the receiving water body.

	POLLUTING COMPONENT	TREATMENT	ENVIRONTMENTAL IMPACT (if not treated)
SOLIDS	3. Total Solids a. Non-filterable/Suspended (settleable or non-settleable)	Screening, comminution, grit removal, sedimentation filtration, flotation, chemical polymer addition, coagulation, natural systems (land treatment)	1. Leads to the development of sludge deposits and anaerobic conditions when discharged into the receiving environment, thus impairing water quality. 2. Restricts wastewater use for agricultural irrigation or aquaculture. Causes decline in growth and yield of most plants. 3. Total Suspended Solids (TSS) increase: • turbidity which prevents light to pass through and causes fish's gills to get plugged up • silting which reduces lifetime of lakes
	b. Filterable (colloidal or dissolved)	Activated sludge, trickling filters, sand filters, rotating biological contactors, oxidation ditch, sequencing batch reactor, lagoon systems	Impairs water quality of receiving water.
	CHEMICAL FRACTION		
ORGANICS	1. Organics a. Biodegradable organics (protein, carbohydrates, fats)	Activated sludge, trickling filters, rotating biological contactors, lagoon variations, intermittent sand filtration, physical-chemical systems, natural systems	1. Fats increase biochemical oxygen demand. 2. Fat traps trash, plants and other materials, causing foul odors, attracting flies and mosquitoes and other disease vectors. 3. Fats cause septic conditions in ponds and lakes by preventing oxygen in the atmosphere from reaching the water. 4. Higher concentrations of fats and grease can result in poorer effluent quality thus polluting the receiving water body.
	b Refractory organics (surfactants, phenols, agricultural pesticides)	Carbon adsorption, tertiary ozonation, natural systems	-
NUTRIENTS	2. Inorganics a. Dissolved inorganics (calcium, sodium, sulfate) b. Nutrients (nitrogen, phosphorus)	Chemical precipitation, ion exchange, ultrafiltration, reverse osmosis, electrodialysis. For nitrogen: nitrification and denitrification, ammonia stripping, ion exchange, chlorination, natural systems For phosphorus: metal-salt addition (alum, $FeCl_3$) lime coagulation/sedimentation, biological phosphorus removal, biological-chemical phosphorus removal, natural systems	Impairs water quality of receiving water 1. In certain proportions and conditions, these nutrients can give rise to harmful algal blooms. 2. Encourages the growth of algae (eutrophication).
GASES	3. Gases (nitrogen, oxygen, carbon dioxide, hydrogen sulfide, ammonia, methane)	Ammonia stripping, acid and base gas scrubbers, biofilters and soil bed	1. Hydrogen sulfide and ammonia can be toxic and pose asphyxiation hazard. Both gases also emit odors, which can be a serious nuisance. 2. Volatile organics can be toxic to humans and other microorganisms. 3. The formation of nitrogen gas can cause large globs of sludge to overflow, thus polluting the receiving water body.
PRIORITY POLLUTANTS	4. Priority pollutants (metals, non-metals, organic compounds, halogenated compounds, pesticides, herbicides, insecticides)	Chemical precipitation, ion exchange, nanofiltration, reverse osmosis and biological degradation in natural systems and reed beds	1. Some metals and compounds cause mutation, cancer and birth defects. 2. Metals accumulate in fish and plant and can be toxic and/or hazardous.
	BIOLOGICAL FRACTION		
MICRO-ORGANISMS	Micro-organisms classified as: a. protista (bacteria, fungi, protozoa, algae)	Application of copper sulfate, sludge wasting and return	1. Algae covers surface waters since they reproduce rapidly, and affect the quality of water for drinking in terms of taste and odor. 2. Algae affects the value of water for water supply because they cause taste and odor problems. 3. Bacteria can cause sludge bulking resulting in higher suspended solids in the effluent and receiving water body.
	b. plants (ferns, mosses, seed plants, liverworts)	-	-
	c. animals (vertebrates, invertebrates)	-	-
	d. pathogenic organisms (coliforms)	Chlorination, hypochlorination, bromine chloride, ozonation, UV radiation, biological degradation in natural systems	Cause communicable diseases.

1.5 Stages of Treatment

To be able to address these different polluting elements, wastewater might need to undergo several stages of treatment.

Primary treatment involves the separation of solids through sedimentation or settling. Wastewater might be contained in a tank a number of hours to allow solids to settle at the bottom of the tank. Settled solids, called sludge, are then removed or drawn from the tank and further treated.

Secondary treatment, or biological treatment, breaks down organic matter present after primary treatment with the aid of micro-organisms. Aerobic micro-organisms need oxygen to absorb the organic matter from wastewater. Oxygen, therefore, must be continuously introduced or maintained to prevent the depletion of micro-organisms. On the other hand, anaerobic treatment is applied to wastewater with high organic content such as market wastes.

Tertiary treatment focuses on the removal of micro-organisms, nutrients, priority pollutants, and gases. Chlorination and ultraviolet radiation kill micro-organisms. Nitrification and denitrification remove nutrients. Adsorption takes away toxic elements. Ammonia stripping gets rid of gases.

1.6 Effluent Standards

Treatment aims to reduce the effluent output to a quality that conforms to environmental standards. In the Philippines, effluent standards are applied to the final effluent or discharge of treated/untreated wastewater. Water quality standards are based on the classification of the water body that will be the final point of discharge. Selected pertinent portions of the effluent standards are shown in Table 1-2 on the next page.

If final disposal is into soils, effluent quality is applied to the wastewater discharge, while the disposal process must conform to agricultural regulations that may be issued.

1.7 Domestic and Commercial/ Industrial Wastewater

Households produce wastewater from the toilet, bathroom and shower, laundry and kitchen. Wastewater from the toilet includes feces, urine and flushing water.

In this Sourcebook, wastewater streams have been classified using color codes (See Figure 1-4):

- Yellow water – urine only, with or without flushing water
- Brown water – feces only
- Black water – combination of feces and urine, with or without flushing water
- Gray water – wastewater from bathroom, shower, laundry and kitchen

Yellow water contains metabolic wastes, dissolved salts, and a large amount of nutrients and inorganic materials that are expelled by the body. Approximately 90% of the body's total nitrogen, 55% of total phosphorus, and a significant portion of potassium is contained in urine. Yellow water can be a significant source of nutrient for plants. Recognition of this resource is one of the important bases of ecological sanitation.

On the other hand, disease-causing organisms are normally found in large quantities in feces. Hygienic handling of brown water or black water is critical.

Gray water comes from all other sources in the home, such as the shower or bathroom, laundry, or kitchen. It comprises the largest fraction of the total wastewater flow. Generally, gray water has very low nutrient content. Phosphorus content becomes high with the continued use of phosphate-containing detergents for washing clothes. High concentration of solids and organic materials (fat, oil, and grease) in gray water comes from cooking, food waste and kitchen drains.

The characteristics of *domestic* or household wastewater are similar in most homes. Wastewater from beach resorts are also mainly from the kitchen, laundry and showers. Thus, the characteristics of wastewater from beach resorts do not differ from those produced by households, except in volume

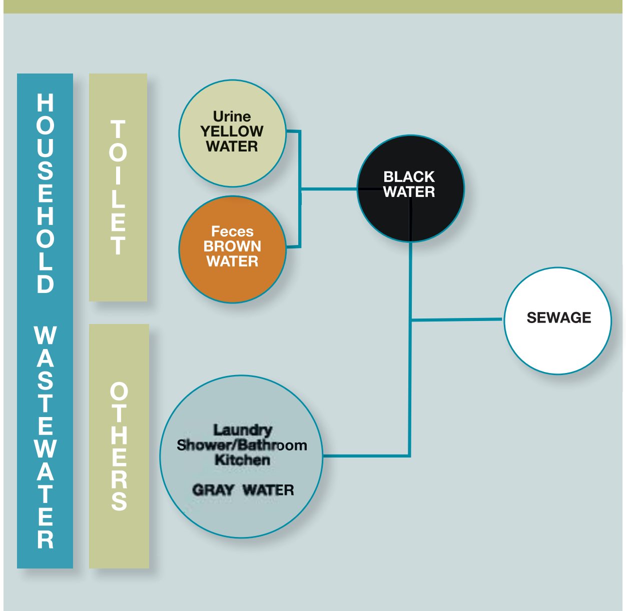
On the other hand, *industrial and commercial wastewater* such as that produced by hospitals and markets is more polluting – with higher organic and solid content – and is sometimes toxic or hazardous. Special treatment processes or *pre-treatment* need to be applied to target these polluting elements and reduce the wastewater to domestic wastewater quality before regular treatment processes can be applied. Sometimes, the separate collection, treatment and disposal of hazardous streams are required, such as from cancer patients treated in chemo-therapy. If wastewater streams from such sources are combined with others, all the wastewater will need to undergo full treatment (primary to tertiary).

Table 1-2
Effluent Standards
(excerpt from DENR DAO #35 Table 2B)

PARAMETER	UNIT	INLAND WATERS (CLASS D)	COASTAL WATERS (CLASS SC)	CLASS SD & OTHER COASTAL NOT CLASSIFIED
Color	PCU	-	(C)	(C)
Temperature °C rise (max rise in deg. Celsius in RBW)		3	3	3
pH (range)		6.0-9.0	6.0-9.0	5.0-9.0
COD	mg / L	200	200	200
5-Day 20°C BOD	mg / L	120	100	120
Total Suspended Solids	mg / L	150	150	(F)
Total Dissolved Solids	mg / L	1,500 (H)	-	-
Surfactants (MBAS)	mg / L	-	10	-
Oil/Grease (Petroleum Ether Extract)	mg / L	-	10	-
Phenolic Substances as Phenols	mg / L		0.5 (I)	1.0
Total Coliforms	MPN/ 100mL	(J)	-	-

(C) Discharge shall not cause abnormal discoloration in the receiving waters outside of the mixing zone.
(F) Not more than 30 mg/L increase (dry season)
(H) If effluent is the sole source of supply for irrigation, the maximum limits are 1,500 mg/L and 1,000 mg/L, respectively, for old industries and new industries.
(I) Not present in concentration to affect fish flavor or taste or tainting.
(J) If effluent is used to irrigate vegetable and fruit crops which may be eaten raw, fecal coliforms should be less than 500 MPN/100 mL.

Figure 1-4
Types of Household Wastewater



1.8 Alternative Approaches to Sanitation Management

In the Philippines, as in many developing countries, very little attention is paid to sanitation. Only 10 of the country's approximately 1,650 towns and cities have sewerage systems, and these are very limited in scope. The majority of the population relies on on-site treatment through septic tanks that are ill-constructed or poorly maintained.

Among the most significant set-backs for sanitation is the high cost of investment and maintenance required for conventional sanitation systems.

In recent times, a number of approaches have emerged in response to these problems. Each of these approaches can be implemented independently or as part of other approaches. What these approaches have in common is that they all try to move away from centralized sanitation management. They use technology that is cheaper to build, operate and maintain, and easier to manage.

Ecological Sanitation

Ecological sanitation, or "**ecosan**", is a new paradigm that aims at the systematic closure of local material flow-cycles. It supposes that rather than being pollutants or waste, local materials can be useful resources. Ecosan is based on an overall view that material flows are part of an ecologically and economically sustainable wastewater management system that can be tailored to the needs of the users and local conditions. The basic principle of ecosan is to close the nutrient loop between sanitation and agriculture.

Ecosan is likewise concerned with the misuse of resources presently dedicated to the collection, conveyance and treatment of wastewater. Under conventional systems, large quantities of clean water, suitable for drinking, are applied for flushing and carriage of dirty water. Significant energy is also used for conveying and treating wastewater in centralized treatment plants that are often electro-mechanized.

Ecosan incorporates the following principles:

1. A conscious effort to conserve resources in the management of sanitation and wastewater
2. Recycling and reuse of waste matter
3. Rendering recyclables from waste (human and animal excreta, gray water) safe for reuse
4. Minimization of the use of energy and water in sanitation and wastewater management
5. Pollution prevention

Ecosan is enhanced by –

1. Collecting the different flowstreams, i.e., urine, feces and gray water separately

2. Non-dilution of waste streams to guarantee high concentration of recyclables

The main objectives of ecosan are:

- reducing the health risks related to sanitation, contaminated water and waste
- improving the quality of surface and groundwater
- improving soil fertility
- optimizing the management of nutrients and water resources

Closing the loop enables the recovery of organics, nutrients, trace elements and energy contained in household wastewater and organic waste and their subsequent productive reuse. Although the reuse focuses predominantly on agriculture, the options are not limited to this application only.

An essential step in this process is the appropriate hygienization and handling of the materials throughout the entire treatment and reuse process. This is done to ensure a satisfactory sanitization of the excrement. Therefore, unlike conventional sanitation systems, ecosan systems not only control the direct hygienic risks to the population but also protect the natural environment. In practice, the commonly applied ecosan strategy of separately collecting and treating feces, urine and gray water minimizes the consumption of valuable drinking water. At the same time, it enables treatment of the separate wastewater flows at low cost for subsequent reuse in soil amelioration, as fertilizer, as service or irrigation water or for groundwater recharge. Ecosan systems restore the natural balance between the quantity of nutrients excreted by one person in one year and that required to produce their food. This is particularly urgent with regard to fresh water and mineral resources. For example, current estimates for phosphorus state that economically extractable reserves will be used up within the next 100 years.

Ecosan does not favor a particular technology. It is a philosophy in recycling oriented resource management and offers modern, convenient, gender-friendly and desirable solutions. Nevertheless, appropriate technologies include urine-diversion toilets, compost toilets, biogas plants, wetland treatment plants, rainwater harvesting, and aquaculture.

Introduction of ecosan to communities will need to be supported by intensive education to correct practices of managing excreta and materials. Particularly for communities accustomed to traditional sanitation systems, significant retooling and possibly, retrofitting of existing facilities will be required.

While a majority of ecosan experiences come from a rural context, it would be incorrect to suppose that ecosan is only applicable in this environment. Ecosan projects could be roughly divided into four types and illustrated in Figure 1-5 below.

Figure 1-5
Four Types of Ecosan Projects

BASIC TYPES OF ECOSAN PROJECTS

Project type / **Characteristics**	**A**  **rural upgrading**	**B**  **urban upgrading**	**C**  **new urban development areas**	**D**  **non-residential (tourism, schools...)**
User of sanitation facilities	household	household/neigborhood	household/neigborhood	tourists, employees, pupils...
User of the end products (Range: in house/other)	household	household (party) / farmer, external user (party)	household (party) / farmer, external user (party)	user - institution (party) / farmer, external user (party)
Level of initiative and decision (min/max)	micro / macro	micro / macro	micro	micro / macro
Considered resources (minimum/optimum)	feces + urine only / plus gray water, rainwater harvesting, organic waste	feces + urine + gray water only / plus rainwater harvesting, stormwater management, organic waste	feces + urine gray water + stormwater management / plus rainwater harvesting, organic waste	feces + urine gray water + stormwater management / feces + urine + gray water + stormwater management
Service provision for operation, transport, treatment and marketing (range in house/other)	household	household / public/private service provider	household / public/private service provider	user institution / public/private service provider

Source: GTZ Ecosan Sourcebook (2004)

Decentralized Wastewater Treatment Systems

Decentralized wastewater treatment systems or **DEWATS**, is a client-centered approach to wastewater treatment, rather than simply a technical hardware package. It aims at introducing and designing the most appropriate combination of wastewater treatment technologies based on the needs of clients, considering their objectives, local conditions and financial means.

DEWATS seeks to involve the user in sanitation and wastewater management as much as possible. Therefore, it combines participatory community/client consultation processes together with expert advice. DEWATS recognizes that one shortcoming of centralized systems is that they often leave users without any control over the provision of service.

The approach tries to avoid utilization of mechanical or energy-dependent parts and imported materials. Emphasis is on the utilization of locally available resources. It recognizes that centralized systems are often expensive to construct and difficult to operate and maintain. Thus, while the hardware introduced in DEWATS is based on standard engineering designs, the system includes only such technologies that are considered suitable for decentralized application, requiring only simple operation and maintenance.

It does not promote "ready-to-install prefabricated" technology. Instead, it uses a modular approach to system design in order to cater to particular needs. DEWATS engineers are trained to determine which modules to combine to deliver the best option for clients, depending on the kind of wastewater to be treated and the desired quality of the wastewater outflow.

The technology DEWATS uses is a combination of anaerobic and aerobic wastewater treatment processes. The use of combined processes allows DEWATS to link and enhance the treatment capacity of each independent stage/module. This addresses the limitations of a specific process when implemented as a stand-alone system. DEWATS uses four anaerobic process modules: bio-digester, septic tank, baffle reactor, and anaerobic filter. There are two aerobic process modules: horizontal gravel filter and pond. These are implemented in combination with any or all of the anaerobic parts.

DEWATS is designed so that maintenance and daily management are reduced to a minimum. However, a trained person is needed to perform and record operation and maintenance. Though minimized, maintenance tasks are still necessary. For example, desludging due to the sludge accumulation in the tank needs to be done at regular intervals (once every two years). Monitoring and removal of scum in the anaerobic chambers, and harvesting of phragmytes plants in the horizontal gravel filter when over-grown are other required maintenance jobs.

DEWATS can be applied to housing settlements, as well as commercial, social and industrial uses, such as hospitals, hotels, universities/schools, slaughter houses, public markets, and food processing facilities.

Septage Management

In the Philippines, a majority of urban dwellings and enterprises rely on septic tanks as the only means of treating their wastewater. Given this, it is important to ensure that septic tanks are operating optimally and that residual waste from septic tanks is managed properly.

Septage management refers to the periodic desludging or removal of septage from septic tanks using vacuum trucks or other desludging equipment, and treatment and disposal of the septage.

Septage is the mix of liquid and solids in a septic tank, which becomes a major source of pollution when it is disposed without effective treatment, either on land or in water bodies.

A septic tank performs primary treatment by separating solids from the wastewater inflow, causing anaerobic decomposition and storage of the accumulated solids. Wastewater is then passed out of the tank as effluent. For effective treatment, the inflowing wastewater needs to be retained in the tank from 24 to 48 hours. With years of usage, solids accumulate and fill the tank such that the retention time of the wastewater becomes shortened. The accumulated solids need to be removed to restore the treatment capability of the septic tank.

Septage has very high BOD (over 10 times that of domestic sewage) and a high solids content. Treatment of septage is required before it is disposed. It can be treated using various methods, including lime stabilization, a mechanized septage treatment facility, or waste stabilization ponds. The supplement to the IRR of Chapter XVII of the Code on Sanitation of the Philippines (P.D. 856) (issued May 2004) states that "it is mandatory that septage and domestic sludge shall be processed and treated prior to disposal." It cites the following treatment techniques:

- Thickening
- Stabilization
- Conditioning
- Disinfection
- Dewatering
- Heat Drying

The current practice in the Philippines is for individual homeowners to have their septic tanks desludged only when they are completely full and overflowing. They pay a private contractor to perform this service. Most, if not all, of these contractors dispose of the septage without treatment. Therefore, cities and municipalities need to develop septage management programs to ensure that the septic tanks are inspected and desludged on a regular basis, perhaps every 3-5 years depending on the size and number of occupants. The proper treatment of septage before disposal also needs to be enforced.

1.9 The Range of Options: Sanitation Technologies and their Combinations

The flowcharts in the following pages present the range of sanitation technology options available and their possible combinations. Sanitation systems, as already discussed, are made up of various components.

Systems vary according to:

- their dependence on water for carriage: systems can either be non-water reliant or water-reliant
- the size of the potential user group: systems can be individual, cluster- or municipal-wide
- their location: systems may be on-site or off-site, or with a combination of on-site and off-site components
- their approach: systems could employ traditional or alternative waste management principles

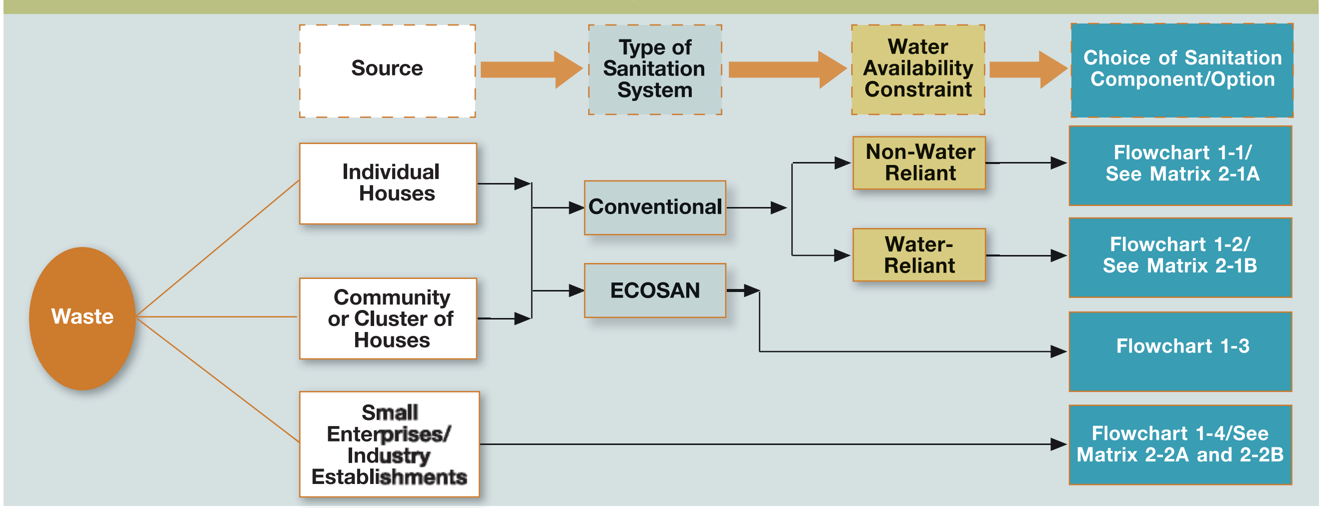
The flowcharts are structured to reflect how options might be combined into the above system classes. To illustrate, each of the flowcharts will reflect these categories of system combinations:

However, to avoid too many permutations, the flowcharts for non-water reliant and water-reliant systems have been separated. **Flowchart 1-1** deals with non-water reliant systems and **Flowchart 1-2** deals with water-reliant systems.

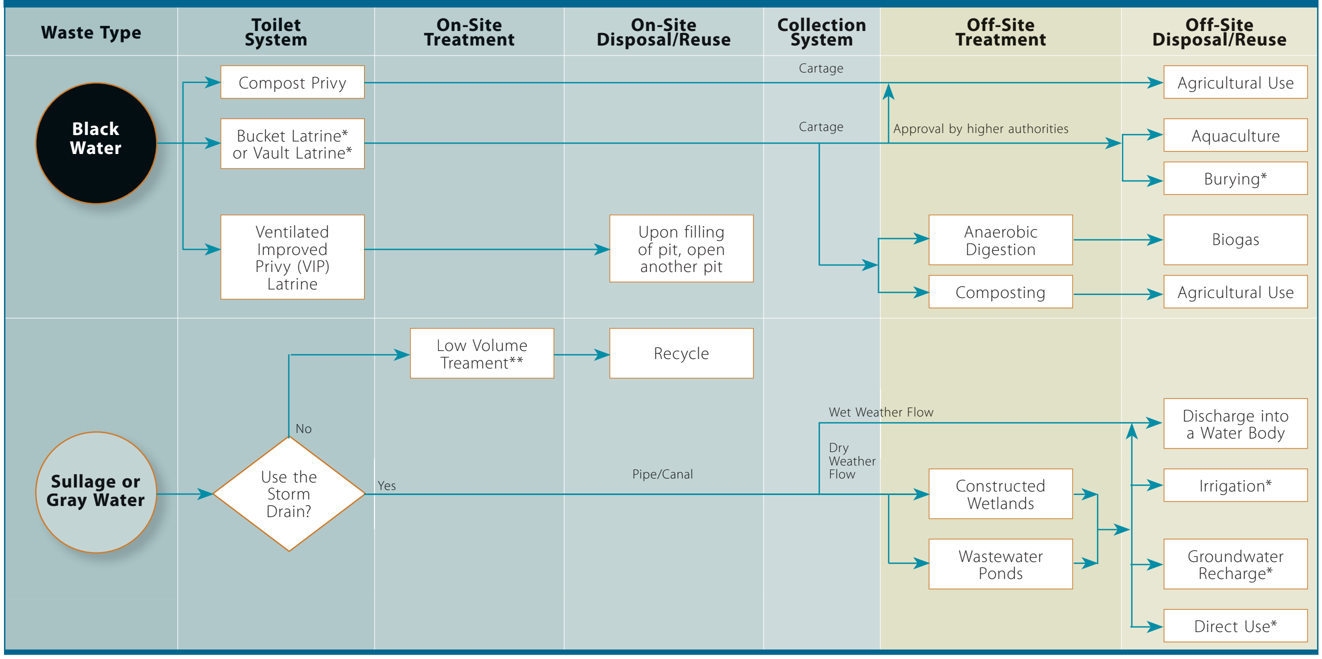
Flowchart 1-3 shows how wastewater can be managed using an ecological approach. Ecological and traditional sanitation management can be used in combination. Thus, a number of the ecological technologies appearing in Flowchart 1-3 can also be seen in the first two flowcharts. In Flowchart 1-3, the non-water reliant and water-reliant systems appear in a single chart.

Flowcharts 1-1, 1-2 and 1-3 are related to the management of wastewater from homes and beach resorts. Management of industrial or commercial wastewater is illustrated in **Flowchart 1-4** to emphasize the need for special treatment processes before a part of the waste stream can be treated as domestic waste.

Figure 1-6
Categories of System Combinations



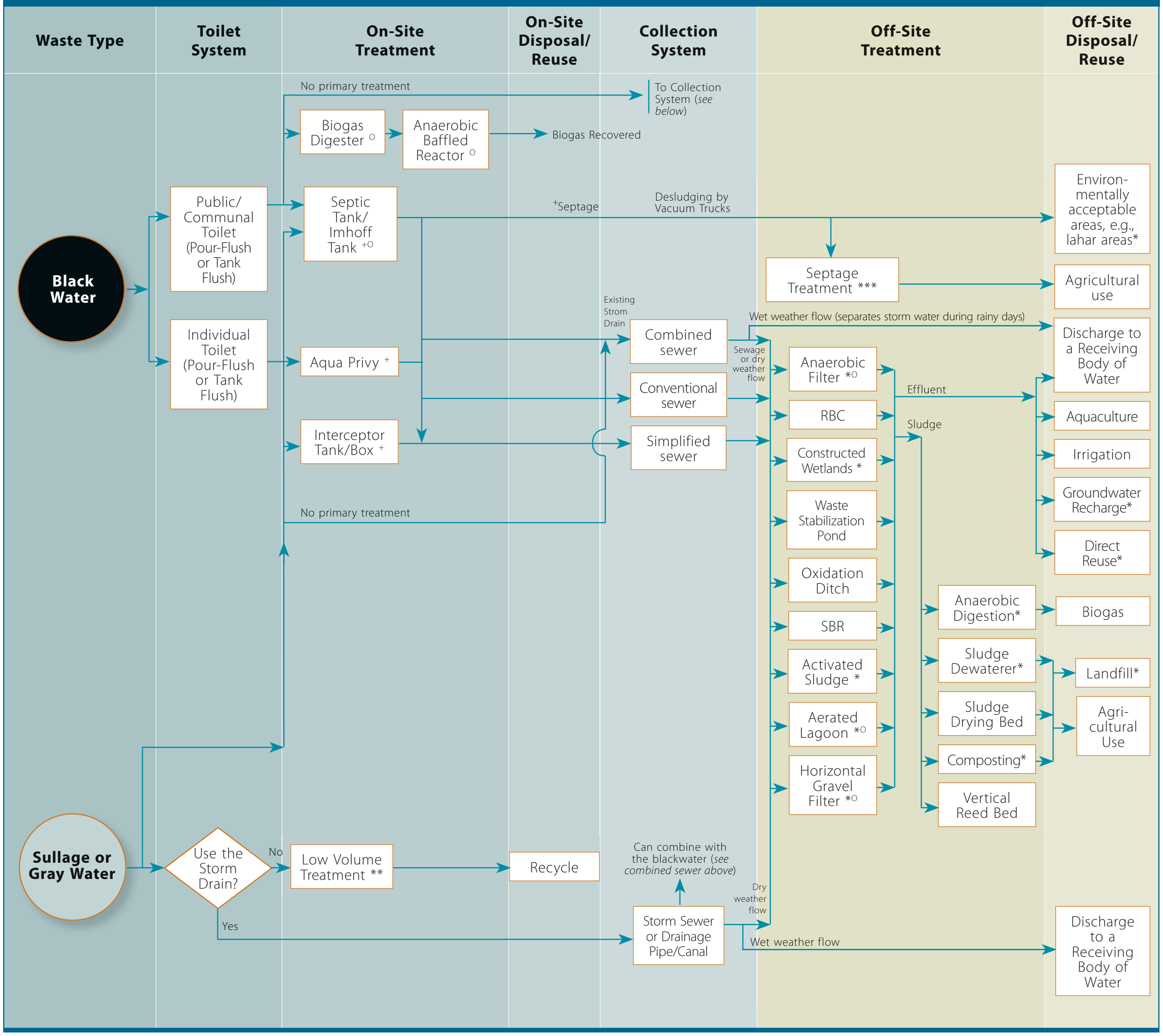
Flowchart 1-1
The Range of Non-Water Reliant Sanitation Systems for Domestic Wastewater



* Not included in technology sheets
** Biological treatment, membrane technology or soak away pit

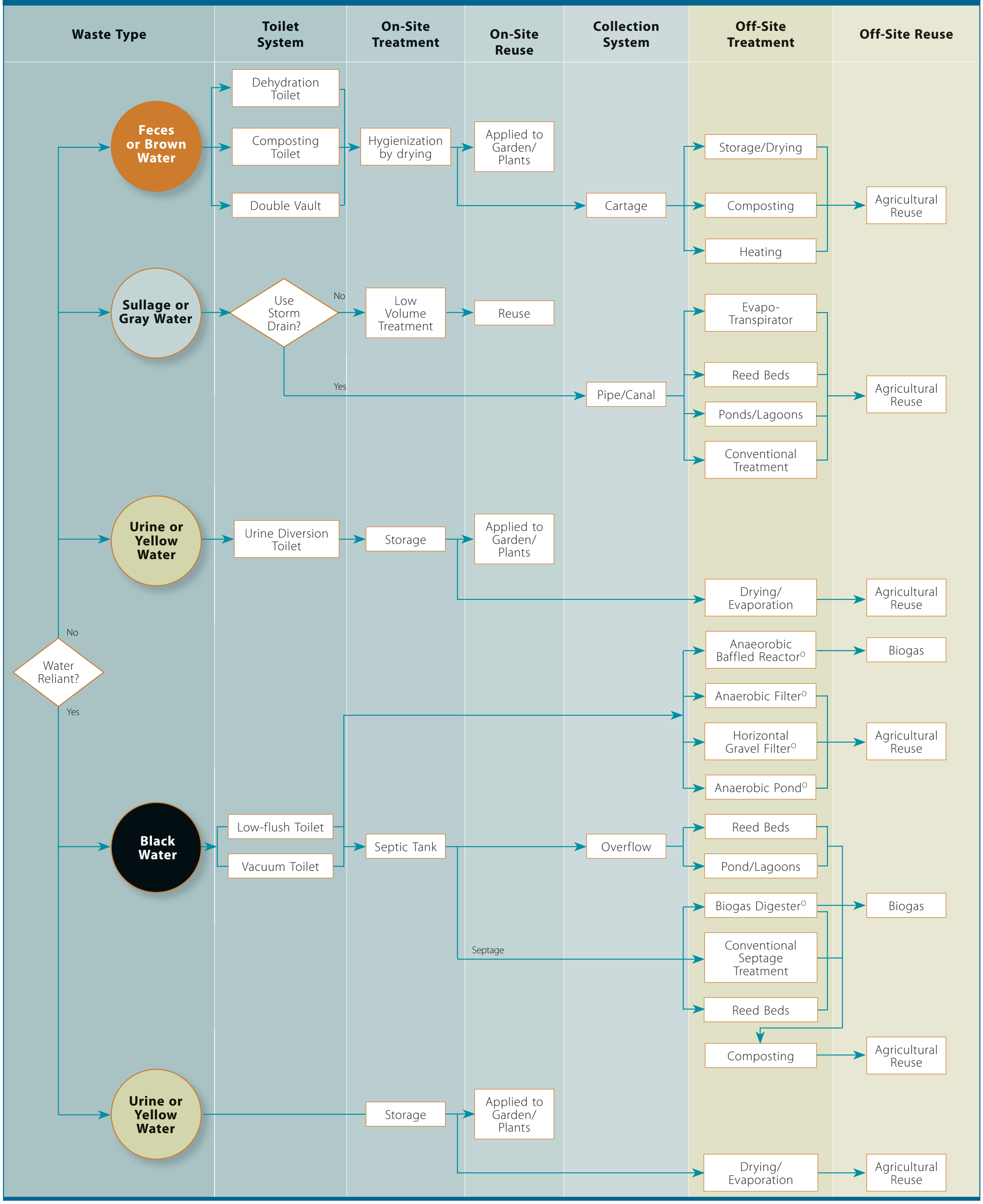
Flowchart 1-2

The Range of Water-Reliant Sanitation Systems for Domestic Wastewater



+ Septage
o Also employed in DEWATS approach to wastewater treatment
* Not included in the technology sheets
** Biological treatment, membrane technology or soak away pit
*** Septage treatment can be accomplished by co-treatment with sewage or sludge, composting or anaerobic digestion

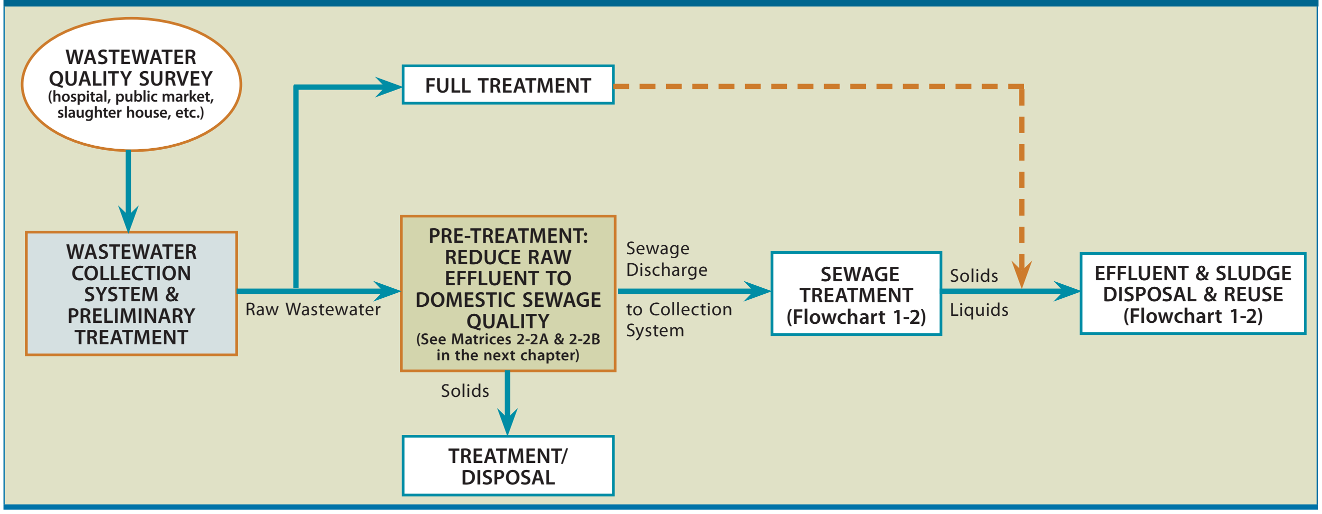
Flowchart 1-3
The Range of Ecological Sanitation Systems for Domestic Wastewater



° Also employed in DEWATS approach to wastewater treatment

Flowchart 1-4

Stages of the Waste Process for Small Enterprise & Industry



CHAPTER 2
DECIDING ON SANITATION OPTIONS

In the Philippines, until recently, the decision on how sanitation would be managed was singularly taken by the capital investor, e.g., a family investing in a toilet and septic tank, or a government agency constructing and operating a sewerage system. This practice still exists. Sanitation facilities are almost exclusively toilets and septic tanks on one end of the spectrum and centralized sewerage systems on the other [2].

In the past, population density was low, and the distinction between rural and urban was much more defined. Household sanitation facilities could exist as stand-alone systems, relying on the carrying capacity of the natural environment. This is no longer tenable. Rural areas are rapidly becoming built up, with the country's rate of urbanization exceeding the regional average. As houses are built closer together, the volume and concentration of waste increases and the capacity of natural systems to process it becomes progressively limited. Thus, sanitation and wastewater planning needs to look more comprehensively across the range of solutions and consider a broader set of views and resources.

Decentralizing responsibility for sanitation to local governments, starting in the 1990s, presents both an opportunity and a challenge for moving towards comprehensive sanitation planning. On the one hand, decisions can be taken at a level where people have the highest degree of interest in, and understanding of, their particular situation. This involves community participation and can result in better decisions about the sanitation service that is feasible and appropriate, given physical, institutional and socio-economic conditions. On the other hand, serious information gaps on sanitation concepts and options exist at this level, even among technical professionals within local government units.

2.1 Iterative Decision-Making

The selection of sanitation options involves the consideration of technical and non-technical issues. An assessment of physical factors that limit potentially feasible options or compel corrective actions in their design, construction or operation is necessary. Decision-making will also need to consider non-technical factors, such as the acceptability of options by users, to better ensure that sanitation systems will operate effectively in the long-run.

2 Only a handful of cities have sewerage systems. Most either use the storm drains or do not have collection systems.

As a **first step** in decision-making, it is easiest to eliminate from the very beginning those options that, on technical grounds, cannot be effectively utilized at all. Some options cannot be used in specific situations given the physical and technical constraints. Factors that exclude certain types of sanitation technology options are referred to as **Restricting Variables**. The presence of restricting variables will only eliminate some, but not all options, and may continue to be relevant in later stages of decision-making for those options that do not get excluded.

The **second step** in decision-making is a review of factors that will affect the design, efficiency or acceptability of certain options. These factors are referred to as **Influencing Variables**.

Influencing variables are further classified into two – technical factors and demand factors. **Technical factors** relate to physical parameters, while **demand factors** relate to socio-economic considerations, including cultural preferences.

The presence of technical influencing factors will not eliminate options, but need to be considered in the plan, design and implementation of projects. Typically, the responses to technical influencing variables are to:

- introduce corrective or mitigating measures in the system so that potential hazards to health and the environment are reduced or eliminated, or
- consider them in the design and construction of systems so that standards are met and efficiency of the systems is preserved.

Demand factors also influence the design, efficiency and acceptability of options. They relate to socio-economic issues that affect (increase or decrease) the motivation of investors, users or consumers to invest in a facility, use it and/or to pay for its use. They also relate to cultural preferences in the choice of the appropriate option.

Deciding on the combination of options that is technically feasible and socio-economically viable, therefore, requires judgment based on an investigation of various issues. Usually, this decision is arrived at after a series of discussions and deliberations among project stakeholders.

2.2 Decision Aids

This Chapter identifies Restricting and Influencing factors and how they affect proposed solutions. The Sourcebook organizes information around these issues into quick reference decision-aids:

a. **Model Survey Instruments for Community Sanitation and Sanitation for Enterprises** - The surveys comprise questionnaires for socio-economic (**Survey Instrument 1-a**) and technical (**Survey Instrument 1-b**) investigation. In the discussions of factors, a cross-reference to the relevant item in the questionnaire is made. The survey instruments are in **Annex 1**.

b. **Tables on Technical Restricting and Influencing Variables** – The most common technical factors and their effects are presented in two tables:

   Table 2-1 on Restricting Variables identifies physical or technical conditions that render some options inoperable/infeasible.

   Table 2-2 on Technical Influencing Variables identifies physical or technical variables that need to be considered in the design, construction or operation of some sanitation options.

c. **Checklist of Demand Factors** – A list of considerations relating to demand factors are given in **Subsection 2.5**.

This Chapter also puts forward the following three decision-aids that compare the several options under each system component:

a. **Matrices 2-1A and 2-1B Effect of Site Specific Conditions to Technology Options for Domestic Wastewater** compares domestic sanitation options against a list of site specific conditions. Using the color scheme of a traffic light, the matrix lets the user know, at a glance, the effect of these conditions to certain options and therefore, if one should go ahead (green grid with vertical lines), stop (red grid with horizontal lines) or proceed with caution (yellow grid with dots).

   Comparison of Technology Performance - The lower half of Matrices 2-1A and 2-1B compares the sanitation options according to their performance based on 13 criteria.

b. **Preliminary Matrices 2-2A and 2-2B Pre-treatment/Treatment Technology Options for Public Markets and Hospitals**. These are used in conjunction with the above matrices (Effect of Site Specific Conditions to Technology Options for Domestic Wastewater) in the case of public markets and hospitals that will need pre-treatment of non-domestic waste water streams.

These decision aids can assist project planners make informed comparisons of the options and communicate these issues with other project stakeholders.

2.3 Restricting Variables and Sanitation Technologies Ruled Out

Table 2-1 on Restricting Variables identifies the most common physical or technical conditions that render some options inoperable/infeasible in the first column; the second column lists the sanitation options that are ruled out by their presence; and, the third column provides the cross-reference to the Model Survey Instrument.

Table 2-1
Table of Restricting Variables

Technical or Physical Condition	Technologies Eliminated	Survey Instrument Index
1. Water supply is not available	Water carried systems such as flush toilets and piped sewerage. Only dry systems can apply (*See options for non-water reliant systems in Flowcharts 1-1, 1-3 and Matrix 2-1A*)	Survey Instrument 1b Item C)1.
2. Limited space	Treatment and disposal systems that require substantial lot areas. Among treatment systems that need large spaces are natural systems, e.g., wetlands, ponds, lagoons, leaching fields, reed beds. Disposal systems that need large spaces include soil infiltration or irrigation (for effluent disposal) and landfill (for sludge disposal). Also rules out pit privies or pit latrines that require the development of subsequent pits as the first one becomes full.	Survey Instrument 1b Item B) 3 & 4.
3. Area is prone to flooding	Systems that become ineffective when flooded, such as pit privies, leaching pits, constructed wetlands, aerated lagoons, waste stabilization ponds, reed beds, and landfills (for sludge disposal). In highly urbanized areas, where land is scarce and expensive, areas prone to flooding may be considered, as it may be cheaper to mitigate flooding at the site than to purchase land.	Survey Instrument 1b Item B) 5 & 6.
4. High groundwater table	Facilities that require good drainage such as leaching pits, unlined wetlands, lagoons, ponds, and filtration fields	Survey Instrument 1b Item B) 8 & 9.
5. Difficult vehicular access into the area	Systems that rely on desludging/haulage services, e.g. by vacuum trucks for septic tank desludging and compost haulage	Survey Instrument 1b Item B) 2 & 3.
6. Irregular roads/path circulation systems	Conventional piped sewerage systems because these require orderly road or grid patterns. Simplified condominial sewerage could be adopted for this site condition.	Survey Instrument 1b Item B) 2.
7. Poor soil permeability	Systems that rely on leaching to the ground for disposal such as leaching pits and pit privy. Impermeable soils include clay and consolidated loam.	Survey Instrument 1b Item B) 7 & 8.

2.4 Technical Influencing Variables and their Effects

The first column on Table 2-2 Technical Influencing Variables identifies what variables need to be considered in the design, construction and implementation of sanitation systems. The second column discusses why or in what way the factor is relevant. The third column describes how the particular variable can be measured or estimated, or the way that these variables usually occur. The last column cross-refers the variable to relevant questions in the model Survey Instrument in Annex 1.

Table 2-2
Table of Technical Influencing Variables

Technical Factors	Relevance	Estimation or Common Occurrence	Survey Instrument Index
1. Content of wastewater	The types of pollutant occurring in the wastewater will dictate the treatment process that needs to be employed. *(See discussions on Chapter 1 Section 1.4)* Waste from hospitals, public markets and slaughter houses cannot be treated as purely domestic waste. Some of the waste streams from these establishment need to be pre-treated, or otherwise, the combined waste streams need to be fully treated.	Waste from markets and slaughter houses have high protein content from fish, poultry, meat processing activities. Waste from hospitals and laboratories are classified into: domestic (similar to those produced by households) and hazardous health care wastes. Hazardous health care wastes include: pathogens, chemical, pharmaceuticals and radioactive elements. *(See discussions on Hospitals on Chapter 3 Section 3.3)*	Survey Instrument 1b Item D) 1 & 2. Survey Instrument 2 D) 2
	The waste content has an effect on the reuse or application of waste by-products. For systems that rely on the recovery of nutrients, such as bio-digesters and compost privies, the wastewater must have high organic content.	Waste from food processing and pig farms will have high organic material content suitable for biogas recovery. Urine contains high levels of nitrogen, potassium and phosphorous suitable for application as fertilizer.	
2. Volume of wastewater produced or number of users	The collection and treatment components of sanitation systems need to be sized according to the expected volume of waste that needs to be processed each day. The volume of wastewater inflow into systems usually depends on the number of users that will be served	Estimated volume of wastewater produced per capita per day is 50 liters. For public markets, the estimated volume of wastewater produced per stall per day is 30 liters. For hospitals, the estimated volume of wastewater produced per bed per day is 60 liters.	Survey Instrument 1b Item B) 2
	For treatment plants, the volume of wastewater needs to be considered in the design, so that the appropriate retention time can be allowed to process wastewater effectively.	Estimated sludge accumulated per capita per year is 40 liters	
	The number of users will need to be considered for constructing the appropriate number of toilet facilities, especially for public toilets.	The frequency that males urinate per day is about 8 times. The frequency that females urinate per day is about 10 times.	
3. Space availability	The dimensions of sanitation structures need to be laid to suit the available space.	<u>Septic tank</u> – Area of at least 0.3 m^2 per person <u>Waste stabilization ponds</u> – Area of at least 1.8 hectare for 260 m^3/day volume of wastewater or a community of 3,000. <u>Compact treatment systems such as SBR</u> - footprint of 540 m^2 for waste volume of 3,000 m^3/day (or equivalent population of 38,000). <u>Engineered reed beds</u> – Area of about 2 m^2 per person. Note that natural systems such as ponds, can be incorporated into parks or the design of landscapes. Other systems, such as anaerobic reactors, can be built underground. *(For the approximate footprint of more options, refer to Martrix 2-1B and the Technology Sheets on Chapter 4.)*	Survey Instrument 1b Item B) 3 & 4. Survey Instrument 2 Item E)
4. Compliance with Environmental Standards and Regulations	Before final disposal into the environment, the quality of effluent or sludge must meet the relevant environmental standards.	Minimum effluent standards are set by the Department of Environment and Natural Resources (DENR). Effluent standards depend on the classification of the water body where the effluent is finally being discharged. *(For the Philippine effluent standards, please see Chapter 1 Subsection 1.6.)* Sludge for soil conditioning is regulated by the Department of Agriculture (DA). It must have pathogen levels (less than 2.0x E-10 MPN/gram total solids) so as not to cause threat to public health and the environment.	Survey Instrument 1b Item B) 6.
	Another set of regulations requires the installation of sanitation or wastewater treatment facilities for houses and other establishments as part of compliance.	For houses, the Sanitation Code of the Philippines requires installation of a septic tank. For other establishments, the applicable rules pertain to securing an environmental compliance certification. An environmental compliance certificate (ECC) is required for environmentally critical projects under PD No. 1586.	

Technical Factors	Relevance	Estimation or Common Occurrence	Survey Instrument Index
		In the grant of an ECC, one of the conditions is that the project/ establishment shall have all its effluents conform to DENR standards. The DENR Effluent Standards under DAO #35 shows examples on Table 2-2, Section 1.6 of Chapter 1. A DENR Memorandum Order issued on 10 February 2004 requires "sewage treatment facilities as a condition of the ECC for all new projects such as hospitals, malls, restaurants, hotels and other residential buildings, subdivisions and similar projects. All existing facilities and establishments are also required to set up sewage treatment facilities as a condition to the renewal of their PO."	
5. Compliance with Engineering Standards for Design and Construction	Systems need to be constructed according to specifications and engineering standards, e.g., in relation to concrete strength. Industry associations also normally provide standards for sanitation wares, such as toilet bowls, etc.	For buildings and other infrastructures, refer to the Philippine Building Code and the DPWH Standards and Specifications. Plumbing fixtures, toilets, septic tanks, etc. refer to the Philippine Sanitation Code.	
6. Terrain/ Topography	Terrain is relevant particularly for the collection component of systems. A flat terrain will require deeper trenches to induce water flow and one or two lift pumps. A rolling or hilly terrain will likely need more pumping stations	Most population centers are in the relatively flat plains, where land development is cheaper. Minimum gradient of collection system is 0.005 or 5 meters vertical (down) in 1000 meters horizontal distance.	Survey Instrument 1b Item B)5
7. Depth of Groundwater Table	A shallow groundwater level poses construction difficulty for conventional sewerage. Construction will need to use equipment for dewatering and trench protection.	A groundwater table within 1 meter below ground surface is considered shallow.	Survey Instrument 1b Item B) 1
	Combined systems usually have unlined joints, therefore, shallow groundwater levels may incur more groundwater infiltration into the system.		
	Some systems rely on leaching to the ground as a cleansing or treatment system. In these cases, seepage to the ground risks contamination of groundwater.	Toilets and septic tanks should be built at least 25 meters away from water wells. Lining can be used for natural reed bed systems, toilets and septic tanks to avoid leaching to the groundwater	Survey Instrument 1b Item B) 1
8. Risk of pollution of water or food sources, infection and health hazards and other undesirable effects	Some sanitation systems, because of the nature of their operating systems, are more prone to risks or undesirable effects, such as smells. The improper operation of system components also causes hazards and undesirable effects. These issues should be considered so that project planners can institute mitigation measures.	The sanitation components that are most liable to pollute or contaminate the environment are the toilet and disposal components. Collection components, particularly open combined sewers, also pose a greater risk to health. Systems requiring manual handling of feces and urine need to protect against the possibility of direct or indirect contact. Open systems like pit privy, open sewers, anaerobic ponds, etc., are usually prone to smells. Non-water reliant systems, open ponds, trickling filters and disposal by land application, if not designed, constructed or implemented properly, can risk the breeding of insects. *(For details on other options, see Matrix 2-1B)*	Survey Instrument 1b Item D)
9. Potential for resource re-use or recovery	Some options will allow the recovery of material or resource.	Most ecological sanitation technologies allow recovery of materials for reuse, e.g. urine-diverting toilets, biogas plant, compost toilets. Sludge or compost can be used as fertilizer.	

2.5 Demand Variables

In order to realize their full benefits, sanitation facilities must be used and maintained properly. Sanitation facilities that do not operate properly can pose even greater health and environmental hazards than those they were designed to prevent.

Acceptance and understanding of proposed sanitation solutions by their potential users are therefore essential to make sure that users will --

- invest in sanitation facilities,
- continue to use the facilities in a health-promoting way, and
- contribute to the ongoing functioning of facilities by paying for their costs and ensuring their proper maintenance.

A supply-driven approach, where facilities are decided based on assumptions by technical experts alone, commonly encounter use and maintenance problems because facilities introduced do not match consumer demands and expectations. Or, they do not pay enough attention to consumers' knowledge and behavioral gaps.

Demand factors discussed here relate to factors that increase or decrease the motivation of consumers to use a facility and pay for its continuing use.

The concept of demand is used by economists to describe the quantity of goods or services that a person chooses to buy at a given price. In this way, demand is equated with willingness to pay – what consumers choose to buy, given their spending limitations and the prices of various goods and services.

Cost to Investors and Users

One part of the 'demand' equation is the cost of sanitation services.

In general, there are two cost components of sanitation facilities:

- cost of construction (capital costs)
- cost of operation and maintenance, including management costs (recurrent costs)

Recurrent or O&M costs include electricity, personnel, transportation, rentals, cleaning, and parts replacement. Capital costs include the cost of the site and the investment to construct the facility, as well as the cost of money used to make such investment (e.g., interest from a bank loan, etc).

Capital and recurrent costs will vary according to the technology, level of service, and efficiency of facilities under consideration. The estimates of the capital investment and O&M cost for the various sanitation options are shown in the Technology Sheets in Chapter 4.

How to Estimate Capital Costs to Users/Consumers

Often, sanitation costs are allocated among different groups: users/households, communities, utilities or service providers, and national and local government entities. For example, the cost to construct shared infrastructure, such as the collection and treatment components, is often assigned to utilities or government, with or without subsequent repayment from users (or from government to utilities), because of the high level of investment required. The benefits to public health and the environment resulting from the investment justify investment of public funds in shared infrastructure, in promoting change in behavior that maximizes the potential use of sanitation facilities, and in increasing demand for sanitation services.

Depending on what percentage of costs is ultimately assigned to households, the total cost of the project can be divided by the number of households that will be potentially served to get the capital cost per household.

If it is intended that all capital costs will be recovered from their users during the life of the system, the Cost Recovery Table shown as Table 2-3 provides a sample estimate of the level of contribution that will be required annually from each participating household. Samples are provided for two types of collection systems and four treatment options.

The annual contribution from each household for capital cost recovery is based on the investment cost (including cost of money), divided by the assumed economic life of a system and by the number of participating households. For the sample below, the calculations assume a 20-year economic life of the sanitation facility, with cost of money at 12 percent per annum. Various cost scenarios are presented based on the size of the facility (capacity in cubic meter per day) and the number of household users. The cost of land was not included.

Table 2-3
Sample Capital Cost Recovery Table for Collection and Treatment Systems

Capacity (m^3/day)	No. of Households (HH)*	Annual Cost per HH to Recover Capital within Economic Life (P)					
		Collection System		Treatment System			
		Simplified Sewerage	Combined Sewerage	Imhoff Tank	Oxidation Ditch	Sequencing Batch Reactor	Waste Stabilization Pond
< 100	< 166	4.529	2.043				
101 - 200	167 - 334	4.523	2.040				
201 - 400	335 - 667	4.512	2.035	115	5.981	5.814	3.824
401 - 800	668 - 1.334	4.511	2.035	92	4.362	4.475	2.731
801 - 1.600	1.335 - 2.667	4.511	2.035	69	3.181	3.445	1.912
1.601 - 2.500	2.668 - 4.167	4.511	2.035	46	2.466	2.789	1.366
Economic Life, year		**20**	**20**	**20**	**20**	**20**	**20**
Annual Interest Rate, %		**12**	**12**	**12**	**12**	**12**	**12**

* Wastewater flow per HH (5 persons/HH) at 120 liters per capita per day

Table 2-3 can be used to guide decisions on allocating costs among project stakeholders, if only partial cost recovery from consumers is intended. The same kind of calculation can be used for other components of sanitation infrastructure simply by replacing the relevant values. (*Please refer to specific technologies in Chapter 4.*)

Consumer's Willingness to Pay

Cost is only one part of understanding demand. Another part of demand relates to the perception of consumers about the value derived from goods or services for which they pay.

Often, however, consumers will have limited knowledge about various sanitation options that are available and about their benefits and costs. In many instances, consumers will also prefer to invest in household level improvements (e.g., upgrading their septic system). They may not be willing to pay for community-wide systems that are important for achieving overall environmental health objectives.

Thus, in investigating the consumers' willingness to pay, it is important that consumers understand the costs and implications of various realistic and feasible options.

The investigation must also be clear about what costs are being assigned to which stakeholders, based on an understanding of the resources that are available to various participants in the project.

How to Determine Willingness to Pay

Willingness to pay can be determined in various ways:

- A simplistic way of measuring the willingness of consumers to pay is by equating it with affordability. This is usually measured by the cost of various options as a percentage of household income. The threshold of **affordability** commonly used for water and sanitation services is 5 percent of the household income.[3]
- Another method is to find out what consumers are already paying for in terms of similar or alternative services; for example, what people pay for in environmental fees, for the use of public toilets or to buy safe water, such as bottled water.

  Alternatively, observations can be made about what it costs people to cope with the lack of such services or to obtain them; for example, the time, money and labor spent coping with flooding or toilet back-ups to measure willingness to invest in drainage.
  These methods use the **revealed preference** technique.

  In most cases, revealed preference can only provide an indication of the minimum that people are prepared to pay for a service, especially when the price they are currently paying is subsidized.

  Observations in one community can be used with caution to determine potential willingness in another similarly-situated community.
- The third method is to ask people about what they are willing to pay for specific goods and services given hypothetical scenarios. This uses the **stated preference technique**. This technique is concerned with finding out the maximum amount people are prepared to pay for a service or improvement.

  Care needs to be taken in designing and conducting these investigations to ensure that people understand and respond to realistic scenarios (services are accurately described and priced) and that answers are free from bias. Surveys or focused-group discussions (called informed choice dialogues) are often used to investigate people's stated preferences.

In conducting willingness to pay investigations, it is also useful to understand what consumers forego by spending for sanitation (**opportunity costs**). Consumers may have other spending priorities so that even if they could afford to spend on sanitation, it is not their priority. For example, hospital managers may prefer to purchase additional equipment, such as an X-ray machine, that will generate revenues for their hospitals rather than construct a wastewater treatment facility, even if they could afford it. Understanding these limitations can help project planners respond effectively through promotion (demand-creation), appropriate financing incentives/programs and product development.

Other Factors Affecting Demand

Aside from price, the following factors also increase or decrease the motivation of consumers to invest in sanitation, use the facility properly, or pay for its maintenance and operation:

a. Consumer **knowledge** of
   - what constitutes proper hygiene and sanitation
   - the benefits of sanitation and the consequences of inaction, lack of sanitation or poorly functioning systems
   - different options available to address sanitation problems, their operation and costs and where to go for sanitation services or products

b. Consumer **attitude, motivation and desires**.

3 However, there seems to be no empirical basis for this threshold value, except for its common usage. It is observed that households, including the poor, consistently spend more than this amount for water and sanitation services.

These could relate to:

- what consumers feel about (or the strength of their views about the value of) specific sanitation facilities and hygiene practices
- consumer preference for the design, location, ease of use/features, convenience and levels of sanitation service
- motivations for investing, using and maintaining sanitation facilities. There can be internal or external stimuli of motivation:
  - o internal motivations could be the improvement in status and privacy; or convenience of use
  - o external motivations would include social pressures/shame or a sense of contribution to a greater cause (e.g. environmental protection and disease prevention)
- competing consumer priorities;
- consumer optimism that the solution is worthwhile and that success is likely and confidence in the leadership and the concerted effort (if requiring community action)
- consumer desire to upgrade or improve the level of their existing waste disposal method.

c. Available sanitation **skills and facilities** (supply-side factors that deflate demand)

Consumer demand is likely to be affected by many supply-side constraints. For instance, poor maintenance by households of their septic tanks could be due to the low level of skills of local masons to construct a properly functioning septic tank or because of a lack of pit emptying service in the locality.

In the same way, demand for water-dependent sanitation facilities will obviously be affected by the availability of water supply in an area.

d. Consumer **practices and cultures**. These could relate to:

- present hygiene practices and risk behaviors or habits, for example, in relation to hand washing with soap or the manner of anal cleansing
- practices that relate to the use and maintenance of sanitation facilities - For example, in certain cases, sanitation facilities need to be designed to allow the recovery and reuse of resources where communities practice agricultural reuse of waste materials.

e. **Incentives** encourage persons to act in a specific way. Incentives take the form of rewards and penalties. The presence of regulatory and economic incentives and the effectiveness of their implementation also influence consumer demand. Examples of these incentives are:

- pollution fines and penalties
- subsidies for specific activities or target groups
- zoning ordinances
- water quality and discharge standards

Table 2-4

Checklist of Demand Factors

	Demand Factors	Implications	Survey Instrument Question Index
1.	**Annual Capital Costs to Consumers of Proposed Project** [Total Capital Cost of System Including Intersts X % of Capital Cost Assigned to Consumers] ÷ [Economic Life of System in Years X No. of Household Users]		Survey Instrument 1b B) 1
2.	**Recurrent Costs to Consumers of Proposed Project** Total O&M Costs ÷ No. of Household Users		Survey Instrument 1b B) 1
3.	**Consumer's Willingness to Pay** **Affordability** Average Annual Income per Household ≥ Total Annual Capital and Recurrent Cost Is the total capital and recurrent cost equal to or less than 5% of the average annual income? ◎ Yes ◎ No	A 'yes' answer means that households are likely to consider the proposed service affordable.	Survey Instrument 1a E) Survey Instrument 1a B) Survey Instrument 1a B) 1
	Revealed Preference Total Costs to Households for Alternative Service + Total Costs to Households for Coping ≥ Total Cost of Proposed Project to Households Is the sum of alternative service and coping costs to households equal to or larger than the actual cost of the proposed project? ◎ Yes ◎ No Do 80% or more of the households in the target community pay more by way of alternative and coping costs than the actual cost of the proposed project? ◎ Yes ◎ No	A 'yes' answer demonstrates high motivation within the community to improve their services.	

	Demand Factors	Implications	Survey Instrument Question Index
	Stated Preference Stated Amount Willing to be Paid for the Cost of Specific Option/Level of Service Is the stated amount equal to or larger than the project cost? ◎ Yes ◎ No Did 80% or more of the households in the target community express a willingness to pay for an amount equal to or greater than the actual cost of the proposed project? ◎ Yes ◎ No	A 'yes' answer means a high willingness to pay for the proposed service.	Survey Instrument 1a D)
	Willingness to Participate Does 80% or more of the households in the area express willingness to have such a project? ◎ Yes ◎ No	A 'yes' answer demonstrates high motivation of households to participate in the project.	
	Opportunity Costs Households can be asked to rank their spending priorities for money that is saved or set aside	This can reveal the most important spending priorities that compete with sanitation	
4.	**Consumer Knowledge** Are target households able to answer questions on proper hygiene and sanitation correctly? Questions can relate to: • when and how hand-washing should be done • other good hygiene practices • how and what diseases are transmitted • how sanitation prevents disease transmission • consequences of poor sanitation	The level of consumer knowledge identifies areas where interventions, such as hygiene education, might be needed to complement the introduction of sanitation facility. Lack of knowledge about sanitation and its benefits can also affect consumer demand for the service.	Survey Instrument 1a C)
	Where do they go for information?	This helps to target communication campaigns.	
5.	**Consumer attitude, motivation and desires** Is the attitude of households towards sanitation positive, negative, or indifferent? What motivates consumers to seek sanitation services? • ask consumers to list benefits perceived to be brought by sanitation • ask consumers to rate whether they agree or disagree with declarations about the benefits or importance of sanitation and about common misconceptions or risk practices	This tests the motivation of consumers to participate in the sanitation project; to use the facilities and to pay for its continuing operation and maintenance.	Survey Instrument 1a C) 7 Survey Instrument 1a C) 8
	Have households been making sanitation investments? • Have they invested in sanitation facilities? Why or why not? • Do they plan to improve these facilities? Why or why not? • What are their preferences in terms of location, design, feature or level of service of sanitation?	This confirms the statement of consumers (above) with their actions and can reveal constraints or motivations other than those identified by the project planners.	
6.	**Sanitation Skills and Facilities Available to Consumers** What sanitation support systems are available in the area? Questions can look at: • Skills available for constructing, repairing and maintaining sanitation systems • Support services for sanitation systems, e.g. desludging services	Consumer motivation is often affected by the availability of skilled service providers, support services or the facility of accessing these services.	
	Do households know about different sanitation options?	Motivation for improving sanitation conditions may be affected by the lack of consumer knowledge about possibilities for improvement.	
7.	**Sanitation Practices and Preferences** What are their current hygiene practices?	This would reveal risk behaviours that need to be addressed along with sanitation systems development.	Survey Instrument 1a C) 7, 8
	What are their 'sanitation preferences'? E.g. • Are consumers washers or wipers? • Do they prefer to sit or squat? • Is there a history of applying waste matter for agriculture?	Practices also reveal preferences of consumers that should inform the design and operation of sanitation facilities.	Survey Instrument 1a C) 7
8.	**Incentives** Are there regulations about sanitation and wastewater? Are there sanitation programs being implemented? Do schools have hygiene programs?		

2.6 Review and Comparison of Technology Options

The following matrices on **Effect of Site Specific Conditions and Comparison of Performance of Technologies** help appraise the various domestic sanitation options based on the:

- effect of site specific conditions to particular technologies
- performance of technologies against 13 selected performance parameters

On the left-most column, the matrices cite physical and technical variables. The effects of these variables are plotted against each of the possible sanitation options using the color scheme of a traffic light. A green-colored grid (with vertical lines) indicates that a certain variable does not restrict the option, hence, a 'go' signal is given. A yellow (dotted) grid means 'proceed with caution' and implies that the technology remains viable so long as corrective or mitigating measures are adopted. A red grid (with horizontal lines) is a 'stop' signal. It means that under the condition cited, this technology is not useable.

The lower half of the matrices reviews the performance of sanitation options against the following parameters: footprint (land area required), capital cost, O&M cost, system robustness, system flexibility, ease of construction, simplicity of operation, usability of byproducts, health implications, technical rating appropriateness, treatment efficiency (for BOD and TSS), energy use and strength handling.

In assessing performance, the following scales and definitions were used:

Table 2-5
Technology Performance Rating Scale

Performance Indicators	Explanation	Rating scale used: from low to high performances						
Footprint	land area required	large	medium/ large	medium	small/ medium	small		
Capital costs	capital investment costs	very high	high	medium/ high	medium	low	very low	
O&M costs	operations and maintenance costs	high	medium/ high	medium	low	very low		
System robustness	ability to withstand shock loading or changes in the wastewater characteristics; adequate performance for a specified period of time under specific conditions	poor	poor/fair	fair	fair/good	good	very good	excellent
System flexibility	plant expansion/upgrading/retrofitting accomplished easily; also reliability; can function despite breakdown of some equipment or unit; can operate in a wide range of flow rates	poor	fair	good	excellent			
Ease of construction	facility of construction	very difficult	difficult	fair	easy	very easy		
Simplicity of operation	ease of operation	difficult	fair	simple	very simple			
Usability of byproducts	ability to harvest by product of sanitation processes for other productive use	no	yes, gray H_2O	yes				
Health implications	existence of potential hazard	hazardous	some hazard					
Technical rating appropriateness	design process matched to expected flow rates and waste characteristics; requirements for their proper operation met; treatment process sufficiently designed to various factors, such as temperature, inhibitory elements, etc.	0	1	2	3	4	5	
Treatment efficiency BOD TSS	based on two parameters, BOD and TSS	 poor poor	 fair fair	 fair/good fair/good	 good good	 excellent excellent		
Energy type	energy or inputs used to operate the system	electro mechanical (E/M)	electrical (E)	chemical	natural			
Strength handling	can handle highly polluted water, particuarly organic in nature and high flow rates	poor	fair	good	excellent			

It must be noted that scales used are relative rather than normative, that is, the rating given to one technology is based on its relative performance against the other technologies within its category that are included in the list.

Only domestic sanitation systems are assessed in the manner described above. **Matrix 2-1 A** deals with non-water reliant domestic sanitation systems and **Matrix 2-1 B** deals with water-reliant domestic sanitation systems.

Based on the situation in a proposed site, some sanitation technology will not be feasible and can be dropped from the list of options. The remaining options can then be subjected to a second level of evaluation by comparing their performance against a proposed set of criteria.

Matrix 2-1A & 2-1B (Lower Half) Comparison of Technology Performance compares sanitation technologies according to their performance based on 13 measures. The criteria are largely technical variables. It is not possible to know at this stage how acceptable the technologies will be to their users.

In many cases, there are trade offs to be made between these performance qualities. For example, where space is limited, compact systems can be installed to function equally efficiently, but perhaps at the price of higher construction and maintenance costs. Only the planners, proponents and communities involved in the project will be able to decide what those trade offs will be. It is, therefore, not possible to predict which of these 13 factors present the highest constraint for them. Decision-makers will have to rank or assign weights to these different factors according to the primary constraints presented by their own situations.

The second level evaluation is enhanced by the more detailed descriptions of technologies from the technology sheets on Chapter 4. The technology sheets include information on system operations principles, advantages (pros) and disadvantages (cons), ease of operation or maintenance, applicability, efficiency, reliability and costs.

Matrix 2-1A

Effect of Site Specific Conditions and Comparison of Performance of Technologies for Domestic Wastewater (Non-Water Reliant Systems: Toilet, Collection and Treatment)

		PARAMETERS	NON-WATER RELIANT SYSTEMS (a): TOILET SYSTEMS: With or Without Urine Diverting Bowls: Below Ground: Compost Privy (b) (c)	Below Ground: Dehydration Toilet	Above Ground: Bucket Latrine/ Family Pail	Above Ground: Tank/ Container for Urine	Pit Latrine or Privy (c) (d)	COLLECTION: Sanitary Manual Collection (e)	Vacuum Truck	Hauling Cart/Truck	TREATMENT: Anaerobic Digestion for Biogas	Composting of Sludge	Dehydration or Stabilization of Sludge	Storage and/ or Drying of Urine
Site-Specific	1.	Nature of Area - Urban environment	(f)											
		- Rural environment												
	2.	Flooding in the area												
	3.	High groundwater level												
	4.	Soil permeability					(g)							
	5.	Difficult vehicular access to facilities												
	6.	Limited space												
Option-Specific	7.	Footprint	large	medium	small	medium	small	-	-	-		large	large	medium
	8.	Capital costs	medium	high	very low	medium	very low	low	very high	medium		medium	medium	medium
	9.	O&M costs	low	very high	low	medium	low	low	high	medium		low	medium	low
	10.	System robustness	poor/fair	excellent	excellent	excellent	excellent	fair	excellent	good		poor/fair	poor/fair	poor/fair
	11.	System flexibility	poor	good	excellent	good	excellent	fair	excellent	good		poor	poor	poor
	12.	Ease of construction	difficult	easy	very easy	very easy	very easy	-	-	-		difficult	easy	very easy
	13.	Simplicity of operation	fair	fair	simple	simple	very simple	simple	difficult	fair	difficult	fair	simple	very simple
	14.	Usability of byproducts	yes	-	-	yes	no	yes	yes	yes		yes	yes	yes
	15.	Health implications	-	some hazard	hazardous	some hazard	-	hazardous	-	some hazard		-	some hazard	some hazard
	16.	Technical rating appropriateness	4	3	varies	3	3	2	5	4		4	4	3

NOTES:

(a) Normal sullage or gray water separated from toilet wastewater for individual toilet systems. For community systems, the wastewater is gray water and/or brown water. The toilet can either be conventional or ecosan type.
(b) Need to be mixed with other organic matter such as wet refuse, dried leaves, etc.
(c) Toilets can be individual units or communal.
(d) Includes VIP latrine, bore hole and overhang latrine, bench or open pit privy, Antipolo closed pit toilet, or reed odorless earth closet (ROEC).
(e) Manual collection refers to handling of feces and urine in closed or covered receptacles and carried by hands and observing sanitary practices.
(f) Needs a concurrent program to collect and dispose of the compost on a regular basis.
(g) Not good for moist soils, sandy soils, fissured rocks and limestone formation.

LEGENDS:

- Stop: Not Applicable
- Go: Applicable
- Caution: Applicable with corrective measures
- Not a factor to consider

Matrix 2-1B

Effect of Site Specific Conditions and Comparison of Performance of Technologies for Domestic Wastewater (Water-Reliant: Toilet and Collection)

		PARAMETERS	TOILET SYSTEMS (a)						COLLECTION SYSTEMS (b)		
			Community Pour-Flush Public Toilet			Community/Individual Pour-Flush Toilet	Individual Pour-Flush Toilet		Combined Sewerage System	Conventional Sewerage	Simplified Sewerage
			With Anaerobic Reactor	With Septic Tank/Imhoff Tank	With Leaching Pit	No Pre-treatment	With Septic Tank	Aqua Privy			
Site-Specific	1a.	Water supply - Piped	Go	Go	Go	Go	Go	Go	Go	Go	Go
		- Fetched	Go	Go	Go	Go	Go	Go	Go	Stop	Stop
	1.	Nature of Area - urban environment									
	2a.	Topography							Caution	Caution	Caution
	2.	Flooding or poor drainage in the area	Go	Go	Stop	Go	Go	Go	Caution	Go	Go
	3.	High groundwater level	Caution	Caution	Stop	Go	Caution	Caution	Caution	Caution	Go
	4.	Soil permeability			Caution (b)						
	5a.	Inorderly roads/paths circulation system (c)				Go					Caution
	5.	Difficult vehicular access to facilities	Stop	Stop	Go	Go	Caution	Caution			
	6.	Limited space	Go	Go	Caution	Go	Caution	Go			
Option-Specific	7.	Footprint	large	medium	small	-	medium	medium/small	-	-	-
	8.	Capital costs	high	medium/high	very low	-	medium	medium	low	very high	medium
	9.	O&M costs	high	medium	very low	-	medium	medium	low	high	medium
	10.	System robustness	fair	good	excellent	-	good	excellent	excellent	excellent	fair
	11.	System flexibility	good	excellent	fair	-	excellent	good	excellent	excellent	excellent
	12.	Ease of construction	fair	easy	very easy	-	easy	easy	very difficult	very difficult	easy
	13.	Simplicity of operation	fair	simple	very simple	-	simple	simple	fair	simple	fair
	14.	Usability of byproducts	yes	-	-	-	-	no	-	-	-
	15.	Health implications	-	-	-	-	-	-	-	-	some hazard
	16.	Technical rating appropriateness	5	4	2	-	4	4	0/1	0/1	5

NOTES:

(a) Normally sullage or gray water is separated from toilet wastewater for individual toilet systems. For community systems, the wastewater is gray water and/or brown water (toilet flushings). The toilet can either be conventional or ecosan type.
(b) Not good for moist soils, sandy soils, fissured rocks and limestone formation.
(c) To accommodate a pipe network.

LEGENDS:

- Stop: Not Applicable
- Go: Applicable
- Caution: Applicable with corrective measures
- Not a factor to consider

Matrix 2-1B (con't)
Effect of Site Specific Conditions and Comparison of Performance of Technologies for Domestic Wastewater (Water-Reliant: Treatment)

		PARAMETERS	TREATMENT SYSTEMS (a)											
			Activated Sludge	Constructed Wetlands	Sequencing Batch Reactor (SBR)	Aerated Lagoon	Oxidation Ditch	Waste Stabilization Ponds	Trickling Filter	Rotating Biological Contactor (RBC)	Sand Filter (Intermittent Open)	Anaerobic Filter	Anaerobic Reactor	Leaching or soakaway Pits
Site-Specific	1a.	Water supply - Piped												
		- Fetched												
	1.	Nature of Area - Urban environment												
		- Rural environment												
	2a.	Topography												
	2.	Flooding or Poor drainage in the area												
	3.	High groundwater level												
	4.	Soil permeability												(b)
	5a.	Inorderly road/paths circulation system (a)												
	5.	Difficult vehicular access to facilities												
	6.	Limited space												
Option-Specific	7.	Footprint	small/ medium	large	small	large	large	large	small/ medium	small/ medium	large	medium	medium	small
	8.	Capital costs	high	low	high	medium	medium	medium	medium	high	high	medium	fair	low
	9.	O&M costs	medium/ high	low	medium/high	medium	medium	low	medium	medium	high	medium	medium	low
	10.	System robustness	fair	fair	fair/good	very good	good	poor	fair	poor/fair	excellent	fair	fair	excellent
	11.	System flexibility	excellent	poor	excellent	excellent	excellent	poor	poor	poor	poor	poor	poor	poor
	12.	Ease of construction	easy	very easy	easy	very easy	very difficult	very easy	easy	very easy	very difficult	easy	easy	very easy
	13.	Simplicity of operation	fair	very simple	fair	simple	fair	very simple	difficult	difficult	difficult	difficult	fair	very simple
	14.	Usability of byproducts	yes	no	yes	no	no	no	no	no	yes, grey H_2O	yes	yes	no
	15.	Health implications	-	-	-	-	-	-	-	-	-	-	-	-
	16.	Technical rating appropriateness	3	2	3	3	2	5	4	3	0	2	3	1
	17.	Treatment efficiency												
		BOD	good	fair	good	good	good	good	good	fair/good	excellent	good	good	poor
		TSS	good	good	good	fair/good	good	good	good	good	excellent	good	good	poor
	18.	Energy type	E/M	natural	E/M	E/M	E/M	natural	E	E	E/M & chem.	natural	natural	none
	19.	Technical rating appropriateness	good	poor	good	good	good	excellent	fair	poor	fair	excellent	excellent	poor

NOTES:

(a) To accommodate a pipe network.

LEGENDS:

- Stop: Not Applicable
- Go: Applicable
- Caution: Applicable with corrective measures
- Not a factor to consider

Matrix 2-1B (con't)
Effect of Site Specific Conditions and Comparison of Performance of Technologies for Domestic Wastewater (Water-Reliant: Effluent/Sludge Disposal/Reuse)

		PARAMETERS		EFFLUENT DISPOSAL/REUSE			SLUDGE DISPOSAL/REUSE				
				Discharge into a body of water	Soil Infiltration/ Irrigation	Aqua Culture	Biogas Recovery	Sludge Drying Bed	Reed Bed	Composting	Land Application (Agricultural Use)
Site-Specific	1a.	Water supply	- Piped								
			- Fetched								
	1.	Nature of Area	- Urban environment		Stop	Stop	Caution	Caution	Stop	Caution	Stop
			- Rural environment		Go	Go	Go	Go	Go	Go	Go
	2a.	Topography									
	2.	Flooding or Poor drainage in the area			Caution	Caution	Go	Caution	Stop	Caution	Stop
	3.	High groundwater level			Stop	Caution	Caution	Go	Caution	Go	Go
	4.	Soil permeability			Caution (a)						Caution (a)
	5a.	Inorderly road/paths circulation system **(b)**									
	5.	Difficult vehicular access to facilities					Go	Caution		Caution	
	6.	Limited space			Stop	Go	Caution	Caution	Stop	Caution	Stop
Option-Specific	7.	Footprint		small	large	large	small	medium	large	large	large
	8.	Capital costs		low	medium	low	high	low	medium	medium	medium
	9.	O&M costs		low	low	low	medium	low	low	low	low
	10.	System robustness		excellent	excellent	excellent	good	fair	good	poor/fair	excellent
	11.	System flexibility		excellent	good	fair	good	good	fair	poor	good
	12.	Ease of construction		-	very easy	-	easy	easy	easy	difficult	very easy
	13.	Simplicity of operation		very simple	fair	fair	difficult	simple	fair	fair	fair
	14.	Usability of byproducts		-	yes	yes	yes	yes	no	yes	yes
	15.	Health implications		-	some hazard	some hazard	-	-	-	-	some hazard
	16.	Technical rating appropriateness		3	5	4	3	5	2	4	5

NOTES:

(a) Preference for smaller watershed or catchment areas with modular or decentralized facilities.
(b) To accommodate a pipe network.

LEGENDS:

- Stop: Not Applicable
- Go: Applicable
- Caution: Applicable with corrective measures
- Not a factor to consider

Technology Options for Public Markets and Hospitals

As discussed in Chapter 1, wastewater from enterprises such as hospitals and public markets needs to be managed differently from domestic waste. In these cases, wastewater first undergoes pre-treatment to reduce its quality to domestic sewage, or non-domestic wastewater streams are collected and managed separately from domestic waste streams. For hospitals and public markets, the Sourcebook includes Preliminary Matrices 2-2 A (Public Markets) and 2-2 B (Hospitals) which present pre-treatment options for the various waste streams.

In the case of public markets, wastewater from meat and fish processing will have higher organic and protein content than wastewater coming from houses. In the case of hospitals, components of wastewater will need to undergo pre-treatment as they typically contain chemical, toxic or pathological elements. Pre-treatment options for public markets appear on Matrix 2-2 A and for hospitals, Matrix 2-2 B.

The domestic wastewater streams from these establishments, or wastewater that is reduced to such a quality through pre-treatment, can be treated the same way as household wastewater. It is only at this time that Matrices 2-1 A and B become relevant.

Matrix 2-2A
Treatment Technology Options for Public Markets

WASTEWATER STREAMS		TOILET SYSTEM			FULL TREATMENT			
		Pour-Flush	Tank-Flush	Flush Valve	Anaerobic Pond	UASB	Anaerobic Reactor	Septic Tank/ Imhoff Tank (See Matrix 2-1 B)
1.	Combined system (if available)	▥	▥	▥	To central treatment plant (See Matrix 2-1 B)			
2.	Separate system							
	Domestic wastes	▥	▥	▥	▥	▥		▥
	Sullage wastes							▥
	Meat and fish processing wastes				▥	▥	▥	
	Maintenance wastes (dirty water)							▥

LEGENDS:

▥ Readily applicable
☐ Not an option for the given parameter

Matrix 2-2B

Pre-Treatment/Treatment Technology Options for Hospitals

	WASTEWATER STREAMS (a)	Pre-Treatment Technology Options for Reuse/Recovery									Toilet Systems				Sewage Treatment	Effluent Sludge Treatment	Effluent/Sludge Disposal	
		Evaporation	Distillation	Metallic Recovery	Chemical Precipitation	Electrolytic Recovery	Reverse Osmosis	Ion Exchange	Neutralization	Dilution	Pour-Flush	Tank-Flush	Flush Valve	Ecosan Toilet	Refer to Matrix 2-1B	Storage (b)	Burial/ Discharge to Sea (b)	Refer to Matrix 2-1 B
A.	**Separate Waste Stream**																	
1.	Dialysis, pathology, autopsy (c)						■	■							■			■
2.	Respiratory therapy and pathological laboratories (d)		■												■			■
3.	Radiology photographic chemicals (e)			■	■	■	■	■		■ (f)					■			■
4.	Radioactive wastes	■						■	■	■						■	■	
5.	Clinical chemistry chemicals								■						■			
6.	Disinfection cleaning solution														■			
7.	Maintenance wastes	Install oil and grease interceptor tank for vehicle station													■			
8.	Utility wastes														■			
9.	Laundry														■			
10.	Canteen/Kitchen	Install grease traps													■			
11.	Toilets/Wards										■	■	■	■	■			
12.	Wards with patients treated with cytotoxic drugs				■										■	■	■	
13.	Dental Wastes (g)			■											■			■
B.	**Combined Wastes (on-site or discharge to municipal sewers)**																	
1.	Wards (pathogens, infectious wastes, hazardous chemicals, pharmaceutical wastes, radio-active isotopes, genotoxic drugs, cytostatic drug wastes)														Dilution, neutralization, chemical coagulation, activated sludge, lagooning or intermittent sand filter, chlorination	Anaerobic digestion and/or sludge drying beds		Refer to Matrix 2-1 B
2.	Other sources as shown above																	

NOTES:

(a) Employ waste minimization measures and pollution prevention measures
(b) Storage, burial or discharge shall be in accordamce with R.A. 6969 Toxic & Hazardous Waste Act
(c) Reuse recovered formaldehyde for pathology and autopsy
(d) Reuse recovered solvents
(e) Silver recovery
(f) For small volume or weak or fast decaying isotope
(g) Mercury recovery

LEGENDS:

■ Readily applicable
(blank) Not an option for the given parameter

CHAPTER 3
TYPIFIED COMMUNITY AND ENTERPRISE PROFILES

The profiles in this Chapter highlight the physical and socio-economic factors that need to be considered in the planning of sanitation interventions. The profiles are not intended to replace technical and socio-economic investigations, but may provide pointers to those processes. Some of these pointers are offered at the end of the profiles.

This Chapter presents the sanitation situation in two types of communities and three enterprises: tenured low-income urban community, peri-urban coastal community, medium-sized beach resort, municipal public market and secondary hospitals. This initial selection was guided by the national government's priority to address sanitation in situations that present the highest risks or challenges to environmental health.

3.1 Tenured Low-Income Urban Community

Context

The Philippine urban population grows at the rate of 3% every year. Today, about half of all Filipinos live in urban areas. By 2020, over 90 million people, more than the present population, will live in urban areas. Globally, approximately one-third of the urban population lives in conditions that place them at high risk of disease, mortality and deprivation. Low-income communities within densely populated urban areas set the stage for acute poverty in all forms.

In the Philippines, low-income urban communities can be informal or tenured. This profile relates to tenured low-income urban communities. Tenured low-income communities usually form out of government resettlement or in-settlement programs, or development of low-cost housing communities supported by government.

In Metro Manila, a dense settlement may have 120 to 180 households in a hectare of land.

Area Logistics

The Philippine Government estimates that the need for low-cost housing is about 4 million units up to 2010. A majority (56%) of this will be for Metro Manila, Southern Tagalog and Central Luzon. In response, the government, in recent years, has stepped up its program for socialized housing. About a million units were constructed between 2001 and 2004.

Housing projects are generally planned. Construction is vertical, with apartments uniformly sized and fitted. Projects are normally located in areas with sufficient road access. Network infrastructure for electricity and drainage are available.

On the other hand, low-income urban communities that result from spontaneous settlement, which is subsequently legitimized, tend to be poorly planned, if at all. These settlements are characterized by irregular street layout and permanent and semi-permanent home structures made of concrete. Home lots tend to be small and houses built close to one another. While vehicle access is possible, roads tend to be narrow and often obstructed by parked vehicles, market and vending stalls, and even animal pens. Network infrastructure for electricity, water and drainage is usually available.

Access to Safe Water Supply

Socialized housing projects have provisions for water supply. Water may either be supplied through an independent deep well and elevated-tank system serving the buildings, or through a water utility. Urban resettlement or in-settlement sites are normally served by the water utility.

Continuity of water supply could be problematic in both cases. The improvement of water supply service in these areas does not tend to be a priority for the main utility. Thus, residents will probably have supplemental sources of water, such as from vendors, community hand pumps or rain water collected in containers. Drinking water is boiled and, occasionally, bottled water is purchased.

Resettlement communities are not normally located in central areas where water supply networks are in good condition. Especially for the older in-settlement areas, water might become contaminated due to haphazard pipe installation and leakage of old pipes. Because of the irregular layout of streets and poor access in these areas, it is not uncommon that water supply pipes are laid beside or below the drainage systems, contrary to sanitation building standards. This practice has also been found in a number of housing projects, apparently in order to save on digging costs.

Sanitation Facilities

Government environmental regulations require the installation of water supply, drainage and primary wastewater treatment facilities for all housing projects. Thus, primary sanitation facilities will be available. A number of housing projects in Metro Manila already include small sewerage systems, but a majority of builders are installing only communal septic tank systems, not sewage treatment packages.

For resettlement areas, the installation of water supply and drainage systems is common, but responsibility for sanitation remains a household affair. Thus, it is usual that only household facilities are constructed.

Storm drainage facilities generally consist of open or covered canals, or drainage pipes. The drainage facilities collect storm water and wastewater flows. Drainage improvements are funded by the LGU but maintenance (cleaning, declogging, minor repairs, etc.) is passed on to the local barangays. The main drainage canal/pipe generally outfalls to nearby creeks or waterways or to low-lying areas that are temporary detention ponds of the combined storm run-off and wastewater flow.

Most households have seating pour-flush toilets with a single-chamber latrine or a septic tank. However, a number of households still have toilets without septic tanks because they cannot afford its construction, or they have limited space. In this case, excreta might be flushed from the toilet directly into the drainage system. Animal wastes (e.g., from dogs and hogs) are directly disposed into open canals.

The experience with public toilets in low income urban areas has been unsatisfactory. Maintenance is a major challenge. Besides the disproportionate number of toilets to users and inconvenience of a centralized location, the lack of clear arrangements for, and continuing management of, the facility contributes to these poor results. Thus, users become quickly dissatisfied with the facilities' worsening conditions, leading to a vicious cycle of deterioration.

Volume and Characteristics of Wastewater

Housing projects normally have 1,000 to 5,000 households, depending on the availability of land. Resettlement communities have several thousand households. On the average, households in urban areas have six members. The volume of wastewater can be approximated at 25 to 50 liters per capita per day, given the constrained supply of potable water and expected lower consumption volume per household.

Wastewater is generally domestic in character. However, since small businesses are a primary means of livelihood, it is not uncommon for these chiefly residential areas to host activities that generate wastewater which is not strictly domestic in character. For example, a number of households might raise one or two heads of pig, run a small canteen, or peddle food on the streets. In general, these low-income urban communities also have a small wet market (*talipapa*) in the neighborhood. Therefore, biological materials in waste could be some 25% higher than what one would expect from domestic sources.

Other Physical Issues

As wastewater is usually carried through open storm drainage, solid waste management is a critical related issue to prevent clogging, flooding and contamination.

Hygiene Practices

Most residents from tenured low-income urban communities have access to toilets in their homes and at work. However, a number who are engaged in mobile activities (e.g., driving tricycles and jeeps, or vending), may urinate in the open. On the other hand, open-defecation is not usual. People mostly use water to clean themselves after defecation. Claims of hand-washing with soap after defecation or cleaning of babies/children is high, but needs to be verified.

Diarrhea is common and residents generally relate it to the poor quality of water, e.g. from 'rusty pipes,' rather than sanitation and drainage conditions or hygiene practices. Residents are also generally suspicious about the means of food preparation in small canteens in their areas, and relate children's sickness with spoiled food or reuse of old cooking oil.

Contamination of drinking water through damaged pipes laid under the drains has been found by the DOH to be a cause of at least two major water-related epidemics in low-income urban communities in the last two years. However, no systematic investigations about the linkage between sanitation and hygiene and the incidence of water-related diseases are conducted, except where these have affected an unusually large number of people or led to more serious effects on health.

Consumer Motivation

There is a growing number of poor families in urban areas. The national census of 2000 reports that some 19.9% of families in urban areas are poor – this is up by 2% from 1997. The average annual household incomes of families in the first and second lowest income deciles are respectively: Php 24,506 and Php 39,620.

Frequent episodes of clogged drainage and floods, foul odors from drains and backing up of toilets motivate communities to improve sanitation facilities. However, there is a tendency for those who own septic tanks to pin responsibility for improvements solely on those without.

Existing septic tanks may not be achieving their optimum results since they are often constructed improperly. Many have unlined bottoms that allow sewage to leach into the ground. A large number also have no access manholes to allow maintenance. Septic tank owners do not usually have these tanks regularly desludged. Chambers are allowed to fill-up with sludge, affecting the efficiency of wastewater treatment. The local masons who construct the septic tanks are usually not aware of the design principles necessary to make septic tanks work safely and effectively.

As lot sizes tend to be small in these areas, septic tanks may be built under the living areas of the home, such as the living room or kitchen. This presents a major disincentive for the improvement of septic tanks since it could mean a major reconstruction of the house with attendant costs and disruption of living. Thus, it is not surprising that residents are unwilling to improve their facilities, even when they are provided with information about the appropriate design of septic tanks.

Many residents show willingness to participate in community-organized desludging schedules even as a handful already engage the services of local tank cleaners (*pasipsip* or *malabanan*) individually. Motivated and active community organizations are helpful in shoring up household interest in these community improvement programs.

Local government capacity to implement sanitation projects is very limited in these areas, especially at the barangay level. The barangay structure is often the first to recognize the need to undertake sanitation, drainage and solid waste management improvement programs, but is limited in terms of funding.

Table 3-1
TENURED LOW-INCOME URBAN COMMUNITY

Household No.	120-180 per hectare
Household Size	approximately 5-6 members
Volume of Wastewater	50 liters per capita per day
Sources of Wastewater	Household toilet, kitchen, shower and laundry; small vending stores and canteens
Type of Wastewater	Mainly domestic with possibility of higher biological and grease content from small markets, vending, food stalls & canteens and backyard animal raising

BOD	COD	TSS
180 – 250 mg/l	360-450 mg/l	200-250 mg/l

Physical and Technical Factors

Threats	Opportunities
Limited space for home or community sanitation infrastructure	Network infrastructure for drains and water supply often available
Open drainage; water pipes laid beside or under drainage canals	
Economic activities such as animal raising, markets and food vending integrated into residential community	

Demand Factors

Threats	Opportunities
Content with poorly functioning septic tank system; high disincentive to improve septic tank because of its location inside the house (under the kitchen or living room)	Desire to improve the sights and smells in the area is high among residents as well as barangay leaders
Low awareness of users and local masons on septic tank design and operation	High willingness to participate in community-initiated improvement programs and sanitation activities
Desludging service irregular	High level of hygiene awareness and relatively good practices
High number of mobile workers such as drivers and peddlers who urinate in the open	Presence of community organizations

Pointers for Project Options

- Consider sub-surface sanitation components or those that can integrate into the landscape and serve as a common green area
- One option is to by-pass individual septic tanks in favor of communal systems to avoid major work by individual households or, in the alternative, facilitation of financing for home upgrading
- Water supply pipe repairs, drainage and solid waste management are critical intervention areas
- Communal wash-shower and toilet facilities that are better planned and managed
- Work with community organizations and leaders to help increase motivation
- Work with higher levels of local government to support larger infrastructure investments

3.2 Peri-Urban Coastal Community

Context

Sixty percent of Philippine communities lie on the coast. Many are densely-populated low income villages where at least 25% of the households (rising up to 75% as the communities become more rural) primarily rely on small-scale fishing. This form of livelihood is highly dependent on the quality of the fishing ground. The largest source of pollution of Philippine waters is domestic sewage, which is transported from in-land towns and cities, as well as from the large numbers of communities living on the coast itself. Domestic sewage contributes a large portion of the biological pollution loading of water bodies, compared with the pollution load from cottage or home industries.

Despite regulations against building along the shoreline, settlements build up along these areas because of the economic opportunities and the convenience of transport and trade afforded by the sea[4]. A number of these coastal communities are located just in the outskirts of formal urban settlements, which become the primary market for their goods and labor.

These peri-urban coastal communities can have about 80 - 120 households per hectare of land, or 400 to 600 households in a 5-hectare settlement.

Area Logistics

From a technical point of view, a number of settlements on the coastline are illegal because of regulations requiring all buildings to be built at least 15 meters away from the shoreline. These settlements are, therefore, usually unplanned. They do not readily have access to network infrastructure for water, sanitation and drainage. Electricity is usually available. In some cases, residents rely on liquefied petroleum gas (LPG) for lighting and fuel. Often, however, there will be no street lighting so that getting around at night is not easy.

Access to Safe Water Supply

It is not uncommon for these settlements to rely on shallow or deep wells for water supply. Communal hand pumps are usually scattered around the village. Even those who may be connected to pipe systems will use these hand pump facilities as supplementary source of water. Sometimes, the municipal health office or the barangay will supply the village with chlorine to treat drinking water. The heavy reliance on ground water and the general low quantity of water supplied for hygiene purposes increase the residents' vulnerability to diseases. In this situation, sanitation facilities and proper disposal of wastewater is critical to ensuring continuing safe supply of water.[5]

Sanitation Facilities

Residents do not have formal rights to coastal land, but in many cases, they are relatively secure in their tenure. They have lived in these settlements for long periods, are recognized voters, and governed by formal barangay local governments. Thus, a majority may have invested in their own toilets (seating flush or pour-flush) with either septic tanks or latrines. It is common for toilet facilities to be outside the home.

Not all residents, however, have toilets. A significant number consider toilets beyond the reach of their household budgets. In some instances, the local government will have invested in shared public toilets with septic tanks and even drainage to cater to residents. Satisfaction with public toilets is often low with too many users, poor maintenance, and accessibility.

Interestingly, because beach sand is so porous, many residents and septic tank masons mistakenly believe that it is ideal to allow wastewater to seep into the sand. Thus, a number of septic tanks are built without enclosing the bottom. Enclosed septic tanks are periodically drained into the sand as part of the 'maintenance routine' and this is believed to be appropriate. This has significant implications on the safety of groundwater wells that abound in these settlements.

In some coastal communities visited, drainage canals have been laid. However, most of them do not seem to take the waste and storm water farther than the nearby sea, or to an area where there are fewer houses.

Other Physical Issues

Where access to the sea is not readily available, flooding can be a problem in parts of the settlement because coastal communities sit in lower lying areas. Houses also tend to be built close together in the increasingly small space available. On the other hand, drains are convenient to build because the soil is loose and trenches are easy to dig.

Hygiene Practices

Those without toilets will defecate in the coastal waters or, at night, in dug holes near their homes. This is particularly true among children, who may not be able to find their way to public toilets, or on whom the social

4 The Water Code of 1976 (Presidential Decree No. 1076) requires that buildings should be at least 15 meters away from the body of water.
5 Based on Focused-Group Discussion held in Bgy. Julugan 111, Tanza, Cavite

pressure of using toilets is not so strong. Even among those who have toilets, a number continue to use the sea as a matter of habit or when convenient.

Most will use water for anal cleansing, and while many claim to wash their hands with soap, toilets do not always have soap readily available. Children's diapers or paper wraps are discarded along with other solid waste. Regularity of garbage collection varies widely from place to place.

Continued open defecation and failure to wash hands with soap are problems that sanitation interventions still try to solve. Even if improvements in sanitation systems are introduced, it will be important to motivate residents to improve hygiene practices.

Wastewater Characteristics

In these communities, wastewater is generally domestic in nature and would have the normal characteristics of domestic sewage. Small fish processing (smoking and drying) enterprises also exist within these settlements. From the fish washing and processing, the wastewater tends to have higher levels of biological components such as protein.

Coastal waters are classified as Class SC or SD under the regulations of the Department of Environment and Natural Resources (DENR). Quality of effluent being discharged into these waters must meet the relevant standards. (*Refer to Table 1-2 of Chapter 1*)

Consumer Motivations

Residents in peri-urban coastal communities are generally poor. They are dependent on small-scale fishing, fish vending, and other forms of informal employment. Most of them will have a monthly household income of between Php 3,000-7,000 per household for a family of five to six persons.

A number of families without toilets have expressed a desire to have them. Motivation for toilet facilities is especially high among women and teenage girls. Dignity and security at night are their motivations as most coastal areas do not have street lighting at night. Despite their desire to have toilets, however, investment in them is often in competition with money requirements for cooking fuel and energy, food or clothing, and sometimes, vices like cockfighting.

Those who already have toilets with latrines or septic tanks have very low motivation to improve their faulty systems. Only a small percentage recognizes the need to improve or upgrade their septic tank facilities.

Few residents are aware that they live in an environment with very poor sanitary conditions. There is also low awareness about how their environment is deteriorating due to poor drainage, wastewater seepage, and unhygienic behavior of the residents. People do not seem to know that they are constantly exposed to threats of contamination, and do not relate frequent reports of digestive disorder with sanitation.

There are also weak incentives (rewards and penalties) for motivating residents to discontinue unsanitary practices, such as defecating in the open.

The exposure of residents to stagnant wastewater as well as the accumulation of garbage near the home seem to trigger the clamor for drainage and solid waste collection.

Table 3-2

PERI-URBAN COASTAL COMMUNITY

Household No.	80 – 120 per hectare area
Household Size	approximately 5-6 members
Volume of Wastewater	40 liters per capita per day (due to constrained water supply)
Sources of Wastewater	Household toilet, kitchen, bathroom and laundry; small industry, especially related to fish processing
Type of Wastewater	Mainly domestic with possibility of higher protein content from fish processing

BOD	COD	TSS
200-250 mg/l	360-450 mg/l	200-250 mg/l

Physical and Technical Factors

Threats	Opportunities
Crowded settlements	Nearby final disposal site like the water body
Often no drainage or collection systems; or drainage systems do not really carry wastewater away from the immediate settlement	Drainage digging is easy
High reliance on groundwater sources coupled with prevalent practice of using the beach for seepage of wastewater	Proximity to urban centers allows anticipation of network facilities to expand in these areas in future years

Demand Factors

Threats	Opportunities
High degree of resignation to their living conditions; or oblivious to the unsanitary conditions of the settlement	High motivation among women and teenage girls to have toilets
Very low levels of income	Drainage and solid waste collection often recognized by local governments
Very low awareness about the consequences of unsanitary conditions and practices	Long period of residence and tolerance has allowed residents to invest in more permanent types of structures
Weak incentives	

Pointers for Project Options

- Intensive sensitization campaigns may need to precede sanitation programs in these conditions; embarrassing or difficult discussions about unsanitary hygiene practices (such as open defecation) need to be started
- Willingness of local governments to provide drainage and solid waste management services could be used as an entry point for encouraging more comprehensive approaches to sanitation in these communities
- One area that needs particular attention is what can be done to increase access by very poor families to toilet facilities – sharing arrangements with neighbors, incremental improvements or communal facilities may need to be considered
- Awareness and skills of septic tank masons and persons responsible for operating and maintaining water supply and sanitation facilities within the community need to be improved
- Ecological and dry sanitation systems as well as cartage can be considered
- Rewards and penalties may need to be introduced for improvement of sanitation facilities or behaviors

3.3 Secondary Hospital

Context

In 2003, there were about 1,700 medical centers, hospitals, and infirmaries in the country. This is equivalent to 21 hospitals for each of the Philippine provinces, or 15 for each of the cities. In reality, around 40% of these health care facilities are located in the National Capital Region and Regions III and IV. They include infirmaries, primary, secondary and tertiary hospitals. (*See Table 3-3 below*)

Table 3-3
TYPES OF HOSPITALS

Type of Hospitals	Number (2003)	Authorized Bed Capacity	Service Capability
Infirmary	571	10-75	Maternity service on pre- & post natal care, normal delivery and care of newborn babies
Primary	768	10-600	Non-departmentalized hospital that provides clinical care and management on prevalent diseases in the locality.
Secondary	200	25-500	Departmentalized hospital – provides similar services as primary hospital as well as particular forms of treatment, surgical procedure and intensive care.
Tertiary	150	50-700	Training and teaching hospital - provides similar services as secondary hospital as well as specialized and sub-specialized forms of treatment, surgical procedure and intensive care.
TOTAL	**1,689**		

Most hospitals are privately-owned (61%) and the rest are government-operated.

Area Logistics

Hospitals are almost always found in urban and small and medium town centers, or their periphery, where access to support systems that are critical to hospital operations – such as transport, water and electricity – is high. In most cases, hospitals have access to drainage or water bodies, such as rivers, that serve as a discharge point.

Hospitals are usually built on flat to slightly rolling terrain as these conditions are ideal for building, roads, parking and drainage construction.

Hospital lots are normally large, especially for provincial and public hospitals that are built on government property. In this case, the development spread is horizontal, with most buildings being single- or two-stories high. Private hospitals, on the other hand, have vertical developments and lot space dedicated to parking and small common areas. Land area can therefore be as large as 40,000 sq. m. and as small as 600 sq. m.

Access to Safe Water Supply

Hospitals have good access to water supply. Most hospitals are served by the local water utility or have their own deep well, pump and elevated tank system.

The volume of water used by hospitals varies according to the size of and activities in these facilities. The size of hospitals is normally indicated by its bed capacity. The volume of water used is normally between 0.5 to 0.75 m^3 per bed per day.

Volume, Characteristics and Sources of Hospital Wastewater

Ninety percent (90%) of the volume of water used by hospitals is discharged as wastewater. Between 75-90% of this wastewater is domestic quality wastewater from hospital toilets, showers, kitchen, laundry, and office areas.

However, given the special nature of hospital activities, the remaining 10-25% of wastewater needs to be handled carefully as it can pose great risks of infection and toxic effects. Hospital activities include handling and washing of potentially contaminated samples from patients, using hazardous or toxic chemicals, e.g., to process x-rays, and using strong cleaning compounds for disinfecting the various hospital units and supplies.

Hospitals produce two general streams of wastewater. These are:

Table 3-4
WASTEWATER STREAMS FROM HOSPITALS

	Wastewater Steams	Source
1.	**Domestic wastewater** – similar to wastewater produced by households	
	• Gray, black and yellow water	
	• Sullage or gray water with higher concentrations of surfactants from soaps	Laundry, kitchen, lavatories
	• Oil and grease	Kitchen
2.	**Hazardous healthcare waste** – by-products of health care activities. May contain:	
	• Pathogens – usually bacteria, virus and helmiths	Laboratories, operating rooms and medical wards
	• Hazardous chemicals – toxic, corrosive, flammable, reactive and genotoxic	Fomaldehyde from autopsy, pathology, dialysis and embalming Photographic chemicals from X-ray departments
	• Pharmaceuticals – expired, unused or contaminated pharmaceutical products	Cytotoxic chemicals from treatment of cancer patients Pharmaceutical stores
	• Radioactive elements	Radioisotopes (from clinical chemistry and nuclear medicine)

Data on wastewater generated by hospitals in the Philippines and their quality is limited. In fact, very few laboratories in the Philippines have the capacity to test hazardous chemical components of such wastewater. Available samples from different hospitals show the following wastewater characteristics as shown in the Table below.

The DOH has introduced guidelines for the management of solid and hazardous wastes from hospitals. These include general guidance on the handling of wastewater. Specific guidance can also be obtained from the World Health Organization (WHO).

These guidelines mandate hospitals to ensure that high levels of hazardous elements are removed by full treatment before final discharge. If the hospital is connected to a municipal sewerage system, they will need to pre-treat the wastewater to sewage standard prior to combining with municipal sewage. In all cases, waste from patients treated with cytotoxic drugs (used in cancer chemo-theraphy) need to be collected separately. There is very little evidence that hospitals take these precautionary measures.

Wastewater Management and Sanitation Facilities

Wastewater Management

For contaminated or toxic wastes, a number of hospitals use a third-party sanitation service provider to collect hazardous liquid streams in containers to be treated elsewhere. A handful of private contractors offer these services to hospitals.

In other cases, such as in Trece Martires City in Cavite and in Cebu City, hospitals have shared waste treatment facilities.

The most common case, however, is that hospitals are using only septic tanks as a means of primary treatment, without any additional treatment, before wastewater is finally

Table 3-5
WASTEWATER CHARACTERISTICS FROM SELECTED HOSPITALS

Parameter	Effluent Standard for Coastal Waters Class SC*	Hospital A	Hospital B	Hospital C	Combined Range
a. Color, TCU	-	-	45	5	5-45
b. pH	6-9	-	7.7	8	6-9
c. 5-Day 20°C BOD	100 mg/L	109, 413	158	67	67-413
d. COD, mg/L	200 mg/L	-	-	100	100
e. TSS, mg/L	150 mg/L	-	20	9	9-20
f. Mercury, mg/L**	0.001 mg/L**	-	-	traces	
g. Formaldehyde, mg/L**	0.9 mg/L**	-	-	-	
h. Oil and Grease, mg/L	10	-	-	13	10-13
i. Fecal coliform, MPN/100ml	$5x10^3$***	-	-	$3x10^6$	$3x10^6$

* For effluent standards of other classes of water, please refer to Chapter 1, Table 1-2.
** These standards are based on the Philippine National Drinking Water Standard rather than any effluent standards. At present, there are no standards available for these parameters relating to effluent quality.
*** This standard is based on DENR Effluent Quality Standards in case effluent is used to irrigate vegetables and fruit crops.

discharged to drainage canals or water bodies. Primary treatment through septic tanks can only reduce BOD, COD and solids, but hazardous waste will continue to pose health risks.

If hospitals chose to treat wastewater on-site, they need to be able to fully treat hazardous waste, including chlorine disinfection. On the other hand, non-hazardous components of hospital wastewater can be handled in a similar way as domestic waste. Most hospitals, however, do not separate the hazardous from the domestic streams. The common practice is that both types of wastewater go through the septic tank.

Furthermore, smaller hospitals have grown in size, expanding to 100 or more beds, yet their toilet-septic tank facilities are increased only in terms of size, or quantity, without provision for further treatment of the effluent wastewater.

Sludge from hospital septic tanks also retain high concentrations of pathogens and need to be handled and treated properly. Reuse for agriculture is possible, but only under strict guidelines and standards. Only in a limited number of places is there any capacity to treat sludge. Thus, in most cases, it is expected that sludge is discharged to the environment or drainage.

Toilet and Washing Facilities

Most hospitals have sufficient toilet and washing facilities for visitors, patients and staff. It is important that these are available and function well to reduce the risk of spreading diseases. However, in some cases, water supply is interrupted and water is not available for handwashing or flushing.

Consumer (Hospital Owners and Managers) Motivation

Awareness

Hospital owners, managers and even those monitoring the compliance of hospitals with environmental and health regulations lack knowledge about the different components of hospital wastewater and how to treat them. The lack of awareness about discharges and appropriate technologies clearly affects demand for sustainable sanitation for hospital waste.

At present, a large number of hospitals are using only septic tanks. From the point of view of hospital owners and managers, unless an incident associated with the wastewater disposal occurs, a septic tank solution is deemed to be adequate

Regulations, Standards and Enforcement

Hospital waste management regulation is rather general and therefore, recommendatory rather than mandatory in character. The Sanitation Code, Building Code and the new Clean Water Act have broad provisions on waste management, and only general guidelines have been issued by the DOH on hospital waste management.

The DENR mandates all hospitals to have a treatment facility before they are issued environmental clearance to allow them to operate. However, it is not clear what level of treatment needs to be met for a range of specific hazardous wastes.

Nevertheless, DOH and DENR undertake compliance monitoring by periodic sampling and testing of the effluent from hospitals. Hospitals may be penalized or fined for non-conformance to the standards. At present, however, sanitation and environmental inspectors are only able to monitor the basic parameters for domestic waste – Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD) – which fail to address the hazardous substances.

As discussed, most laboratories cannot even test for the full range of important parameters. The low capacity for regulatory enforcement clearly affects the motivation of hospitals to introduce more effective sanitation systems.

Cost of Construction and Maintenance of Sanitation Facility

Installation of effective sanitation facilities for hospitals or improvement of existing systems is constrained by the availability of funds to build and the ability to operate the facility.

Public hospitals are usually patronized by non-paying patients and rely on large subsidies from the government to operate. Any upgrade in sanitation facilities will mean increased cost for public hospitals that rely on limited public funds.

On the other hand, private hospitals seek to recover their capital investments, and it makes more sense for private hospital managers to invest in income-generating equipment, such as X-ray machines, than wastewater treatment plants.

Table 3-6
SECONDARY HOSPITALS

No. of Hospital Beds	25-500
Vol. of Water Consumed	400 liters per bed per day
Sources of Wastewater	Toilets, lavatories, bathroom, laundy and kitchen (domestic); laboratories, operating room, autopsy, pathology, dialysis, x-ray departments and pharmaceutical stores (hazardous)
Type of Wastewater	75-90% domestic waste, with higher concentration of surfactants

BOD	COD	TSS
250-350 mg/l	450-630 mg/l	250-350 mg/l

Physical and Technical Factors

Threats	Opportunities
Presence of hazardous waste: pathogens, chemicals, pharmaceuticals and radioactive elements	Segregation of waste streams possible; hazardous waste stream often low volume
Very few hospitals invest in treatment systems or contract third party service providers	Usually located in areas where logistics are highly developed
	Technical skills and laboratories usually available

Demand Factors

Threats	Opportunities
High cost of treatment; decisions tend to favor revenue-generating capital investments	Specialized attention provided by government agencies
Low awareness among hospital owners and regulators about how hazardous wastes need to be managed	Owners and managers tend to have high sensitivity to ensure safety of facilities and to avoid lawsuit
Low capacity to enforce hazardous waste regulations or implement hazardous waste management activities due to small number of service providers	

Pointers for Project Options

- Hazardous waste streams need to be separately collected and treated; otherwise, all waste streams must be fully treated
- In the absence of strong regulatory enforcement, creative financing solutions need to be developed to facilitate investment in sanitation. These can include solutions already emerging, such as the development of common facilities or service provision by a third party as an alternative to hospitals owning and maintaining their own treatment facilities and financing incentives, which might be more sustainable in the long run
- Regulatory standards and enforcement need to be clarified and improved
- If hospitals will do the treatment themselves, skilled workers need to be employed
- Larger space in public hospitals allow integration of polishing ponds into the landscape

3.4 Public Market

Context

Each city, provincial capital town, and first class municipality in the country has a public market either operated by the local government or sometimes, by a private entity. In large cities, there are two or more of public markets scattered around the communities.

Typically, the market has wet and dry sections. The wet market section houses stalls selling fresh meat, fish and seafood, fruits and vegetables, and flowers, and such products. In many cases, a slaughter house and an area for dressing/culling chickens are provided. The dry section includes stalls for selling rice, grains, canned goods, and similar products. Separate sections are normally provided for displaying and selling clothes, accessories and house wares. Markets also have food stalls or canteens in separate sections either within the main building or in peripheral structures.

Area Logistics

Public markets are usually found in the town centers where access is convenient and facilities for water and electricity are available including good drainage. In old towns and cities where the poblacion (central area) has become crowded, the trend is to locate the public facilities (e.g. market, new commercial centers) at the urban periphery where land prices are lower or government land is available.

The market complex would be around 1,000 or more square meters. They are usually built on flat or slightly rolling terrain as these conditions are ideal for site development (road, parking and drainage) and the construction of buildings and related facilities.

In many cases, the markets are built beside rivers, creeks or waterways to facilitate drainage and disposal of effluent.

The market is usually operated in the daytime, starting at early morning and closing at early evening (or about 14 to 16 hours a day). Market activities, particularly in the wet section, open at very early hours for preparations and cater to buyers who come early for their needs.

Access to Safe Water Supply

Public markets are provided with adequate water supply. It is either served by the local water utility or the market may operate an independent deep well-elevated tank water supply system. Besides preparation and washing of meat, fish and other products, a good supply of water is necessary to allow the frequent washing of the stalls. Cleaning of stalls is done by water jetting (high pressure spray) to wash away decaying or clinging particles.

The volume of water used in the market varies according to their size and facilities. The size of the market is normally indicated by the number of stalls available. It is estimated that each stall utilizes an average of 0.2 m^3/day. A typical market with about 1,000 stalls (each stall of 6 sq. m.) would have a water consumption of some 200 m^3/day.

Volume, Characteristics and Sources of Market Wastewater

Ninety percent of the volume of water used in markets becomes wastewater.

Toilets for stall owners and patrons generate black water. There is also a significant amount of sullage or gray water from cutting, washing and processing of meat and fish, and cleaning of stalls.

Wastewater from public markets is basically of domestic sewage quality, but will exhibit higher concentrations of solids and BOD from the meat and fish processing and cleaning of the wet section. For example, the level of BOD of whole blood can be very high, up to165,000 mg/L as shown in the following table.

Table 3-7
CHARACTERISTICS OF MARKET WASTEWATER

Parameters	Meat Products	Fruits & Vegetables
Flow		Intermittent
BOD	High - extremely high	Average - extremely high
COD	High - extremely high	--
TSS	High – intermittent	Average – extremely high
pH	Neutral	Acid – alkaline
Nitrogen	Present	Deficient
Phosphorous	Present	Deficient
Heavy Metals	none	none

Concentration of pollutants from meat processing can comprise up to 50% of the total market wastewater pollution. Markets with slaughter houses, in particular, have animal by-products that could pose high risks to human health. These could include the entrails and wastes of infected animals.

Data on wastewater generated by some public markets in the country and their quality is limited.

Wastewater Management and Sanitation Facilities

Except for sophisticated multi-product private markets in high-end development centers that have sewage treatment plants, most public markets utilize larger-sized septic tanks to treat wastewater. However, given the large volume and concentration of organic matter in wastewater produced by public markets and the level of efficiency of septic tanks, effluent quality will likely fail to meet the standards required before final disposal into the water body.

Poor drainage contributes to unsanitary conditions and odors. Wet market sections will often have damp and slippery floors. Sometimes, they are slightly flooded by stagnant water because of the constant use of water and poor drainage.

Other Physical Factors

Good solid waste management is important for public markets. Odors may be generated from the uncollected or improperly disposed solid waste. Solid wastes such as trimmings and spoiled vegetables and fruits need to be regularly collected in specially designed bins and disposed within the day. A large volume of solid waste is generated in public markets, and good management is not always available.

Consumer (Market Owner and Managers) Motivation

Among LGUs, interest in establishing and improving public markets is high as these are revenue-generating enterprises. Stall rentals from publicly operated markets is one of the main sources of local government revenues. Some LGUs with old public markets in the town center are able to lease them to private entities for redevelopment and operation. Thus, sanitation projects in public markets have generated fairly encouraging interest from owners and managers.

The insufficient wastewater management systems in public markets seem largely due to a lack of awareness about the nature of market wastewater and technologies available. The National Meat Inspection Commission of the Department of Agriculture (DA) is responsible for providing and implementing slaughter house and market standards. Apparently, the regulations are silent about wastewater management in such establishments.

Table 3-8
MUNICIPAL PUBLIC MARKETS

No. of Stalls	1,000
Volume of Wastewater	200 liters per stall per day
Sources of Wastewater	Toilet, restaurants, wet section cleaning, chicken dressing, meat cutting, etc
Type of Wastewater	90% domestic waste, with higher concentration of organic matter; potentially high risk material from slaughter, washing and parts of infected animals and those from animal guts and manure

BOD	COD	TSS	pH
1,000 - 3,000 mg/l	2,000 – 4,500 mg/l	6,000 – 8000 mg/l	Acid - alkaline

Physical and Technical Factors

Threats	Opportunities
Poor drainage	Area logistics tend to be highly developed: good access to water and disposal
Handling of potentially high-risk matter from infected animals and those from its manure and digestive organs	Sewerage system servicing the market compound usually available
Prevalent use of septic tank as treatment facility may not be sufficient for certain waste streams, including those with infectious pathogens	High potential for recovery of resources (methane, electricity or compost)

Demand Factors

Threats	Opportunities
Low awareness among market owners and regulators about market waste streams and how they need to be managed	High interest in improving public markets among owners
Low capacity of market owners, slaughter house operators and users (stall renters) to detect whether animals being prepared are infected	Revenue stream available to support improved treatment
	Monitoring by the Meat Inspection Commission and Bureau of Animal strengthens monitoring by DOH and DENR

Pointers for Project Options

- Waste streams from infected animals, manure and digestive tracts need to be separately collected and treated; otherwise, all waste streams must be fully treated
- Regulatory standards and enforcement need to be clarified and improved
- Awareness of market owners/managers, slaughter house operators and stall renters need to be raised to reinforce positive attitude towards improving the sanitary conditions in the market
- High potential for recovery of organic material (for methane gas or electricity production and compost).
- Ensure safety in land application of material from markets

3.5 Medium-Sized Beach Resort

Context

The Philippines has a 17,500 kilometer coastline and over 7,000 islands. There is an abundance of natural beaches around these islands, which are readily developed into water recreation resorts. Beach resorts are usually owned by private parties.

The resorts are normally found several kilometers away from urban centers – far enough to provide an escape from urban living, but usually with convenient land access.

The facilities usually include a sand beach area with amenities for temporary shelter and sports. Beach resorts will usually have indoor swimming pools, rooms or cottages for staying over, and kitchen and restaurant facilities.

Small- to medium-sized beach resorts have between 10 to 30 single-bedroom cottages and 20 to 100 picnic sheds. They average an occupancy rate of 35% throughout the year, but during the peak months of March and April, occupancy can be as high as 90%.

Beach resorts are an important source of revenues and jobs for the community as well as for the Philippine tourism industry as a whole. Wastewater management is a critical activity to ensure that the country's coastal resources maintain fitness for recreational use.

Area Logistics

Beach resorts usually develop in clusters. They are found in the coast within a few hours from urban centers. The coast could be by a bay, such as Manila Bay, or sea. The more remote resorts may not have piped water and electricity, but owners usually provide these as part of the resort development.

Generally, groundwater is available at the sites of beach resorts since they are found in low lands where water from the uplands drain towards the sea.

The site geology is normally porous with overlying sand. Natural vegetation and topography is utilized with minor planting and redevelopment to enhance the ambience of a natural resort.

Access to Clean Water Supply

Beach resorts usually have adequate water supply. They are served by the local water utility or have their independent deep well-elevated tank water supply system.

The volume of water used by the resort varies according to their size and facilities. The size of the resort is normally indicated by the number of stalls/cottages or rooms for occupancy. One person is estimated to use 50-60 liters per day in a beach resort.

Volume, Characteristics and Sources of Wastewater

The volume of wastewater generated is normally 90% of daily water usage.

Wastewater comes from individual or communal toilets and shower rooms and from food service areas. A larger amount of bathing water might be used. The wastewater may also contain a larger concentration of surfactants from laundry.

Wastewater may also come from occasional draining of swimming pools.

The wastewater generated from beach resorts is expected to be domestic sewage quality except for the likely oil and grease generated from the kitchen and by the high surfactants from the bathrooms.

Wastewater Management and Sanitation Facilities

Normally, beach resorts have septic tank systems, but these are not usually sufficient to attain an effluent quality required for recreational water disposal. In a number of cases, effluent from the septic tanks are directly discharged to the sea or allowed to seep into the ground. This practice threatens the very basis of livelihoods for beach resort owners and workers, and the allied industries built around the resort. This also poses a high risk to the source of water supply, not only for the beach resort, but for the communities around.

Other Physical Issues

Beach resorts usually pay attention to solid waste management within their compounds to meet client expectations.

Consumer (Beach Resort Owners and Manager) Motivation

Beach resort owners are not usually averse to improving sanitation conditions and facilities, but this seems very much linked to the profitability of the resort. In case the resort is not very profitable, there is less motivation to upgrade the septic tank system.

In relation to this, small resorts are usually only regulated through a business permit process and inspection by local governments in the construction phase.

Sanitation and wastewater management of resorts are regulated by the DENR, which may not be able to monitor small resorts.

Recently, the DENR launched a beach 'grading' program to raise awareness of owners and managers about wastewater issues.

Table 3-9
MEDIUM-SIZED BEACH RESORT

Cottages / Beach Sheds Capacity	20/40
Occupancy Rate	35-60%
Volume of Wastewater	50 -160 liters per person per day
Sources of Wastewater	Toilet, showers/baths, kitchen and restaurants, pool cleaning
Type of Wastewater	90% domestic waste, with higher concentration of surfactant

BOD	COD	Oil / Grease	Surfactants
200-250 mg/l	360-500 mg/l	10-20 mg/l	2-10 mg/l

Physical and Technical Factors

Threats	Opportunities
Prevalent use of septic tank as treatment facility may not be sufficient for grease and surfactant concentration	Area logistics tend to be highly developed

Demand Factors

Threats	Opportunities
Low awareness among resort owners about how beach resort wastewater need to be managed and the effect of pollution on their means of living	Beach resort revenue/livelihood directly related to preservation of water quality
Beach resort revenues	
Weak regulatory enforcement	

Pointers for Project Options

- Grease traps and system efficiency needs to be ensured; effluent must meet the quality required for recreational waters
- Awareness on the effect of pollution, especially the economic impact of water pollution could be used to motivate improvement of sanitation and wastewater management
- Sharing of facilities possible between resort clusters

CHAPTER 4
SANITATION TECHNOLOGY SHEETS

4.1 Selected Sanitation Technology Options

Information sheets on selected sanitation technology are provided in this chapter for:

- 6 options for Toilet Systems
- 2 options for Collection Systems
- 11 options for Treatment Systems
- 2 options for Sludge Disposal or Reuse
- 2 options for Effluent Disposal or Reuse

Table 4-1
List of Sanitation Technologies for Systems of Toilet, Collection, Treatment and Disposal/Reuse

A. Toilet/Pit Systems		**No.**	**B. Collection Systems**		**No.**
1.	Compost Privy	PS-01	1.	Simplified/Settled/Small Bore Sewer	CS-01
2.	Ventilated Improved Pit (VIP) Latrine	PS-02	2.	Combined Sewerage	CS-02
3.	Aqua Privy	PS-03			
4.	Pour-Flush Toilet (PFT)	PS-04			
5.	Public Toilet	PS-05			
6.	Urine Diversion Dehydration Toilet (UDDT)	PS-06			
C. Treatment Systems		**No.**	**C. Treatment Systems**		**No.**
1.	Leaching or Soakaway Pit	TS-01	7.	Engineered Reed Bed	TS-07
2.	Interceptor Tank/Box	TS-02	8.	Biogas Reactor	TS-08
3.	Septic Tank	TS-03	9.	Rotating Biological Contactors	TS-09
4.	Imhoff Tank	TS-04	10.	Sequencing Batch Reactor	TS-10
5.	Anaerobic Baffled Reactor	TS-05	11.	Oxidation Ditch	TS-11
6.	Waste Stabilization Ponds	TS-06			
D. Sludge Disposal/Reuse		**No.**	**E. Effluent Disposal/Reuse**		**No.**
1.	Sludge Drying Bed	SD-01	1.	Discharge into Receiving Body of Water	ED-01
2.	Agricultural Reuse of Sewage, Septage or Sludge	SD-02	2.	Aquaculture	ED-02

COMPOST PRIVY

Description: A compost privy is similar in structure to a pit latrine or aqua privy with some variations like sloping floor and liquid storage. It receives the feces, urine, anal cleansing materials with the addition of other organic matter such as garbage, leaves and grass. Biological decomposition takes place inside the privy producing humus called "compost".

Variations of compost privy include: Clivus Multrum Single-Vault Composting Toilet (Sweden), Biopit Composting Toilet (Sweden), Vietnamese Compost Latrine, Minimus Composting Toilet (Philippines), Comportalet or Composting Portable Toilet (Philippines), Multichamber Carousel Composting Toilet (Norway), Sirdo Seco Double-Vault Composting Toilet (Mexico), CCD Toilet (South Pacific Islands), Movable Bucket/Bin Composting Toilet (Norway), Aquatron System Composting Flushed Toilet (Sweden).

Design: The volume of the pit depends on the needs for fertilizer and the needs of people using the privy. Proportion of excreta to refuse (organic matter) should be about 1 to 5 by volume. Usual Carbon (C):Nitrogen (N) ratio is 25-30 : 1. Design value of 0.3 m^3/person/year is used for calculating the volume of the pit, but using 0.1 to 0.15 m^3/person/year is more realistic.

Another way of calculation is by the formula

$$V = 1.33 \times N \times R \times P$$

where: V is the required volume in m^3
N is the number of users
R is the rate of filling (m^3/person/year)
P is the emptying period (usually one year)

A design can also provide separate urine drainage in slab, which would separate urine and prevent it from going to the compost. This would then reduce nitrogen and moisture levels in the compost pile.

Applications: A compost privy is appropriate for use in areas where there is a tradition of using human excreta on the land. Composts can also be used in fishponds.

Components: Privy pit; slab; superstructure; removable covers; ventilation pipe

Capacity: One average household could produce 1 m^3 of digested sludge in 4 years. Allowing refuse to fill up the tank will shorten the cycle to 9-10 months for composting. Vietnam latrines have 2 small vaults of 0.3 m^3-capacity and take between 45 to 60 days to fill.

Costs: Investment is low.
Capital cost would be about P 50,000
O & M cost would be P 30,000 yearly

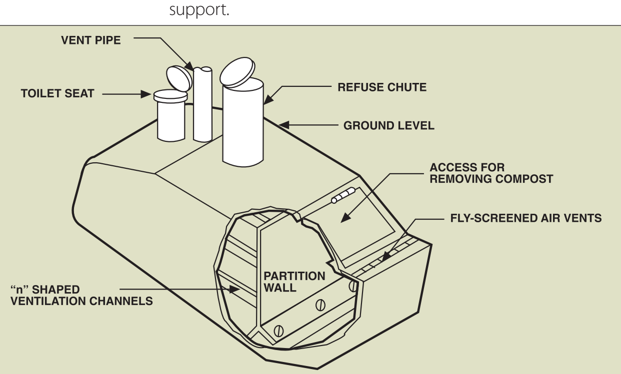
Utility & Efficiency: The correct balance of nutrients must be present/maintained for efficient composting. The microbes need carbon for energy and nitrogen for growth.

Reliability: Reliable during dry season.

Flexibility: Easy to handle. Direct use in gardening is possible.

Reapplication Potential: Self-help potential is highly possible. Training in installation, operation and maintenance can be instituted.

Regulatory/ Institutional Issues:
- This option should be tried first on a pilot scale in the rural areas with agricultural officials and LGUs.
- Requires an entity to conduct training/implementation support.



Operating Principles: Composting involves the biological degradation of the organic compounds of wastes which have relatively high concentration of solids. Initially, psychrophilic and mesophilic bacteria (10-40 ºC) present in the organic waste, decompose it and generate heat. The temperature rises until it limits the growth of the mesophilic bacteria. The temperature then begin to drop, the mesophilic bacteria take over again as decomposition approaches completion. Length of time for the decomposition process is not fixed. Sludge in open compost piles/windrow is composted for 21 to 28 days, but in a compost privy, it takes at least a year. Anaerobic composting is much slower process in the absence of oxygen, and pathogenic bacteria can survive longer in cooler temperature.
For efficient composting, the correct balance of materials must be present for the microbes which digest and degrade the materials. These microbes need carbon for energy and nitrogen to form proteins for growth.
To achieve suitable C:N ratio, it is necessary to add organic matter in the form of crop residues, leaves, grasses, sawdusts or some other easily compostable materials. To reduce acidity and odor of the compost and speed up the composting process, wood ash can be added regularly to the composts. Likewaise urine should be separated to reduce nitrogen and moisture levels in the compost. For the same reason, water should not be added to the pit.
The humus produced by a compost latrine that is functioning well is a dark friable and inoffensive material, rather like a good, moist organic soil.

Maintenance: The compost must be collected regularly and hauled to a point of application/disposal. For multiple- or double-vault composters, when the contents of the tank/privy reach a level of 0.5 m below the ground surface, the slab superstructure are moved to another compost privy. The first pit is filled with grass or leaves and earth. The compost is removed when the second pit is full and the first one is reused.

Construction Materials:
1. Concrete base slab
2. Concrete blocks or brick walls
3. Reinforced concrete cover slabs

Advantages:
1. Suitable in tropical areas where nutrients are quickly leached from the soil
2. Satisfies most sanitary requirements
3. Used as soil fertilizer in agricultural practices
4. Needs no water for flushing as composting requires little moisture
5. Can be built on bedrock; need not penetrate the subsoil
6. Low pollution/health risks, especially if in a sealed unit

Disadvantages:
1. Needs organic matter to correct the C:N ratio
2. Process is rather complicated and needs close supervision, education and follow-up
3. Not free of hazards and regular attention
4. Not suitable in areas with high groundwater table, due to possible infiltration with leachate
5. More expensive than the ordinary pit latrine

TOILET SYSTEM **PS-02**

VENTILATED IMPROVED PIT (VIP) LATRINE

Description: A pit latrine consists of a hole in the ground covered with either a squatting plate or a slab provided with riser and seat. A housing or toilet room is built over the pit. A pit latrine operates without water. Liquid portion of the excreta soaks away into the soil. The VIP is a pit latrine with a screened vent installed directly over the pit. The vent provides odor control and the screen on top of the vent prevents entry of insects attracted by the smell. Filled pits are covered with soil for composting. There are two types of VIP latrines: single pit and alternating-pit. For the latter, there are two adjacent pits below the toilet room and one pit is used at any given time. When one pit becomes full, it is closed and the other pit is used. By the time the second pit becomes full, the first has fully decomposed and becomes innocuous. Materials in the filled pit are removed and the pit can then be returned to service till it becomes full.

Design: The pit volume is given by the product of:
Sludge accumulation rate x Number of people x Filling time

1. Sludge accumulation rate = 40 liters/person/year or rate decreased to 20 liters/person/year if pit is seasonally flooded or water from washings is added to the pit. Increase rate by 50% to allow bulky materials for anal cleansing.
2. Design use of single pit (filling time) = period of 2 years
3. Pit bottom not lined to enable liquid to soak away

Applications: Single-pit VIP latrines are suitable for use in rural areas where the soil is deep and space is available to construct succeeding pits. Alternating double-pit VIP latrines are appropriate for urban areas where people can afford a permanent latrine that does not require relocating after every few years.
VIP latrines can be used in areas where there are no on-site water supplies. Water is needed for handwashing.

Components: Pit; squatting plate or wooden seat & cover; cover slab; and a housing or toilet room.

Capacity:

1. Minimum pit volume = 1 m^3 for household of 6 persons for use in about 2 years
2. Increase in capacity can be achieved by making the pit at least 0.5 m deeper than the minimum since the latrine cannot be used after the sludge surface gets close to the slab cover.

Costs: Options for the construction of a VIP Latrine are:

1. Use of permanent construction materials like concrete hollow block (CHB) walls for the pit and galvanized iron (GI) sheet for the housing. (See figure below)
2. Use of indigeneous materials like wood, bamboo sheeting or used drum for the pit wall, and wood or bamboo post, wood or sawali siding, and nipa roofing for the housing.

Estimated costs for the above options are:

1. For Option a), the cost is P 12,000 and P 55,000 respectively for the pit and housing shed;
2. For Option b), using indigenous construction materials, the major cost is on labor and variable for the local material. Estimated costs are P 2,000 and P 5,000 respectively for the pit and housing.

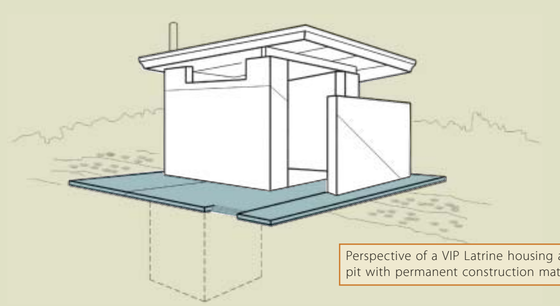
Utility & Efficiency: 50% reduction of solids by digestion. Can be single pit, double pit or multiple pit.

Reliability: Can be relied upon to maintain protection with limited supervision for long periods of time.

Flexibility: Flexible in the use of construction materials particulary indigenous materias. A toilet room in the house could be used in lieu of a separate structure.

Regulatory/ Institutional Issues:

- Compliance with the Philippine Sanitation Code.



Perspective of a VIP Latrine housing and pit with permanent construction materials

Operating Principles: Two important actions take place in the pit which reduce the rate at which it fills:

1. The liquid portion of the excreta soaks away into the soil.
2. The solids in the excreta are broken down into simpler compounds by biological digestion. Soluble products are carried into the soil by the liquid portion of the excreta.
3. Gases (foul air) produced by the digestion are pushed out through the vent by fresh air entering the pit hole.

Maintenance:

1. Regular cleaning and repairs.
2. Periodic inspection of the fly screens and signs of erosion around the edges of the slab.
3. Use of a little bleach or disinfectant to wash the floor slab.
4. Where there is standing water in the latrine pit, small quantities of special oils, kerosene, old engine oil can be added to the pit to prevent mosquitoes from breeding.
5. Stop use of pit when level of solids reaches 0.5 m from the underside of the slab. Fill the pit immediately with soil.

Construction Materials:

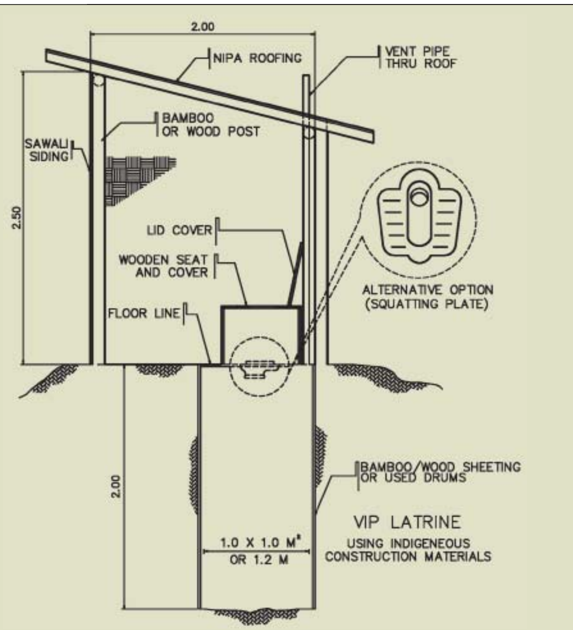
1. Indigenous materials like rot-resistant wood, bamboo, nipa, stabilized soil blocks, stone bricks, etc. could be used for the pit or housing structure.
2. Permanent materials like concrete hollow block (CHB), cement mortar, stone or bricks, metal sheets, etc. could be used for the pit or housing.
3. Reinforced concrete for the pit cover slab or flooring.
4. PVC pipe for the vent pipe.

Advantages:

1. Easy construction using local materials.
2. Minimal water requirement
3. Low annual cost
4. Easy maintenance
5. All kinds of anal cleansing materials may be used

Disadvantages:

1. Lack of space for relocating; the pit is dense in urban areas
2. Potential for groundwater pollution
3. Does not dispose of large quantities of sullage water
4. Not suitable in areas with high groundwater table, due to possible infiltration with leachate
5. Not suitable in areas with impermeable, rocky underground, due to limited infiltration capacity



AQUA PRIVY

Description: The conventional aquaprivy is essentially a small septic tank located directly below a squatting plate which has a drop pipe extending below the liquid level in the tank to form a simple water seal. To prevent odor, fly and mosquito nuisance in the toilet, the water seal has to be maintained by adding sufficient water per toilet visit to the tank via the drop-pipe to replace any losses. The excreta are deposited directly into the tank where they are decomposed anaerobically similar to a septic tank. A housing or shed is built over the tank. A vent pipe with a fly screen at the top end is attached to the housing. A water-tight tank is desirable to minimize losses. An effluent (overflow) pipe is installed above the level of the drop-pipe.

Design: Design considerations are as follows:

1. Tank volume calculated on 1.5 liters per day plus 4.5 liters/ day/person to maintain the water seal (or 6 liters/person/day)
2. Effluent maybe discharged to a soakway pit, soil infiltration or disposed to storm drain or water body.

Applications: The aquaprivy ranks high, with the pit privy, as a desirable sanitation system in areas where there is limited water supply.

Components: Privy tank; floor or slab; housing or shed; toilet bowl or squatting plate with chute or drop-pipe; vent pipe

Capacity: Minimum pit/tank size is 1 m^3 for a household of 5 - 6 persons with desludging period of 2-3 years.

Costs: Pit: concrete plastered CHB wall and concrete bottom (about 1-1.25 m^3) - P 12,000
Housing: indigenous construction materials - major cost on labor and variable for the local material - P 5,000

Utility & Efficiency: 30-40% BOD removal. Needs further treatment such as leaching or secondary treatment processes

Reliability: If properly operated and maintained, it can be a reliable system.

Flexibility: Can be upgraded to full sewerage; medium process flexibility.

Reapplication Potential: Local materials, labor and know-how are readily available. Easy to construct.

Regulatory/ Institutional Issues:

- Compliance with the Philippine Sanitation Code.
- Compliance with environmental regulations in the disposal of the sludge.

Operating Principles: The tank must first be filled with water up to the level of the outlet pipe. After 6-8 weeks, the decomposition process will attain its desired level of operation. Seeding, however, with digested sludge from other privies can hasten the process

Maintenance:

1. Periodic desludging through a manhole.
2. Regular cleaning of the drop-pipe or chute.

Construction Materials:

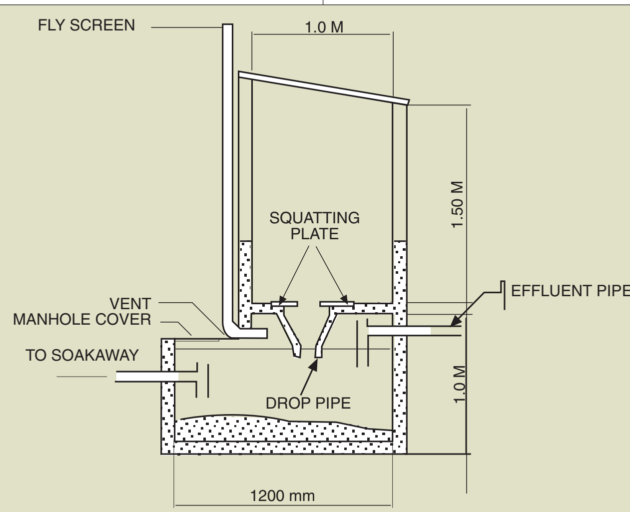
1. Plain or reinforced concrete or concrete hollow blocks for the pit or housing
2. Indigenous materials (bamboo, wood, sawali, etc) can be used for the housing/shed.

Advantages:

1. No danger of clogging by bulky anal cleansing materials
2. Low odor and insect problems
3. Potential for upgrading
4. Minimal risks to health

Disadvantages:

1. Water seal is often broken particularly during cleaning.
2. Needs small but significant amount of water to maintain water level for a successful sanitation technology. Therefore, user education in operation and maintenance of the aqua privy is necessary.
3. The tank requires desludging, usually every 2-3 years.
4. Requires water tight tank, hence more expensive and needs skills to construct.



TOILET SYSTEM **PS-04**

POUR-FLUSH TOILET

Description: The pour-flush toilet has a bowl with a water-seal trap. It is as hygienic as the conventional tank-flush toilet and requires only a small volume of water for flushing. Human waste or excreta is flushed with water poured into the bowl with a pail or scoop. Various types of bowls are commercially available. The bowl can be set in place with the concrete slab cover of the pit or septic tank or offset and pipe-connected to the pit or tank. The toilet can be within the house or a separate structure can be built outside. A pour-flush bowl can be used with compost privy, VIP, aquaprivy or public toilet.

Design:

1. Pour-flush bowl - Commercially available squat or seat types made of glazed ceramic. The squat type can be molded concrete.
2. Toilet structure - Permanent type of minimum 1.2 x 1.2 m shed, concrete hollow block walls 1.5 m high and G.I. sheet roofing, or non-permanent type of indigeneous materials.

Applications: The pour flush toilet can be installed in the toilet room of houses. The location of the toilet is very flexible and the toilet can be some distance away from the receiving pit/chamber. Hence, pour-flush toilet can be used in densely populated urban areas.

Components: Pit slope and pit lining; pit cover; plinth at least 150 mm above ground; Pipe-1:30 slope, 75 mm dia.; superstructures with vent up to overhang of the roof

Capacity: Most commonly used toilet in urban areas or even rural areas, as well as public/communal toilets.

Costs: Capital cost (toilet only, excludes super & substructure):
P 500 for squat-type
P 1,200 for seat-type

Utility & Efficiency: Clean and hygienic; proven efficient

Reliability: With proper sanitation practices, it is reliable

Reapplication Potential: Installation practices generally known; Hardware/materials commercially available.

Operating Principles:

1. The flushing water (1-2 liters) and the liquid portion of the excreta percolate into the ground/soil in the soakaway pit, while it goes with the effluent, or discharge to septic tank, Imhoff tank, aqua privy, interceptor boxes or direct to sewer pipes.
2. The water-seal trap prevents the odors of excreta from escaping and prevents insects from entering or leaving the unit.

Maintenance:

1. Regular washing of the toilet bowl and floor
2. No other solid waste should be put down the bowl
3. Use of flexible rods/materials for removing blockages

Construction Materials:

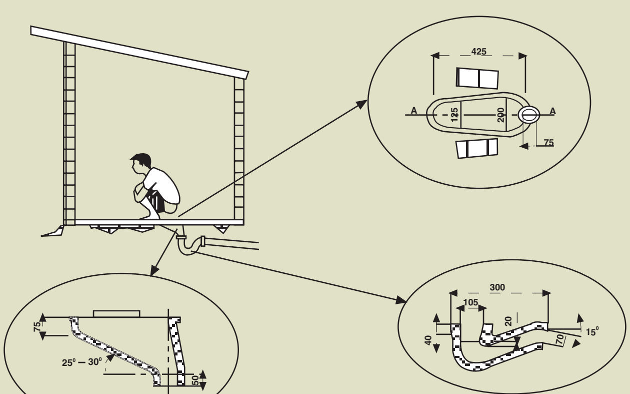
1. Lining materials - brick, stone or hollow blocks or precast concrete or burnt clay liners where there is a high water table
2. Reinforced concrete slabs for support/base
3. Porcelain, concrete or ferrocement, glass fiber, injection molded plastics and glazed ceramics toilet bowls

Advantages:

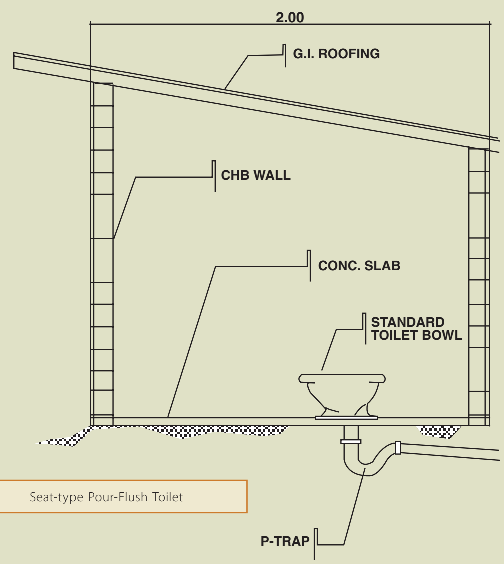
1. Readily available commercially
2. Inexpensive.
3. Less volume of water required (3,000 liters of water/person/year)
4. Upgradeability
5. Hygienic; very easy to clean
6. Reliable; convenient and comfortable

Disadvantages:

1. Requires availability of water
2. Clogs easily if bulky anal cleansing materials are used



Squat-type Pour-Flush Toilet



Seat-type Pour-Flush Toilet

TOILET SYSTEM **PS-05**

PUBLIC TOILET

Description: Public toilet is the more popular name in the Philippines for communal toilet or communal sanitation blocks/centers. It consists of several cells in a common structure with individual toilet bowls/squatting seats. Each toilet bowl is shared by several families. Bathroom and laundry facilities can also be included. Wastewater is discharged into a leaching pit, a septic or Imhoff tank, or an anaerobic reactor.

Design: Each public or communal toilet with 4 cells is shared by at least four families, one cell per family. If there are more families participating, the cells become common to all. Typical design of public toilets provide 8 seats per 200 people.

Applications: Suitable in areas/communities which are densely populated, where space is restricted, and no individual toilets can be set up.

Components: Cells with pour-flush toilets or squatting seats; optimal shower section; optimal laundry section; urinal; nightsoil or excreta-receiving bowl or receptacle; superstructure; pit or treatment unit

Capacity: Depending on the number of sanitation cells, a public toilet can serve 800 users or 20-200 households

Costs: Capital cost: P 250,000 for the 6-cubicle toilet shown in the sketch below, or approximately P 12,000/m^2.

Utility & Efficiency: Basic sanitation services can be provided to a good number of people.

Reliability: Only reliable if toilet is cleaned regularly.

Flexibility: Possible to upgrade collection, treatment and disposal compartments in the latter stage

Reapplication Potential: Design of structure is very basic. Materials, labor and technical know-how are readily available.

Regulatory/ Institutional Issues:
- Compliance with the Clean Water Act.
- Need for community/local government support to operate and maintain the facility.

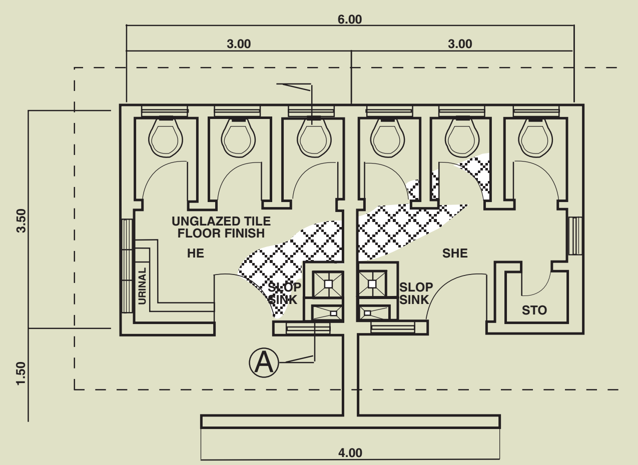
Operating Principles: In densely populated areas, public toilets may be the only practical place for washing, bathing and toilets.

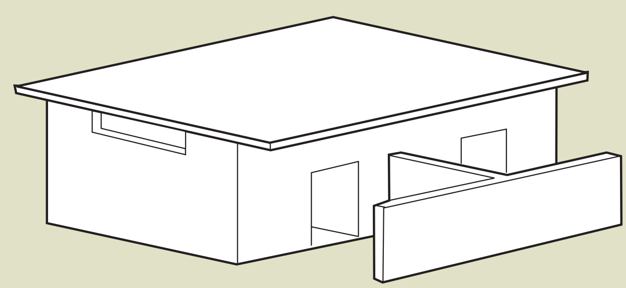
Maintenance: Daily cleaning of facilities essential.

Construction Materials:
1. Reinforced concrete slab
2. Concrete blocks, stones, bricks
3. Wooden trusses, galvanized iron (G.I.) Sheet roofing
4. Plumbing materials such as G.I. or plastic pipe
5. Toilet bowls, squatting seats, sinks, etc.

Advantages:
1. It can provide basic sanitation requirement to many.
2. Low-cost compared to individual units. May be free if operated by municipal/city services.
3. Simple construction and maintenance.

Disadvantages:
1. Limited number of users; inconvenient if one needs to defecate or urinate immediately.
2. Not much privacy.
3. Indivdiuals have no control over maintenance and cleanliness of cubicle being used.
4. Proximity from house and availability at night, not favorable, and further security issues for females.





URINE DIVERSION DEHYDRATION TOILET (UDDT)

Description: A UDDT is a waterless toilet system allowing the separate collection and on-site storage or treatment of urine and feces. Urine is separated in a urine separation toilet and collected in a container. Feces are dropped into a ventilated collection chamber where they are dried and stored. Dried feces and stored urine can be reused in agriculture. No liquids infiltrate into the subsoil, thus there is no danger of groundwater contamination. The most common type of UDDT uses the double-vault system, where two collection chambers for feces are in alternating use. Other variations include single-vault systems and movable container systems.

Design: The volume of collection chambers is designed to store feces for at least 6 months. Collection chambers are equipped with a ventilation system to enhance drying and avoid odor problems. The toilet should be built entirely above ground to allow easy access to the collection chambers through a vertical trapdoor. Solar heating effect is enhanced if this door is made of metal, inclined and facing the sun, and painted in black.

Fertilizer value from urine collected from 1 person in 1 year is sufficient to fertilize 300-400 m^3 of agricultural area.

Applications: Suitable for most climatic conditions, but best in dry and/or hot climates. Most suitable for peri-urban and rural areas; also suitable for urban areas. Collecting systems may be necessary if products cannot be reused within the same perimeter.

The UDDT has been introduced in Luzon, the Central Visayas and Mindanao.

Components: Urine diversion prefabricated toilet chair or squatting pan; sealing cover; superstructure; collections vaults; urine pipes; urine storage tank; ventilation pipe. May also be integrated within the house.

Capacity: Generally one unit is required per household, but it also adaptable for school or public toilets.

Costs: UDDTs have similar or slightly higher construction cost as the VIP or pit latrines. In the long term they are cheaper because their life span is considerably longer. Maintenance costs are very low, but regular interventions (such as vault emptying) are required. There are savings on cost because no water is required and mineral fertilizers are substituted by urine.

Utility & Efficiency: Very efficient in eliminating groundwater pollution and recovering urine and feces for reuse in agriculture

Reliability: Very reliable if properly designed and managed
Requires a certain commitment from the users for proper operation

Reapplication Potential: A variety of ecosan solutions ranging from low to high-technologies exist for rural and low density urban areas.

Regulatory/ Institutional Issues:

- Management by households and/or community organizations

Operating Principles: Two vaults are used alternately with only one vault in use at any time, until it is almost full. Ashes, lime or a bulking agent is added after defecation to maintain high alkalinity and absorb humidity. When this first vault is filled up, the defecation hole is sealed and the toilet bowl is transferred to the second vault. The second vault is now active while the first is passive or "maturing". When the second vault fills up, the dried material can be removed from the first. The product has a sandy appearance and is generally odor-free. Further storage or composting with other organic materials is recommended before reuse to increase hygienic safety.

Urine is collected in a container directly used as fertilizer (in large-scale systems urine should be stored for one month at 20°C before use). A withholding period of one month between fertilization and harvest should be applied.

Maintenance:

- Providing additives, toilet cleaning and inspecting chambers (not exceeding a few hours of work per month)
- Emptying the collection chamber (maximum twice a year)
- Changing the container for urine collection (frequently)

Construction Materials:

- Urine separation toilet: porcelain, fiberglass, concrete, ferrocement or plastics
- Substructure (vaults, slab): concrete, masonry
- Superstructure (toilet cabin): any locally available material, e.g. masonry, timber, bamboo, rattan, etc.
- Urine collection container: plastics

Advantages:

1. Economic savings through products used as natural fertilizer
2. Increased food production through better availability of cheap fertilizers
3. No water wastage; not reliant on water supply
4. No groundwater pollution

Disadvantages:

1. Comparatively new technology: needs information dissemination program for implementation
2. Has higher operation and maintenance requirements than some conventional systems

SIMPLIFIED SEWERAGE

Description: A modified sewerage system which operates as conventional sewers with a number of modifications; the minimum diameter (small bore) and the minimum cover are reduced, the slope is determined by using the tractive force concept rather than the minimum velocity comcept, sewers are installed below sidewalks or inside private properties where possible, and many costly manholes are eliminated or replaced with less-expensive cleanouts.

Design: The design concept takes advantage of having septic tank or aqua privy or imhoff tanks in individual households or communal toilets. For new houses or communities, or houses without septic tank, aqua privy or Imhoff tank, a solids interceptor box/tank should be added between the house and sewer line/laterals, which captures and stores incoming solids, attenuates the flow, and allows the settled sewage to flow out by gravity. The absence of solids in the line permits self-cleansing velocities, flatter gradients and shallower depths. Attenuation of flow reduces the peak flow factor.

Applications: Suitable for areas with topography sloping downward toward treatment site, low-density population and high groundwater or shallow bedrock.

Components: House sewer connection; interceptor/septic/Imhoff tanks/ privies; sewer network

Capacity: Can easily adapt to the population whether urban or rural, high or low density; minimum number of connections required.

Costs: Capital cost: P 56,160 per m^3/day flow. Low to medium investment costs if population density is high, number of connections is large, and 3 to 4 households share one tank/box.
O & M cost: P 245/m^3 or P 2,030/m of pipeline based on regular desludging of tanks, sewerline and inspection.

Utility & Efficiency: The concept is a new technology in the Philippines. Implementation, therefore, needs close monitoring.

Reliability: Reliable if tanks are properly maintained and no coarse materials infiltrate the piping system.

Flexibility: System can be upgraded and extended.

Reapplication Potential: Conditions for simplified sewerage design are available and standards set. All materials are available, locally.

Regulatory/ Institutional Issues:
- Excavation permits needed.
- Will need community participation.

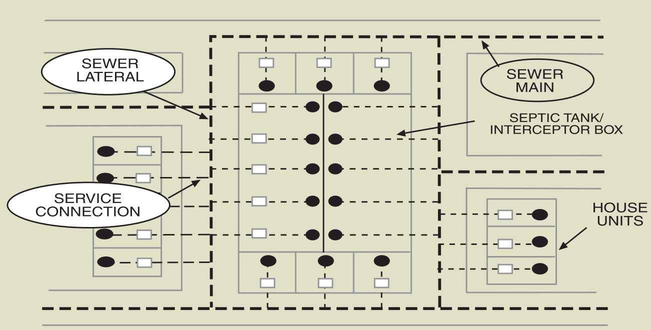
Operating Principles:
1. The sewage solids are intercepted by the interceptor box or baffled box, septic tank, aqua privy or Imhoff tank. The absence of settleable solids negates clogs or blockages in the sewer line despite the smaller diameter and flatter slope.
2. Variation occurs in the rolling terrain where there is a need for pumping. Generally, only one or two pump/lift stations are required in a simplified sewer system.

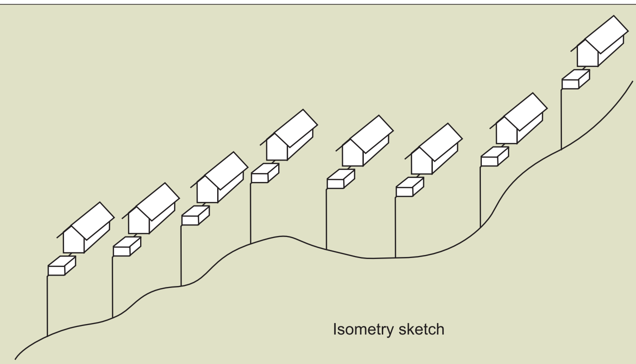
Maintenance:
1. Occasional flushing of the sewer lines.
2. Removal of blockages, rodding machines or flushing equipment.
3. Repairs of sewer lines, as needed.
4. Inspect manhole and conduct television inspection.
5. Desludging of interceptor/septic/Imhoff tanks/privies every 5 years or so.

Construction Materials:
1. Pipes - vitrified clay (VCP), cast iron (CI), brick masonry, steel, concrete or cast-in-place concrete, or polyvinyl chloride (PVC) pipes
2. Cement, reinforcing bars, rubber gaskets

Advantages:
1. Low to medium investment costs, if old septic tanks or aqua privies exist or new tanks are shared.
2. Low excavation, materials and operation costs compared to conventional sewerage (20-50%).
3. Less treatment costs (no pre-treatment).
4. Ease of construction - easily diverted; shallow depths, can follow contours.
5. Low maintenance costs.

Disadvantages:
1. Expert design and supervision required.
2. Each service connection requires a tank/box.
3. Periodic pumping and disposal of septage from tanks.
4. Decentralized maintenance and operation program are required. May require community participation.
5. Illegal connection may be a problem.





Isometry sketch

COLLECTION SYSTEM **CS-02**

COMBINED SEWERAGE

Description: A combined sewerage system is a system combining the disposal of sewage from septic tanks, aquaprivies, or other toilet systems with the storm or rain water through the storm drain system.

Design: Not recommended in high density areas. In other areas, DPWH in coordination with DENR, DOH and other government agencies, shall employ combined sewerage-septage management system (Clean Water Act).

Applications: Not recommended in high density areas. Needs a combined program for sewerage-septage management.

Components: Network of street drains; canals; pipes; manholes; interceptors and sewer overflow structures

Capacity: Capacity is dependent on the drainage area plus the sewage volume generated for that area. Pipes are bigger for a combined system than for separate systems.

Costs: Capital cost: P 25,330 per m^3/day flow. Capital cost includes improvement of existing combined sewerage system, such as:
Interceptor: P 9,480 - 14,620/m
Drainage upgrading: P 420/m - 580/m
O & M: P 350/m

Utility & Efficiency: It is already a common practice in Metro Manila and other urban cities and found acceptable. Treatment efficiency will depend on the process selected.

Reliability: If well designed and operated, the system is reliable.

Flexibility: Can be upgraded to separate sewer system.

Reapplication Potential: Most combined sewers are already existing with no treatment for dry weather flow. What is needed is to divert sewage flow to appropriate treatment units/disposal areas.

Regulatory/ Institutional Issues:

- Coordination/approval of the Department of Public Works and Highways through the City/Municipal Engineer for the use of existing drainage channels must be secured.
- A septage management program must be set-up.

Operating Principles: Combined sewer system to receive relatively clean wastewater from various sewers by means of treatment by on-site primary procedures such as sedimentation and anaerobic digestion.

Maintenance:

1. Regular cleaning of storm drains, canals, drainage pipes or channels.
2. Rodding or removing clogs/stoppages.
3. Repairs of sewer line.
4. Inspection of sewer overflow structures.

Construction Materials:

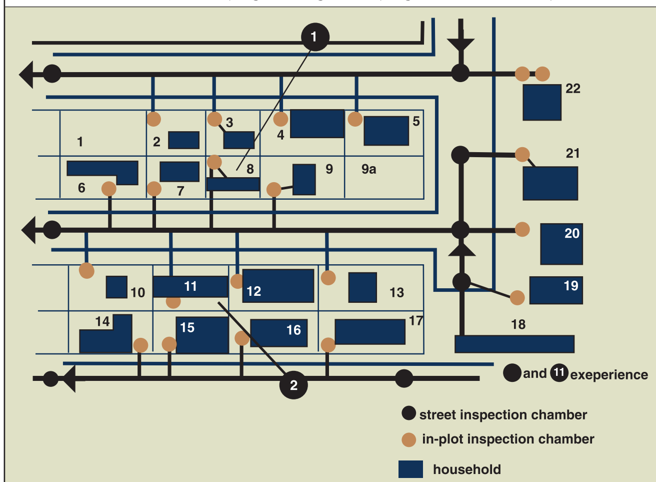
1. Pre-cast reinforced concrete pipe. Cast-in-place sewers, corrugated metal structure/plate structures for sewers
2. Concrete slabs for cover slab
3. Cast-in-frames and covers for manholes
4. Bricks, pre-cast concrete or cast-in-place concrete for manholes
5. Steel and timber tide gates

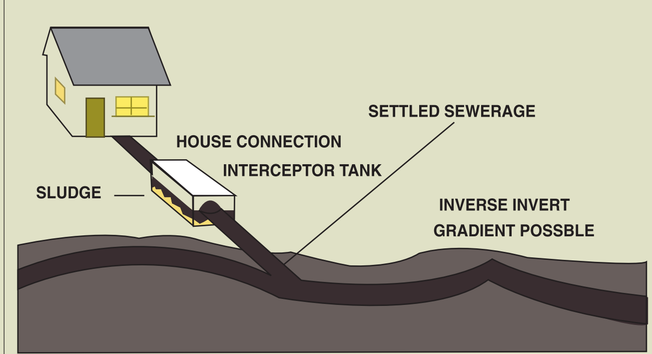
Advantages:

1. Discharge to random open ditches or street gutters is a low cost disposal option. Low first cost.
2. Storm drains are already existing.
3. Less costly to construct than separate sewers.

Disadvantages:

1. Considerable storm flow in treatment plant or considerable sewage flow bypassed.
2. Causes pollution in creeks and esteros.
3. Create health hazards.
4. Unsightly condition.





LEACHING or SOAKAWAY PITS

Description: Leaching or soakaway pits are holes dug in the ground to receive effluent wastes to receive effluent from septic tanks or aquaprivies, and allow it to percolate into the ground. Sometimes used for disposal of kitchen, bathroom and laundry wastewater

Design: Round holes dug into the ground, 1.8 m or more in depth with diameter of 1.0-3.5 m. Side walls are lined with hollow blocks, bricks or stones laid without mortar below the level of the inlet pipe. Design for 8 liters per person per day with infiltration rate of 10 liters/m^2 daily.

Applications: Where water consumption is substantial enough, it will require a soakaway pit. It should be located downhill and at least 15 m away from drinking water sources and wells.

Components: Stone lining (open joints), coarse gravel liners, inlet and outlet pipes, cover slab with a manhole.

Capacity: Life span of a leaching or soakaway pit is normally 6-10 years, if the effluent is only slightly turbid from an efficient primary treatment.

Costs: Cost: P 14,000 for minimun size shown in sketch (i.e. 19 cum volume).
Plus P 540/cum for size larger than minimum.
Practically no maintenance cost.

Utility & Efficiency: Pit content can be treated in a waste stabilization pond or by composting.

Reliability: Not reliable, it may pollute/contaminate groundwater.

Flexibility: Flexible as it can be converted to higher levels of sanitation.

Reapplication Potential: Recommended as alternative when absorption trenches are impractical, pervious soil is deep or where an impervious upper layer is underlain by porous layer.

Regulatory/ Institutional Issues:
- Compliance with Clean Water Act.
- Local ordinances in excavation permit.

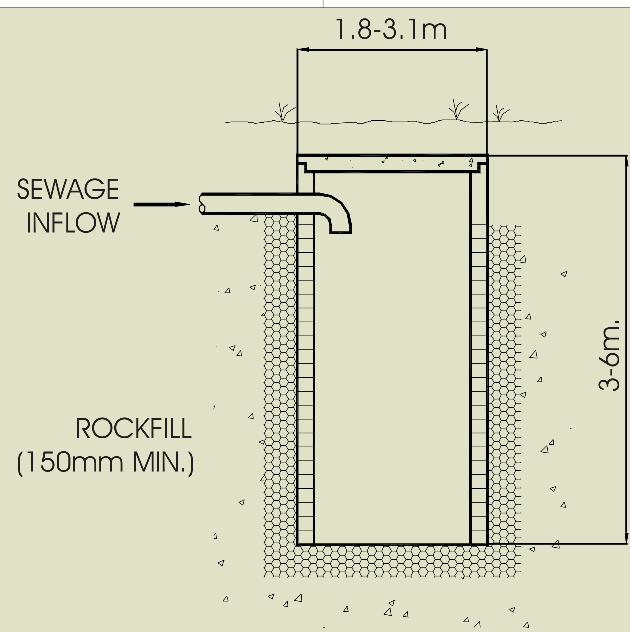
Operating Principles: The liquid portion of the wastes seep into the ground. The solids are retained and accumulate in the pit and gradually seal the pores of the soil.

Maintenance: No maintenance required. The pit should be closed with a tight cover which will prevent access to mosquitoes and flies and to surface water, as well. Sludge layer can be effectively removed by a simple diaphragm pump, if need be.

Construction Materials:
1. Cement grouts
2. Stones, adobe, hollow blocks
3. Reinforced concrete cover slab
4. Rockfill or coarse gravel
5. PVC pipe

Advantages:
1. Accommodates high water consumption.
2. Digestion of the waste proceed more efficiently than in the conventional pit.
3. Contents are liquid enough to be pumped out easily.
4. Makes possible further upgrading of the latrine so that either shower units or conventional water-borne systems can be added, if required.

Disadvantages:
1. Because of the ability of the pit to accommodate high water consumption, this type of pit becomes as popular as a washroom and water use going to the toilet is uncontrolled, thereby, water volume entering the pit is increased substantially and the earth base of the pit cannot cope with the excess liquid (soil conditions not satisfactorily permeable).
2. Not suitable in areas with high groundwater table, due to possible infiltration with leachate



TREATMENT SYSTEM **TS-02**

INTERCEPTOR TANK/BOX

Description: Interceptor tank or box is a rectangular or cylindrical structure placed between the building sewer and the street sewer to intercept the sewage flow from residence/establishment and remove the suspended and floating solids from the sewage. Connection-inspection box is used with or without baffled boxes to intercept solids and trash.

Design: Since most of the solids are removed in the tank/box, there is no need for a scouring or self-cleaning velocity in the sewers. Usual detention time is 24 hours. Volume required for anaerobic digestion of the sludge depends on the volume of solids in the sewage and digestion time.

Applications: Suitable in areas where there are no individual primary treatment units and needs a piped sewerage system.

Components: Influent pipe; effluent pipe; tank/box where sedimentation, digestion sludge storage and sewer storage takes place.

Capacity: 3 m^3 effective volume for a household with five members who uses 100 liters of water per day. Desludging cycle is 5 years.

Costs: Capital cost: P32,000 for unit shown in sketch
Desludging cost is P2,800 every 5 years

Utility & Efficiency: 30-50% BOD removal; 50-85% suspended solids removal.

Reliability: Reliable if properly maintained.

Flexibility: Flexibility in the use of design criteria is unavoidable in order to fit existing conditions.

Reapplication Potential: The design of interceptor box is similar to septic tank and is readily applicable. Materials are also readily available

Regulatory/ Institutional Issues:

- Compliance with Clean Water Act.
- Local ordinances in excavation permit.

Operating Principles: The interceptor tanks remove solids from the sewage by settling the solids and floating the scum. Sludge is removed usually once every 5-10 years.

Maintenance:

1. Removal of solids from the interceptor tank every 5-10 years.
2. The trouble-free operation of simplified sewerage system relies on the correct design of the interceptor tanks.
3. Regular inspection of the tank.

Construction Materials:

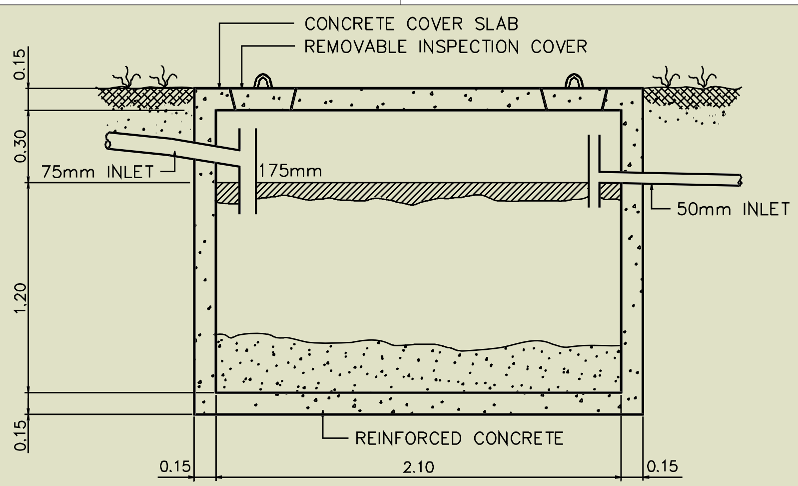
1. Reinforced concrete
2. Cast iron (CI) or polyvinyl (PVC) tee fittings
3. Bricks or concrete blocks with cement base slab
4. Precast concrete

Advantages:

1. Removes solids from the sewage before entering sewer system, thus effectively reducing the size of the piping system.
2. Operation and maintenance requires minimal skills and resources.
3. Reduces primary treatment process in secondary treatment works.

Disadvantages:

1. Maintenance is necessary with trained personnel.
2. If not properly operated and maintained, it may cause blockages in the sewer line.
3. Needs piped water supply.



PLACEMENT OF INLET AND OUTLET
IN THE INTERCEPTOR TANK

TREATMENT SYSTEM **TS-03**

SEPTIC TANK

Description: The septic tank is an underground water tight chamber that receives both excreta and flush water from toilets with or without other household wastewaters (or sullage). The tank serves three purposes: as a sedimentation tank for the removal of incoming solids, while allowing the liquid fraction (or settled effluent) to pass; as a biochemical reactor for the anaerobic decomposition of the retained solids; and as a storage tank in which the non-degradable residual solids accumulate. Scum, such as fats and greases, rises to the top. The clarified liquid flows through the outlet pipe and is usually disposed through a subsurface soil absorption system. The effluent should not be discharged to surface drains, creeks, streams or lakes, without treatment.

Design: Design considerations are as follows:

1. Retention time of at least 24 hours
2. Two thirds of tank volume is reserved for sludge and scum storage
3. Wastewater inflow - 120 liter/person/day
4. Sludge accumulation rate = 40 liter/person/year
5. Maximum filled volume = 50% of tank volume
6. Desludging interval is approximately every 4 years
7. Provide ventilation pipe to permit gas produced in the tank to escape.
8. Must be water tight with one or two chambers.

Applications: Satisfactory and acceptable facility for excreta disposal and other liquid wastes from individual houses, cluster of houses, apartments, and institutions (schools).

Components: Inlet tee pipe; digestion chamber and settling chamber (for 2-chamber tank); outlet tee pipe; manhole cover, clean outs (CO)

Capacity: (typical design)

No. of Persons Served	4	8	12	16	20
Dimensions (m)					
Lenght (L)	2.0	2.5	3.0	3.8	4.0
Width (W)	0.6	0.9	1.1	1.2	1.4
Liquid Depth (D)	1.5	1.5	1.5	1.5	1.5
Freeboad (B)	0.3	0.3	0.3	0.3	0.3
Tank Volume (m3)	2.0	4.0	6.0	8.0	10.0

Costs: Construction cost: (2004)

Tank A: 2m^3 tank (4 persons served) = P 45,000

Other Tanks: Tank A Cost + P 4,000/m^3

Desludging cost = P 2,800 per 4-year interval

Utility & Efficiency: 30-60% BOD removal; 80-85% suspended solid removal; 50% coliform removal.

Reliability: Reliable if regularly cleaned and desludged. ST resistant against shock load.

Flexibility: Flexibility in the use of design criteria is unavoidable in order to fit existing conditions.

Reapplication Potential: Basic septic tank design, materials and technical know-how readily available. Can be upgraded to piped collection for secondary treatment.

Regulatory/ Institutional Issues:

- Conformance to Philippine Sanitation Code.

Operating Principles: The septic tank operates similar to an aqua-privy, I.e., settling solids, anaerobic digestion of solids and storage of digested sludge. Light solids float on the surface of the water in the tank, called scum, is also retained in the tank. Liquid effluent disposed to absorption fields/soil infiltration, leaching or soakaway pits, evapotranspiration mounds or soil conditioner on agricultural land. Sludge from septic tanks or septage is removed by vacuum tankers and co-treated with sewage or other sludge, undergoes own treatment, or disposed in lahar areas or various land applications or surface disposal.

Maintenance:

1. Effluent from septic tank should be inspected periodically to ensure that neither scum nor suspended solids are leaving the system.
2. Regular desludging of septic tank contents should be done when the sludge and scum occupy 2/3 of the tank's capacity. Normally done every 2 to 5 years.

Construction Materials:

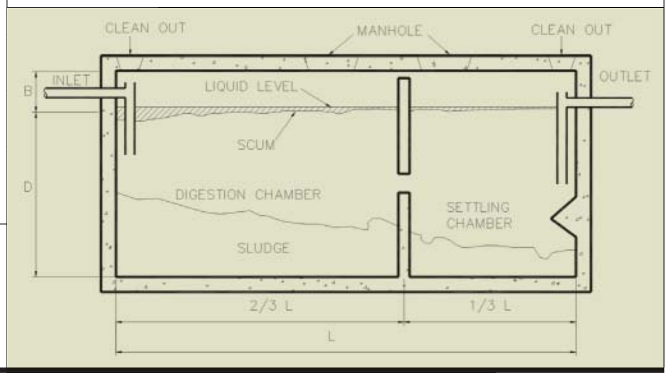
1. Concrete hollow block(CHB) walls, reinforced concrete (RC) top slab and bottom
2. RC manhole cover
3. Polyvinyl chloride (PVC) inlet and outlet pipes
4. Cast iron (CI) or PVC clean outs

Advantages:

1. Flexible and adaptable to a wide variety of individual household waste disposal requirements.
2. Essentially no maintainance needs except the periodic desludging.

Disadvantages:

1. More expensive than other on-site waste treatment systems.
2. Requires a permeable subsoil structure so the effluent can be distributed.
3. Space for drainage field may be required.
4. Drinking water sources must be set away from septic tanks (about 25m.)
5. Needs piped water supply.



IMHOFF TANK

Description: Imhoff tanks are used by small communities with raw wastewater flows on the order of 950 m^3/day (population about 8,000 people or 1,300 households). The Imhoff tank consists of a top compartment, which serves as a settling basin, and a lower compartment in which the settled solids are anaerobically stabilized. Scum and gas vent chambers are located at the sides of the tank. It can be an open or covered tank.

Design: Imhoff tanks are normally designed to retain wastes for 2 to 4 hours; length equals 3 times its width with depth of 7.2 to 9 m, 20% of the total surface area is typically provided for gas vent with width of 0.45 to 0.75 m at both sides. 2.5 m^3/capita storage capacity for sludge digestion is usually provided at the lower compartment.

Applications: Applicable for small communities in urban or rural areas.

Components: Settling compartment; digestion compartment; gas vent and gas chamber; inlet and outlet channels and piping; sludge withdrawal piping; gas vent pipe; tank structure with or without manholes

Capacity: Mostly relatively small plants but it can range from 100-2,000 m^3/day capacity depending in the design. Shown below is a tank for 2,000 m3/day capacity.

Costs: A 1,000 population would need a 100 m^3/day tank with a settling area of 3 m^2, total surface area of 3.75 m^2, total depth of 7.2 m. Using the typical values for the design of imhoff tank, construction cost is Php 1.2M for 2,000 m^3/day capacity.

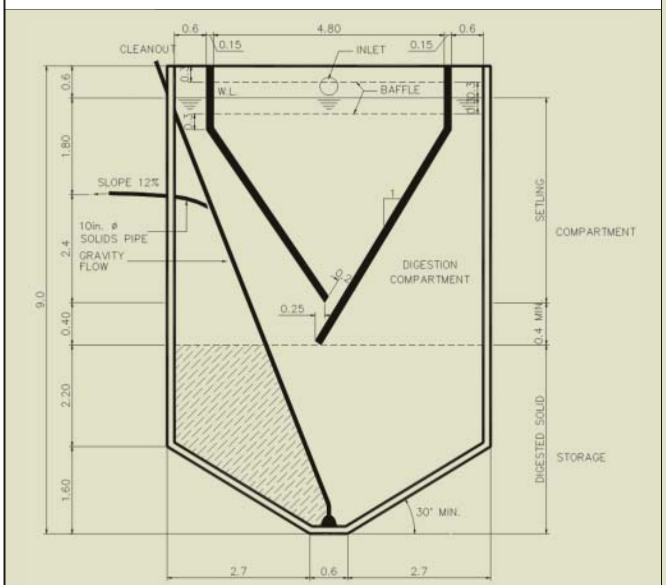
Utility & Efficiency: BOD reduction is about 30-50%, depending on available discharge options; further treatment may still be needed.

Reliability: Reliable if amply designed and desludging carried out routinely. Imhoff tank is resistant against shock loads.

Flexibility: A number of collection, treatment and disposal options can be linked to the Imhoff tank.

Reapplication Potential: Technology and operating procedures are available for Imhoff tanks. Construction materials are readily available.

Regulatory/ Institutional Issues:
- Requires skilled personnel to maintain the facility



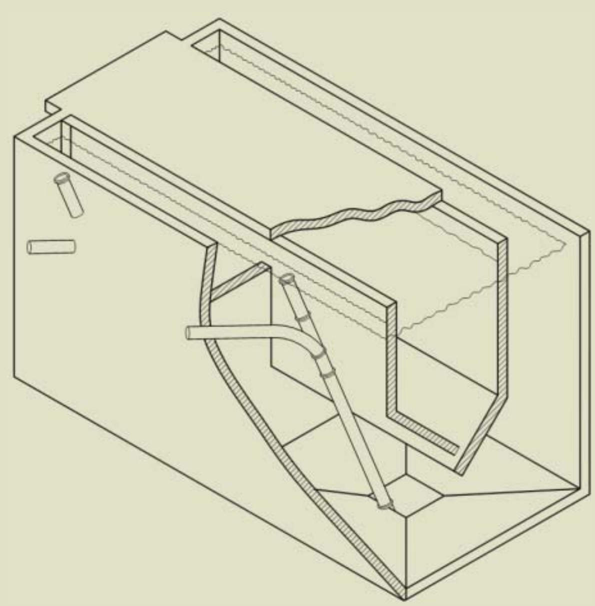
Operating Principles: Settling of solids occurs in the upper compartment. Sludge falls through the slot to the bottom of the settling compartment into the lower tank, where it is digested. Digestion process generates biogas which, is deflected by the baffles to the gas vent chamber, preventing the disturbance of the settling process

Maintenance:
1. Daily cleaning of the scum and other floatables
2. Desludging periodically (once or twice a year)
3. Regular cleaning of the sides of the settling chamber and slot by rake or squeegee
4. Reversing the flow of water twice a month to even up the solids in the digestion chamber

Construction Materials:
1. Reinforced concrete - cement, steel bars, formworks
2. Pipes - cast iron, PVC for inlet, outlet and sludge piping, gas vent

Advantages:
1. Good for small settlements and clustered houses
2. Small area required; land use is limited as it can be constructed under roads or public places
3. Low capital costs
4. Simple operation and maintenance do not require highly skilled supervision
5. More efficient settling than septic tank

Disadvantages:
1. Low treatment efficiency
2. Additional treatment might be needed
3. Requires more often desludging
4. Odor from escaping gases



TREATMENT SYSTEM **TS-05**

ANAEROBIC BAFFLED REACTOR

Description: Anaerobic baffled reactor is actually a septic tank in series where wastewater is forced to flow down through the existence of down-shaft or down-pipe and distributed over the entire area of the floor where it inoculates with active sludge for digestion. The up-flow also causes sludge particles to settle.

Design: Anaerobic treatment is preferred if BOD > 2,000 mg/l. Temperature should be 29° -38°C with pH=6.5-7.5. Not compatible with sulfur compounds. Recommended detention time is between 15-30 days. The design calculation must give detail attention on chamber's geometry, up-flow velocity, organic load, temperature, desludging interval, and retention time.

Applications: The baffled septic tank is suitable for all kinds of wastewater such as wastewater from settlement, hospital, hotel/resort, public market, slaughter house, and food processing industries. The more organic loads, the higher its efficiency.

Components: Settler/integrated with septic tank, designated series of baffled chambers, and down-shaft or down-flow pipe

Capacity: The anaerobic reactor can be efficiently designed for a daily inflow of up to 1,000 population equivalent community wastewater and with BOD of up to 10,000 mg/l. Digester volume can be up to 150 m^3 with inflows up to 10 m^3/d. If used in combination with septic tank and horizontal gravel filter, baffled reactor increases its treatment scalability up to 1,000 m^3

Costs: Capital cost: P12,600 - P30,000/m^3/day flow rate for anaerobic baffled reactor.
Total construction cost depends on material cost and availability, labor costs, and site condition. Detailed feasibility study is required to calculate on-site cost.
O & M cost : P11,000/month plus desludging cost every 5-year interval.

Utility & Efficiency: Reduction of BOD is about 75-90%. Area required ranges from 40 - 150 m^2 depending on the detention period used. Only moderate reduction of infectious organisms; effluent has slight odor (methane).

Reliability: High reliability due to low effect when hydraulic and organic shock loads occur.

Flexibility: Poor flexibility but can be upgraded.

Reapplication Potential: Standardized designs and SOPs are available. It has high potential to be integrated with other post treatments such as anaerobic filter reactor and horizontal gravel filter plant

Operating Principles: Settler or septic tank must be installed to avoid scum and solid particles to enter the baffled section. Inoculation or seeding is required to hasten the achievement of adequate treatment performance. If not, three months of maturation should be acknowledged. If possible, start with a quarter of the daily month. Such flow management will give time for bacteria to multiply before suspended solids are washed away.

Maintenance:

1. Check scum blanket, break up if too thick
2. Control foaming
3. Monitor total solids build up and gas production
4. Regularly schedule cleaning of solid waste build up by manual or vacuum desludging. Desludging must regularly be done on a calculated interval and some sludge must be left to ensure continuous efficiency. Regular control of solid intervention to every chamber must be done

Construction Materials:

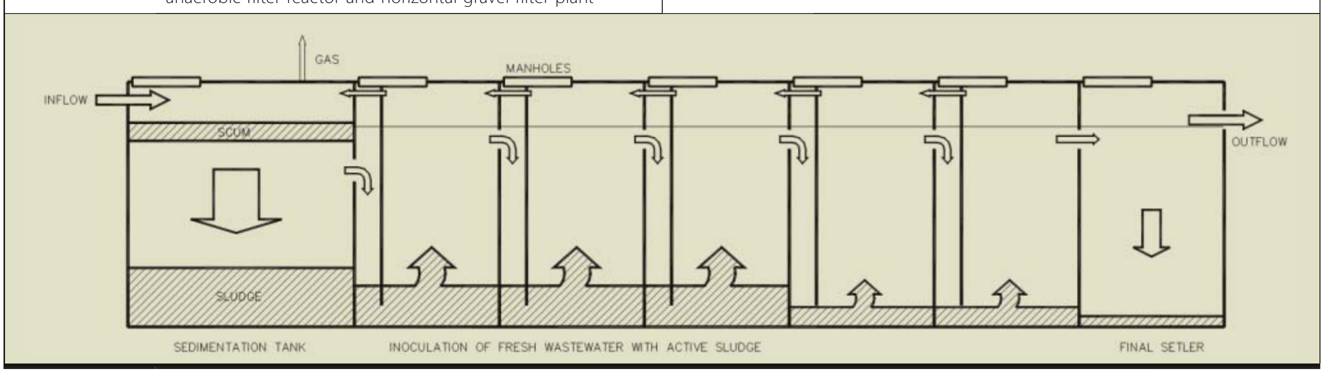
1. Reinforced concrete or steel tanks or concrete hollow block (CHB) or bricks
2. Acid resistant pipes such as polyvinyl chloride (PVC)

Advantages:

1. Suitable for smaller and larger settlements
2. Little space required due to underground construction
3. Low investment costs
4. Very low operation and maintenance costs. No moving parts power needed. Hardly any blockage
5. Simple and durable
6. High treatment efficiency

Disadvantages:

1. Experts are required for design and supervision
2. Master mason is required for water-tight plastering
3. Effluent is not completely odorless
4. Slow growth rate of anaerobic bacteria means long start up period
5. Less efficient with weak wastewater



TREATMENT SYSTEM **TS-06**

WASTE STABILIZATION PONDS

Description: Relatively shallow earthen basins which contain wastewater that allows biological processed (aeration or digestion) to take place, in the presence or without the presence of air/oxygen.

Design: Basic system design: 3 types of ponds (in series):
Anaerobic pond (AP) - organic matter removal
Facultative pond (FP) - pathogen destruction and organic matter treatment

Maturation pond (MP) - pathogen and suspended solids removal

Design factors - volume of sewage, strength of the sewage, desired quality of the effluent, climate

Design life - 20 to 50 years
AP - 100 to 400 gms/m^3/day BOD loading
FP - maximum BOD load per unit area at which the pond will still have a substantial aerobic zone

MP - number and size depends on the bacteriological quality required

Applications: In areas where a large space is available for treatment.

Components: Inlet, anaerobic pond; facultative pond; maturation pond; outlet

Capacity: 260 to 3,200 m^3/day of sewage

Costs: Capital cost: P 32,000 for unit shown in sketch
Desludging cost is P 2,800 every 5 years

Utility & Efficiency:

Pond	BOD Removal	Pathogen Removal	Detention Time	Area Requirement (m²)
AP	50 - 85%	-	2-5 days	2,000 - 8,000
FP	80 - 95%	-	5-30 days	8,000 - 40,000
MP	60 - 80%	90%	15-20 days	8,000 - 40,000

Reliability: Reliable if properly maintained.

Flexibility: Can withstand shock loads.

Reapplication Potential: Natural terrain favors this type of pond. Basic design know-how readily available.

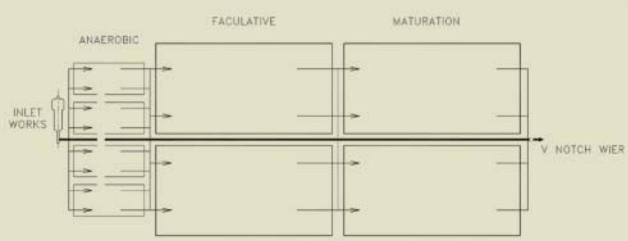
Operating Principles: Depending on the strength of the sewage (BOD & coliform), detention time in anaerobic pond is 2 to 5 days; 5 to 30 days in facultative pond and 15-20 days in the maturation pond.

Maintenance:
1. Periodic vegetation, plants, algae and scum control.
2. Control of odor, if any.
3. Monitor volume and BOD of the sewage.
4. Desludging of AP (say 2 to 5 years) and FP (very infrequent).

Construction Materials:
1. Earth embankments - homogeneous soil with clay or silt contents.
2. Use clay blanket or lining if soil is highly permeable.

Advantages:
1. Simple to build, reliable and easy to maintain.
2. Provides pathogen removal which is better than the conventional treatment.
3. Used in small communities.
4. Low in construction and operating cost.

Disadvantages:
1. Large area requirement.
2. Poor quality of treated effuent.
3. May promote breeding of insects in the pond.
4. Needs to be located far from communities.



ENGINEERED REED BED

Description: Engineered Reed Beds are natural treatment systems, which are widely used for the removal of pollutants from domestic and industrial wastewater and sludge. These systems consist of a bottom-lined bed or channel filled with sand or appropriate soil media. Reeds are allowed to grow at the bed. Flow direction in the filter bed may be horizontal or vertical. The treatment mechanisms are biological conversion, physical filtration and chemical absorption. The mechanisms of BOD removal are aerobic, anoxic and anaerobic. Continues flow often results in saturated filter bodies and mainly anaerobic millieu. In the Philippines, engineered reed beds are mostly for treatment of industrial wastewater and is not yet common for domestic wastewater treatment. Effuent from residential septic tanks discharged to a reed bed green belt has great potential in urban areas.

Design: The land area required for the horizontal subsurface flow reed bed system depends on the wastewater flow rate (or equivalent number of persons), filter media and plant specie. The table below shows an estimate of the reed bed size for a given number of user.

No. of Users	Approx. Area (m^2)	Length x Width (m)	Depth (m)
50	250	32 x 8	0.5
100	500	45 x 11	0.5
500	2500	100 x 25	0.5

The common specie used is Phagmytes spp, noted for its root growth and an endemic specie in the Philippines.

Note: For vertical flow reed bed systems, the area required is half that of the horizontal flow. A square bed layout is preferable.

Operating Principles: The most Important factors in decreasing the wastewater pollutants are the soil, aerobic and anaerobic microbes and the reed plant. The soil layer acts as a filter. Micro-organisms and plants alter organic matter, nitrogen and phosphorous to remove it through gaseous release, uptake, fixation, sedimentation and transformation into other compounds. Concentrations of heavy metals, organic chemicals and pathogens are reduced due to adsorption and natural die-off.

Maintenance:

1. Periodic harvesting of the reeds
2. Maintenance of dike from erosion, pipes from clogging and free-flowing drainage outfalls
3. Periodic washing of filter material

Advantages:

1. Easy and simple to maintain and operate
2. Low-cost secondary treatment option
3. Pleasant landscaping is possible

Disadvantages:

1. Requires larger land area
2. Low treatment efficiency
3. Professional/specialist needed in design & construction

Applications: Wide applications for secondary treatment of industrial wastewater where large land area is available. For residential areas, a sewer network system collects the septic tank effluent and conveyed to the reed bed system.

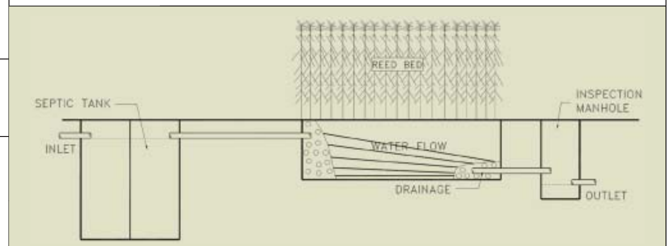
Costs: Estimated cost at P 1,500/m^2 for horizontal flowbeds and P 2,500/m^2 for vertical flowbeds excluding land cost. Operational cost mainly consist labor cost for reed cutting at 3-4 years interval.

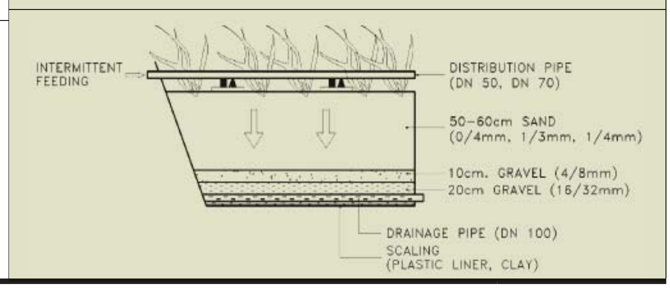
Utility & Efficiency: Low treatment efficiency. Reduction of BOD during secondary treatment about 10-30%. Reduction of infective organisms is high.

Reliability: Usually reliable but shock load and flooding of the filter needs to be avoided.

Regulatory/ Institutional Issues:

- Compliance to Clean Water Act or DENR regulations





TREATMENT SYSTEM **TS-08**

BIOGAS REACTOR

Description: Biogas is a by-product of anaerobic decomposition of organic matter, such as animal manure, human waste, sewage sludge, dried leaves, and crop residues. It is an alternative source of energy for use in household cooking, heating, lighting and for municipal and idustrial use.

Design: 50 - 100 liters of waste to produce 2 m^3 of biogas per day. Chamber must be air-tight. Approximately 15 - 28 m^3 of methane gas per 1,000 persons per day. For pigs, it is 40 - 60 m^3 of gas for 1,000 kgs. of waste.

Applications: Of great benefit to rural areas in developing countries where organic matter is readily available.

Components: Digestion tank; fixed or floating cover; sludge/waste inlet pipe; gas removal pipe; pressure relief and vacuum valve.

Capacity: Small biogas plants can serve at least 200 households.

Costs: Capital cost: P31,600/m^3 of waste flow or P1.00/kg of sludge
O & M cost: P18,000/month, which includes cleaning of facility and desludging

Utility & Efficiency: Utilization of methane gas. BOD/COD reduction through anaerobic digestion is 80 - 85%

Reliability: Resistant against shock loads. Reliable if operated and maintained well.

Flexibility: Upgrading of system not possible due to poor flexibility.

Reapplication Potential: Basic biogas plant design, materials and technical know-how are available.

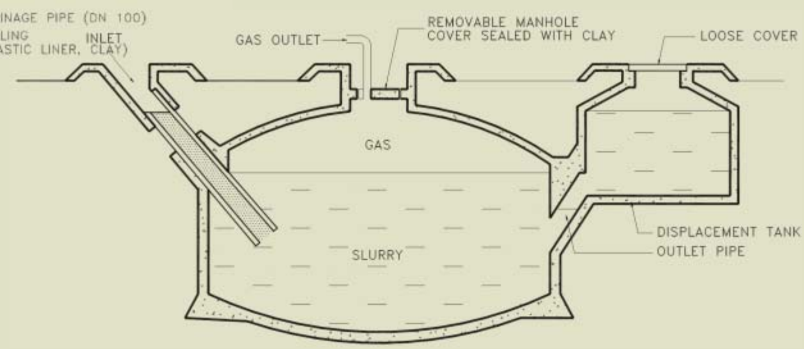
Operating Principles: Human waste is mixed with animal manure and crop residues in an anaerobic digester, where it is decomposed without oxygen at relatively high moisture content (90-99.5%). Wastes are decomposed into volatile acids and then, biogas. Other by products are amines, nitrates and ammonia (fertilizer) by the breakdown of proteinaceous materials. Pure sludge introduced continuously or intermittently, can also be retained in a reactor for varying periods of time, to produce biogas.

Maintenance:
1. Check scum blanket; break up, if necessary
2. Monitor gas production, acidity/alkalinity ratio
3. Control foaming in digester
4. Monitor total solids

Construction Materials:
1. Steel or reinforced concrete tanks
2. Heat and acid resistant piping system

Advantages:
1. Self-reliant technology
2. Savings in power and foreign exchange
3. More efficient as fuel than firewood
4. Recycles nutrient back into the soil

Disadvantages:
1. Needs proper proportioning of organic matter and wastes
2. Users need to be trained in the use and maintenance of the system; expert supervision is required
3. Requires expertise/craftsmanship in construction
4. High risk of corrosion problem and septic odor



TREATMENT SYSTEM **TS-09**

ROTATING BIOLOGICAL CONTACTORS (RBC)

Description: A rotating biological contactor consists of a series of closely spaced circular disks of polystyrene or polyvinyl chloride or polypropylene. The disks are submerged in wastewater and rotated slowly through it.

Design: RBCs are usually designed on the basis of loading factors derived from pilot-plant and full-scale installations. Both hydraulic and organic loading-rate criteria are used in sizing units for secondary treatment. Loading rate is 29-49 kgs of BOD/m^2/day or 16-96 kgs of BOD/1000 m^3 of media.

Applications: Great variety of applications in small package treament units, central sewage treatment plants, local wastewater treatment and industrial waste treatment appropriate for small to medium-sized communities.

Components: RBC mounted on a tank; primary treatment units such as septic tank, Imhoff tank, anaerobic tank; clarifier; flow regulator; pumps; bar screen/comminutor (if needed)

Capacity: Smallest packaged unit for 10-15 house; complete sewage treatment of communities; industrial waste application.

Costs: High capital costs - P 600,000 for a 5 m^3/d module
O & M cost: P 16,000/month
Energy requirement is only 2-3 hp per module

Utility & Efficiency: 90-95% BOD removal; high process stability. Space requirement is 18 m2 for 60-70 m^3 of wastewater. Area is four times bigger than that of SBR.

Reliability: Generally more reliable than other fixed-film processes because of the large amount of biological mass present (low operating food to microorganism ratio, F/M).

Flexibility: Adaptability of the biological films offer excellent opportunity for the purification of single-loaded wastewater; displaceable due to modular design..

Reapplication Potential: Available in modular units and can be installed in locally built tanks.

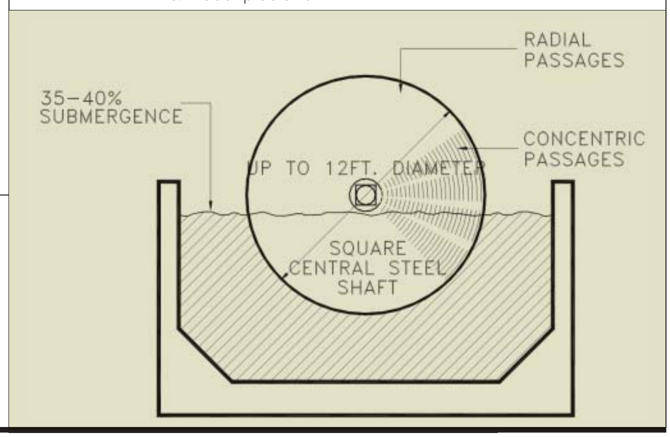
Operating Principles: Biological growths become attached to the surfaces of the disks and eventually form a slime layer over the entire wetted surface area of the disks. The rotation of the disks alternately contacts the biomass with the organic material in the wastewater and then with the atmosphere for adsorption of oxygen. The disk rotation affects oxygen transfer and maintains the biomass in an anaerobic condition. The rotation is also the mechanism for removing excess solids from the disks by shearing forces it creates and maintaining the sludge in suspension so they can be carried from the unit to a clarifier. RBCs can be used for secondary treatment, and they can also be operated in the seasonal and continuous-nitrification and denitrification modes.

Maintenance:
1. Regular spray washing of excess biomass monthly or bimonthly
2. Lubrication of moving parts
3. Purging of settled sludge on monthly or bimonthly basis

Construction Materials:
1. Reinforced concrete, fiberglass reinforced plastic (FRP) or steel tank
2. Circular discs of polystyrene, PVC or polypropylene

Advantages:
1. Low space requirement
2. Can withstand hydraulic and organic surges more effectively
3. High treatment efficiency
4. Low energy and maintenance requirement
5. Well drainable excess sludge

Disadvantages:
1. Contact media are not readily available in the market
2. High capital cost of equipment
3. Must be covered for protection against rain, wind, sunlight, and vandalism
4. Failures in shafts and media
5. Odor problems



TREATMENT SYSTEM **TS-10**

SEQUENCING BATCH REACTOR (SBR)

Description: The Sequencing Batch Reactor (SBR) is a fill and draw activated sludge treatment system. The processes involved are similar to the conventional activated sludge system. The SBR, however uses a single reactor basin for aeration and sedimentation/clarification and surface liquid removal. One tank or multiple tanks can be used. SBR, oxidation ditch and submerged membrane bioreactor are biological sewage treatment processes identified as preferred processes for the capacity range of 1,000 to 20,000 m^3/d.

Design: Detention time - 16-36 mins.; BOD loading 0.02-0.07 kg BOD/kg MLVSS; 2,500-6,000 MLSS; 0.91-1.36 kgs of oxygen required per kg BOD applied.

Applications: Capable of handling all types of wastewater i.e. domestic, commercial and industrial wastes in limited spaces. Can treat sewage from small-sized communities.

Components: Bar screen, comminutor, equalization tank, SBR (reactor), programmable logic controller (PLC), blower/diffusers/aerators, valves and controls

Capacity: Recommended capacity range of 1,000 - 20,000 m^3/day or an urban community with a population of about 3,500 to 200,000. Smaller plants to 100 m^3/day capacity can be made available.

Costs:

Plant Capacity (m^3/day)	Capital Cost (P)
200	17,050,000
1,000	44,990,000
5,000	126,420,000

Annual O & M cost: Php 3,000/m^3 of flow

Utility & Efficiency: Excellent in most cases. 85-98% BOD and TSS removal. Area requirement: 180-1,000 m^2 for equivalent people of 1,000-10,000, or 0.52 m^2/m^3 of flow. Better control bulking sludge

Reliability: Relatively easy to operate due to microprocess technology and fewer mechanical equipment.

Flexibility: Tremendous flexibility achieved by changing operational strategy (cycle duration, cycle sequence and aeration mixing strategy). Greater flexibility with nutrient removal.

Reapplication Potential: Packaged plants already available, but design, materials, equipment and labor are also readily available.

Regulatory/ Institutional Issues:

- Requires an entity to operate and maintain the facility

Operating Principles: In this process, four different phases are carried out - filling while aeration is in process, settling of the aerated sewage, settled sludge is decanted while the treated water overflows for further chlorination. Blowers are used to aerate and mix the effluent.

Maintenance:

1. Check oil and grease level
2. Check equipment if functioning
3. Sampling and analyses
4. Observe process performance
5. Perform sludge settleability tests
6. Measure pH, temperature and dissolved oxygen
7. General housekeeping cleanliness
8. Maintenance records

Construction Materials:

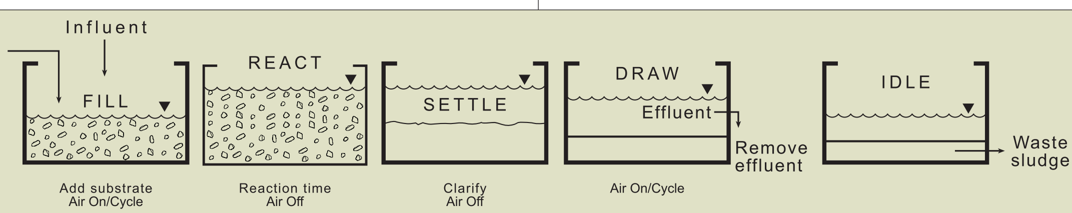
1. Steel reinforced concrete or plastic tanks
2. Metals for auxiliary facilities

Advantages:

1. Efficient treatment
2. Tolerates hydraulic and organic shock loads (high inlet variation)
3. Modular construction facilitates future expansion
4. Provides a simple, reliable, automatic and flexible wastewater treatment process within a basin (simple design and construction)
5. Highly flexible and fully automatic (simple and easy control and operation)
6. Relatively small space requirement

Disadvantages:

1. Most of the component parts are patented and comes from abroad
2. Capacities are fixed and no flexibility
3. More expensive than other treatment methods
4. In case of power failure, reactor may overflow
5. Requires more skilled attention



OXIDATION DITCH

Description: Oxidation ditch is a process where screened and degritted raw materials are mechanically aerated in various forms - ring-/oval-shaped ditch or channel, to provide BOD reduction. After treatment, liquid and sludge are separated in a final settling tank

Design: Mixed liquor suspended solids (MLSS) from 5,900 to 4,300 mg/l. Food to microorganism (F/M) ratio is 0.06 and sludge age is 20 days. Circulation is 0.25-0.35 m/s.

Applications: Use for small communities or where large area of land is available. Batch applications are more adaptable where total waste flow is experienced over a portion of the day (i.e. 8-12 hours).

Components: Oval ditches; blower and diffusers; mechanical motors/mixers or submerged mixers; live feed system; adjustable weirs; covers; clarifiers

Capacity: For flow range of 200 - 3,000 m^3/day
Area required 465 m2 for a 600 m^3/day flow

Costs:

Plant Capacity (m^3/day)	Capital Cost (P)	Annual O&M Cost (P)
200	19,370,000	228,000
600	35,760,000	319,200
2000	67,910,000	478,800

Annual O & M cost: Php 3,000/m^3 of flow

Utility & Efficiency: BOD removal efficiency is 95-97%; capable of removal efficiency equal to that of tertiary treatment plants.

Reliability: Capability to handle hydraulic shock loadings.

Flexibility: Process is flexible. Maximum flexibility with consistent high quality effluent

Reapplication Potential: Available in modular units and can be installed in locally built tanks. Design know-how, materials, and labor are also locally available. Equipment has to be imported.

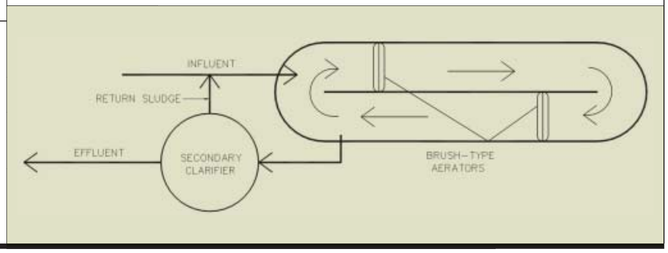
Operating Principles: As the mixed liquor flows through the channel/ditch, it is subjected to alternating aerobic and anoxic conditions. Aeration is provided by blowers and diffusers while mixers keep solids in suspension in the anoxic zones and impart required velocity. The effluent from oxidation ditch is settled in a final clarifier.

Maintenance:
1. Adjustment of rotor immersion by raising/covering a weir
2. Preventive maintenance on rotors and other equipment
3. Maintenance of weirs, slide gates, structures and other appurtenances

Construction Materials:
1. Stainless steel, galvanized steel or painted carbon steel
2. Reinforced concrete walls/structure for ditch and clarifier
3. Steel clarifier (boat-type)

Advantages:
1. No primary settling tanks needed
2. Capable of meeting tough discharge standards
3. Relatively small space requirement
4. Most stable performance of all continuous flow mechanical biological system

Disadvantages:
1. Requires highly skilled attention and operation
2. Large energy requirement for equipment operation
3. Large volume of sludge generated



SLUDGE DRYING BED

Description: Sludge drying bed is one method for dewatering sludge through reduction of moisture content by filtration and evaporation. The bottom of the filter bed is laid with perforated pipes for draining the filtrate or seepage water. After drying, moisture content is reduced by 35% or less. Sludge drying beds are normally located near treatment plants to receive/treat the sludge produced by primary/secondary treatment.

Design: 0.21 - 0.58 m^2/capita of area requirements. Width of bed is usually 4 m and depth of sand and gravel layer is 70 cms average. 1-2 m^3 of sludge/m^2 of bed loading.

Applications: Applicable where space is available. Most commonly used means for dewatering sludges.

Components: Concrete structure for bed and walls; filter media (sand and gravel); splash block; underdrain system; inlet pipe

Capacity: For treatment plants serving a population of 1,000 up to 20,000

Costs: Investment lowest among sludge dewatering methods.
O & M: No other cost except for labor

Utility & Efficiency: Dried sludge is not fully disinfected, but solid content is increased to 50-70% total solids.

Reliability: Reliable during dry season, but efficiency decreases during wet season.

Flexibility: Good process flexibility.

Reapplication Potential: Have good potentials for implementation by communities and/or local government.

Regulatory/ Institutional Issues:

- Requires a work force for operating and maintaining the facility.

Operating Principles: Sludge is applied to the beds in 20 cm depth or layer. Drying take place due to evaporation and filtration or percolation. The dried sludge is removed manually and applied for agricultural use or sold as organic compost. The filtrate, however, needs to be treated further.

Maintenance:

1. Replacement of sand every 6 months or 1 year
2. Prevent weed and grass encroachment
3. Regular dried sludge removal

Construction Materials:

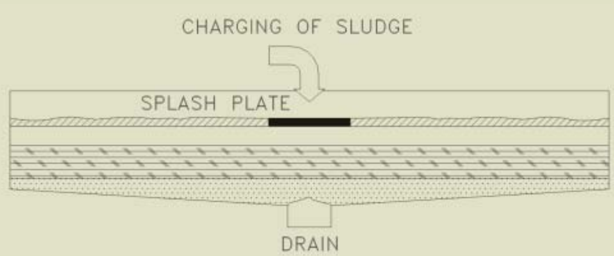
1. Concrete walls
2. Sand and gravel
3. Cast iron (CI) or polyvinyl chloride (PVC) pipes
4. Asphalt paved sludge beds

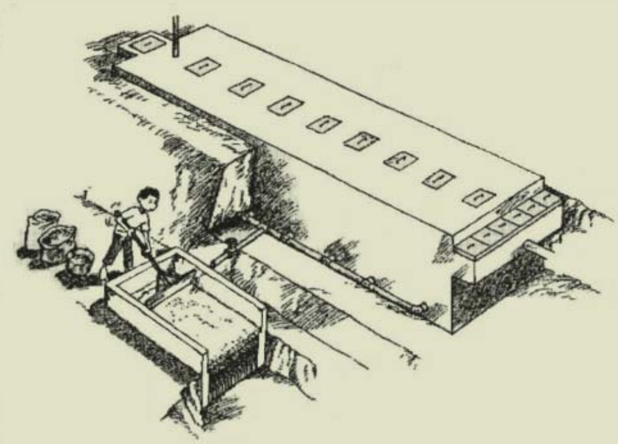
Advantages:

1. Simple to operate
2. Lowest cost option among sludge dewatering methods
3. Energy-saving

Disadvantages:

1. Filtrate/seepage water has to be treated
2. Requires solar power
3. May produce odor and flies nuisance





SLUDGE DISPOSAL **SD-02**

AGRICULTURAL REUSE OF SEWAGE, SEPTAGE OR SLUDGE

Description: Application of septage, sludge or sewage (treated or untreated) to sites infrequently visited by the public such as urban, tourist, and recreational areas. Stabilization/treatment to reduce pollutants, odors, pathogens, and vector attraction may be encouraged or required. Land application may be done by means of spreading by hauler truck, farm tractor, wagon or other vehicle, spraying ridge and furrow irrigation or by specialized equipment to inject the sewage/septage/sludge beneath the soil surface. Application of stabilized wastes can be for specific sites such as lahar areas, agricultural fields, forest land, reclamation sites.

Design: The purpose of this guide is to present practical information on the handling, treatment and disposal of septage in a concise, recommendation-oriented format for easy reference. It is not intended to provide detailed engineering design information. Typical rate is 10 tons/hectare/year.

Applications: Applicable for most rural communities with sufficient suitable land.

Components: Receiving and holding facility; application equipment; mixing system

Capacity: Depends on land availability and it may vary from 100-1,000 m^3/ha/year.

Costs: Can be expensive if farms or agricultural areas are numerous and long transportation distances are involved.

Utility & Efficiency: The pathogen and vector reduction requirements can be met by raising the pH of the septage/sludge/sewage to 12 or greater for 30 minutes. pH is raised by adding alkali such as lime and caustic soda.

Reliability: A properly managed land application program achieves beneficial reuse of waste organic matter and nutrients without adversely affecting public health.

Flexibility: Provision for receiving and holding facilities to provide operational flexibility.

Reapplication Potential: System can be implemented by settlements in rural areas by self-help or by local authorities or service providers.

Regulatory/ Institutional Issues:

- Compliance with the Clean Water Act, local ordinance
- Social acceptability may be difficult to obtain
- Restriction on food crops subjected to land application of septage/sludge/sewage

Operating Principles: Sludge is applied to the beds in 20 cm depth or layer. Drying take place due to evaporation and filtration or percolation. The dried sludge is removed manually and applied for agricultural use or sold as organic compost. The filtrate, however, needs to be treated further.

Maintenance:

1. Replacement of sand every 6 months or 1 year
2. Prevent weed and grass encroachment
3. Regular dried sludge removal

Construction Materials:

1. Concrete walls
2. Sand and gravel
3. Cast iron (CI) or polyvinyl chloride (PVC) pipes
4. Asphalt paved sludge beds

Advantages:

1. Simple to operate
2. Lowest cost option among sludge dewatering methods
3. Energy-saving

Disadvantages:

1. Filtrate/seepage water has to be treated
2. Requires solar power
3. May produce odor and flies nuisance

DISCHARGE INTO RECEIVING BODY OF WATER

Description: The discharge of treated wastewater or wet weather flow from combined sewers into rivers is an acceptable way of disposal if special conditions are met. Usually, water is directly discharged into river through pipes. For discharge, it is necessary to ensure that the self-purification capacity of receiving streams is not toppled or adversely affected. Moreover, it is necessary not to endanger health of residents who live down stream on the riversides. It should be guaranteed that they can still use river water in the usual way (e.g. hygiene, nutrition). The discharge of untreated wastewater into rivers can only be accepted under certain conditions and should only be seen as a temporary solution.

Design: The purpose of this guide is to present practical information on the handling, treatment and disposal of septage in a concise, recommendation-oriented format for easy reference. It is not intended to provide detailed engineering design information. Typical rate is 10 tons/hectare/year.

Applications: Applicable for most rural communities with sufficient suitable land.

Components: Receiving and holding facility; application equipment; mixing system

Capacity: Depends on land availability and it may vary from 100-1,000 m^3/ha/year.

Costs: Can be expensive if farms or agricultural areas are numerous and long transportation distances are involved.

Utility & Efficiency: The pathogen and vector reduction requirements can be met by raising the pH of the septage/sludge/sewage to 12 or greater for 30 minutes. pH is raised by adding alkali such as lime and caustic soda.

Reliability: A properly managed land application program achieves beneficial reuse of waste organic matter and nutrients without adversely affecting public health.

Flexibility: Provision for receiving and holding facilities to provide operational flexibility.

Reapplication Potential: System can be implemented by settlements in rural areas by self-help or by local authorities or service providers.

Regulatory/ Institutional Issues:
- Compliance with the Clean Water Act, local ordinance
- Social acceptability may be difficult to obtain
- Restriction on food crops subjected to land application of septage/sludge/sewage

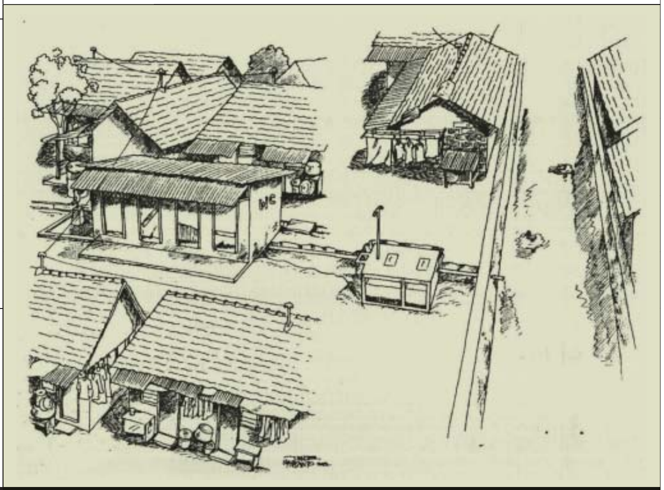
Operating Principles: The wastewater (raw or treated) discharged should have a quality better than the receiving water quality standard. Dilution and assimilative capacity may no longer be considered by the regulating agency.

Maintenance:
1. Replacement of sand every 6 months or 1 year
2. Prevent weed and grass encroachment
3. Regular dried sludge removal

Construction Materials:
1. Concrete structures
2. Pipes - concrete, cast iron, PVC vitrified clay

Advantages:
1. Very low-cost disposal option
2. Implementation can be done by communities
3. Operation and maintenance is very simple

Disadvantages:
1. Use of raw river water downstream is not recommended
2. Depending on treatment options and river flow, overload of rivers is possible



EFFLUENT DISPOSAL **ED-02**

AQUACULTURE

Description: With the help of fishponds and aquaculture, pre-treated wastewater can be utilized and contained nutrients can be recycled into the food chain. In principle, pre-treated wastewater is let into a pond where the contents are utilized by different species of microorganisms, plants and fishes. For a full scale treatment and to maintain optimized conditions for the species it is common to use pond systems in series of two or three modules.

Design: Retention time is 10-40 days; mean depth is 0.9 m (0.5 m at inlet and 1.5 m at outlet). Need for a depuration pond to remove contaminants.

Applications: Suitable in areas where there are fishponds or in areas near the sea, rivers, swamp/marshs, etc. Also applicable where space is available within urban settlements.

Components: Fishpond with earthen embankments, inlet and outlet pipes; fish population

Capacity: Small and large scale applications possible. Pre-treatment determines scope of aquaculture.

Costs: Feasibility of effluent reuse option depends on land prices/free land use possibility. Pay back function through yield.

Utility & Efficiency: If proper function can be guaranteed, good treatment efficiency can be expected.

Reliability: Usually reliable but in cases of careless use, forms a hazard to residents. Collapse of the system can occur

Flexibility: Can be upgraded with introduction of secondary treatment before the fishpond.

Reapplication Potential: High self help potential where aquacultures has a tradition. But cooperation of experts is recommended for pollution control.

Regulatory/ Institutional Issues:

- Subject to compliance with the Clean Water Act
- For coordination with owner(s) of the fishpond

Operating Principles: Nightsoil or compost or treated sludge is collected by carts, trucks or boats and brought to the fishponds to be fed upon by fish. Depuration takes place in another clean pond water.

Maintenance:

1. Removal of weeds and other aquatic plants regularly
2. Prevent formation of floating scum and to allow oxygen to come through
3. Maintain the riprap of the embankments

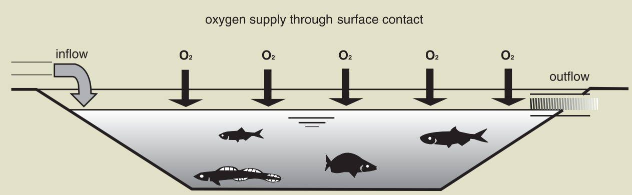
Construction Materials: None if fishponds are existing, otherwise need liner material for some soil types. Piping is required

Advantages:

1. Utilization of nutrients
2. Relieves rivers through the reduction of direct pollution load

Disadvantages:

1. Solution limited to very certain situations
2. Hazardous to human health if not functioning properly, and collapse of the treatment unit is possible. Cannot treat harmful industrial wastes
3. May need inclusion of anaerobic pond at head of works to reduce recycle of fish worm eggs



ANNEX 1
SURVEY INSTRUMENTS

SOCIO-ECONOMIC AND DEMAND INVESTIGATION IN RESIDENTIAL COMMUNITIES	SURVEY INSTRUMENT	1a

A. General

1. Community Name	2. Barangay	3. Town/City	4. Province
5. Respondent's Name	6. Sex ◎ Male ◎ Female	7. Age	8. Civil Status ◎ Single ◎ Widow/er ◎ Married ◎ Separated
9. Relationship to the family	10. Occupation	11. Educational Attainment	

B. Household Information

1. Ave. HH Monthly Income	2. Ave. HH Monthly Expenses ◎ Below P5000 ◎ P5001 - P7000 ◎ Over P7000	4. No. of Household Members who are :	
		Children	Adults (18+)
3. Expense Items	Cost per Month	5. No. of Household Members who are :	
Food		Schooling	Working
Clothing			
House rent & maintenance			
Transportation		Other Expense Items Details	Cost per Month
School fees, supplies, allowance			
Light			
LPG/gas			
Potable water			
Use of communal toilet& bath			
Garbage disposal			
Medical			
Recreation or entertainment			
Others (from right column)		Total, to left column	
TOTAL			

C. Standard of Living

1. Housing Materials / Status of Ownership

Permanent Hollow blocks / GI roofing	◎ Owned	◎ Rented	◎ Shared	◎ Free *(allowed to stay)*	◎ Others
Semi-permanent Wood, hollow blocks, GI roofing	◎ Owned	◎ Rented	◎ Shared	◎ Free *(allowed to stay)*	◎ Others
Temporary/makeshift Bamboo, nipa, coconut hatches, scrap materials	◎ Owned	◎ Rented	◎ Shared	◎ Free *(allowed to stay)*	◎ Others

2. Lighting Facilities

◎ Electricity ◎ Kerosene ◎ Others ____________________

3. Cooking Facilities

◎ Electricity ◎ LPG ◎ Kerosene

◎ Wood ◎ Charcoal ◎ Others ____________________

4. Sources of Potable Water

◎ Handpump/tubewell ◎ Standpipe/public faucet (Level II)

◎ Improved spring ◎ Individual faucet (Level III)

◎ Rain water ◎ Water purchase (in containers)

◎ Bottled water ◎ Others, specify

5. Uses of Water Supply

	Potable	Secondary Quality
Drinking	________ %	________ %
Cooking	________ %	________ %
Bathing	________ %	________ %
Cleaning	________ %	________ %
Laundry	________ %	________ %
Flushing toilet	________ %	________ %
Others (specify)	________ %	________ %
TOTAL	________ %	________ %

Total % of Potable + Secondary Quality Water must be equal to 100%.

6. Sources of Secondary Quality Water

◎ Open dug well ◎ River/lake

◎ Underdeveloped spring ◎ Water purchase

◎ Rain water ◎ Same as potable water source

7. How many percent of drinking water is -

Boiled ________________ % Drunk as is ________________ % Bottled water ________________ %

D. Health, Sanitation and Hygiene (Beliefs, Practices and Perception)

1. Number of children born dead in the last 10 years

2. Family members who died from tropical diseases in the last 10 years

Number of family members	Their ages at death

3. Water and sanitation diseases observed based on signs and symptoms as recalled in the last 2 weeks
   - ◎ Diarrhea
   - ◎ Stomach Ache

4. Water and sanitation diseases diagnosed in the last 3 months:
   - ◎ Gastroenteritis ◎ Hepatitis A ◎ Fungal infection ◎ Dengue
   - ◎ Typhoid fever ◎ Amoebiasis ◎ Scabies ◎ Malaria
   - ◎ Intestinal parasitism (e.g. hookworm) ◎ Cholera ◎ Poliomyelitis ◎ Filarial
   - ◎ Schistosomiasis

5. Who got sick?
   - ◎ Adult member — Specify cause:
   - ◎ Child 5 years old and above — Specify cause:
   - ◎ Child below 5 years old — Specify cause:

6. Causes of sanitation diseases as known to households
   - ◎ Poor sanitation/hygiene ◎ Poor nutrition ◎ Accidents/physical trauma ◎ Others (specify)
   - ◎ Contaminated water ◎ Poor infrastructure/drainage ◎ Overcrowding *Limited house space*

7. Common remedies applied
   - ◎ Doctor consultation ◎ Hospital treatment ◎ Others (specify)
   - ◎ Herbal ◎ Self medication

8. Average cost per treatment

9. If you did not consult a doctor or availed of hospital services, why?
   - ◎ Lack of medical services & facilities ◎ Limited government assistance
   - ◎ Expensive medicines ◎ Low wage or unemployed

10. How could some water-related diseases be prevented?
    - ◎ Boil drinking water. ◎ Wash hands with soap and water after toilet use. ◎ Use toilet properly for defecation and urinating.
    - ◎ Chlorinate drinking water. ◎ Reduce stagnant water around house. ◎ Use disinfectants to clean house/toilet.
    - ◎ Bathe regulary.

11. Do you have a toilet facility in your house?
    - ◎ Yes
    - ◎ No

12. If yes, what type of facility?
    - ◎ Tank flush with septic tank ◎ Sanitary pit privy/ ventilated pit latrine ◎ Pit privy/cesspool/ overhung
    - ◎ Pour-flush latrine ◎ Bucket system ◎ Aqua privy

13. Why is a toilet facility important to you?

14. Problems with your present toilet facility
    - ◎ Frequent clogging ◎ Vector problems
    - ◎ Foul odor ◎ Others:

15. Do you want to improve your present facility? ◎ Yes ◎ No
    Why?

16. Type of improvement:
    - ◎ Upgrade
    - ◎ Others:

17. How much are you willing to spend for the improvement?

18. If there is no present facility, why have you not installed one?

19. Do you want to install one? ◎ Yes ◎ No
    Why?

20. How much are you willing to spend for the new facility?

21. What type of toilet facility would you want to install?
    - ◎ Pour-flush ◎ Cistern flush ◎ Septic tank ◎ Aqua privy
    - ◎ Pit privy ◎ Pour-flush latrine ◎ Tank flush ◎ Cesspool

Result of inspection of facility

22. Privacy
    - ◎ With door
    - ◎ Curtain only

23. Water and sanitation supplies available
    - ◎ Water ◎ Soap ◎ Tissue paper

24. Toilet location
    - ◎ Inside the house
    - ◎ Outside the house

25. Durability
    - ◎ Concrete walls
    - ◎ Board walls

26. Others
    - ◎ Separate bathing room ◎ Combined toilet & bath ◎ Waste receptacle

SOCIO-ECONOMIC AND DEMAND INVESTIGATION IN RESIDENTIAL COMMUNITIES	SURVEY INSTRUMENT	1a

D. Health, Sanitation and Hygiene (Beliefs, Practices and Perception)

27. Defecating/urinating practices	Father	Mother	Grandpa	Grandma	School Kids	Pre-Schoolers	Babies	Care Givers	Other Adults
Defecate at -									
	Choices: (a) private toilet (b) public toilet (c) open area (streets, fields, sea, etc.) (d) wrapping in newspaper or using pail or garbage bin.								
Urinate at -									
	Choices: (a) private toilet (b) public toilet (c) open area (streets, fields, sea, etc.) (d) using pail.								
Anal cleansing by -									
	Choices: (a) Stick/corncob/stone (b) Water (c) Newspaper (d) Tissue paper (e) None								
Washing of hands after anal cleansing -									
	Choices: (a) With water only (b) With soap and water (c) None								
Consult doctor in case of diarrhea									
	Choices: (a) Yes (b) No								

28. Who takes care of your pre-school children's hygiene?

- ◎ Mother/Father
- ◎ Older siblings
- ◎ Others (specify)

29. How do you dispose of babies' disposable diapers?

- ◎ Burning in backyard
- ◎ Wrapping and throwing
- ◎ Burying
- ◎ Throwing in garbage
- ◎ Flushing feces in toilet bowl before throwing in the garbage

E. Sanitation Improvement Options and Willingness to Pay

This section of the survey willl be taken up in the Focus Discussion Group where the types of improvement will be explained. Obtain reaction of the participants. Note that approximate costs may still change.

Option	Description	Willingness to pay				
Option 1:	Use of community sanitation center (communal toilets) with septic tank or other treatment facility	Willingness to pay:				
		◎ Over P1,000	◎ P1,000 - P750	◎ P500	◎ P250	◎ nil
Option 2:	Use of settled sewerage (collection system) - capital investment by LGU or other entity	Willingness to pay for connection fee of P5,000 plus the following O&M cost				
		◎ Over P1,000	◎ P1,000 - P750	◎ P500	◎ P250	◎ nil
Option 3:	Use of combined system and treatment facility	Willingness to pay for maintenance of existing drainage (canals/pipes) used as collection system				
		◎ Over P1,000	◎ P1,000 - P750	◎ P500	◎ P250	◎ nil
Option 4:	Disposal/re-use of effluent and sludge	Willingness to pay for disposal service fee				
		◎ Over P500		◎ P500	◎ P250	◎ nil

F. Social Activities and Facilities / Institutions

1. Community organizations present	Name
◎ Youth organization	
◎ Mothers' organization	
◎ Senior citizens' organization	
◎ Parish councils	
◎ School-based organizations	
◎ Cooperatives	
◎ Day care centers	
◎ Health centers/clinics	
◎ Others, specify	

2. Programs and services of community organizations

- ◎ Health and nutrition
- ◎ Livelihood
- ◎ Others, specify
- ◎ Environment & sanitation
- ◎ Sports

3. Degree of reach or coverage of benefits of projects

- ◎ All households
- ◎ Only a few households
- ◎ Majority of households
- ◎ Don't know

4. Do you have any preference on the type of sanitation services and/or technology for the community?

- ◎ Pipe system
- ◎ Covered canals
- ◎ Slush/sewer
- ◎ Desludging (Malabanan)

5. Have you been consulted in the choice of toilet/sanitation services in your Barangay? ◎ Yes ◎ No

G. Related Community Problems

1. Do you know of any problem related to wastewater, water, garbage, sanitation or hygiene that affected relationships between and among households?
   If yes, specify

2. How was it resolved?

Interviewed by	Date of Survey	Checked by:

TECHNICAL SURVEY OF RESIDENTIAL COMMUNITIES

SURVEY INSTRUMENT 1b

A. General

1. Community Name	2. Barangay	3. Town/City	4. Province
5. Respondent's Name	6. Sex ◎ Male ◎ Female	7. Age	8. Occupation

B. Physiography / Zonal Location

1. Barangay Population	2. As of year-	3. Number of Houses	4. Number of Households	5. Persons per Household

Arrangement of Houses and Accessibility

6. Arrangement	7. Accessibility
◎ Irregular ◎ Regular pattern	◎ Limited space ◎ Backyard/frontage space
◎ Clusters of ________________ houses	◎ Narrow passages ◎ Bounded by national/provincial/city road

Area and Topography

8. Barangay area (ha.)	9. Town/City area (ha.)	10. Map obtained from LGU or other sources ◎ Yes ◎ No
11. Topography ◎ Flat ◎ Rolling/hilly ◎ Sloping		12. Photo taken ◎ Yes ◎ No

Drainage Condition

13. Type of drainage ◎ Canals ◎ Pipes ◎ None	14. Do you notice wet spots? ◎ Yes ◎ No
	15. Are there wetlands nearby? ◎ Yes ◎ No
16. Incidence of flooding ◎ Every heavy rainfall ◎ During typhoons ◎ Rarely	17. Is there a river/canal nearby? ◎ Yes ◎ No

Surface Soil Condition

18. Condition	19. Topsoil depth (meters)
◎ Clayey ◎ Silty ◎ Sandy ◎ Gravelly	

Geology

20. Is there any adobe/rock exposed nearby? ◎ Yes ◎ No If yes, specify type:

21. Water Table Condition *(check open well, canal, etc., in vicinity)*

◎ Shallow (less than 2 m.) ◎ Deep (over 2 m.) ◎ Depth of water from ground (m.):

Climate

22a. When are the rainy months?	22b. When are the dry months?	23. Condition during Survey
		Temperature (°C) : ◎ Dry ◎ Humid

24. Zonal location of community	25. Land use of adjoining property
◎ Urban ◎ Rural ◎ Peri-urban	◎ Residential ◎ Commercial ◎ Industrial

TECHNICAL SURVEY OF RESIDENTIAL COMMUNITIES | SURVEY INSTRUMENT 1b

C. Existing Water Supply and Sanitation Condition and Practices

1. Water Sources

◎ Open well Distance from house (m.) Frequency of fetching water/day No. of buckets (20 liters) filled up/day	◎ Handpump Distance from house (m.) Ownership of handpump ◎ Individual ◎ Communal Estimated water consumption (m^3/day)	◎ Level II / Standpipe Distance from house (m.) Operating hours/day Barangay water system? ◎ Yes ◎ No	◎ Level III System Operating hours/day Estimated water consumption (m^3/day) under Levels II and III

2. Sanitation Practices / Types

Toilet Type			Sullage/grey water
◎ Direct ◎ Pour-flush ◎ Tank flush ◎ Cistern flush	◎ Open pit/overhung ◎ Pit privy/latrine ◎ Aqua privy ◎ Wrap & throw	◎ VIP latrine ◎ Pour-flush latrine ◎ Cesspool	◎ Septic tank/privy Septic tank size: ______ x ______ x ______ m. ◎ Storm drain ◎ Street

3. Drainage / Discharge

3a. Type of storm drain ◎ Open ◎ Covered ◎ Drain pipe ◎ No system	3b. Where does the wastewater flow? ◎ Seep to ground ◎ Drainage ◎ No system 3c. Where does the septic tank effluent go? ◎ Seep to ground ◎ Drainage ◎ Others, specify

3d. Are you aware of any ordinance on sanitation and wastewater practices?

◎ DOH regulations ◎ DENR administrative orders ◎ Clean Water Act ◎ not aware

D. Water Pollution Situation

1. Observed pollution sources ◎ Poor drainage ◎ Poor sanitary practice	2. Uses of water bodies within the area ◎ Source of drinking water ◎ Recreation ◎ Bathing ◎ Fishing ◎ Washing ◎ Others, specify	3. Receiving water body *(conduct visual inspection)* Color: Odor:
4. Wastewater characteristics (describe)	Sampling made ◎ Yes ◎ No	Sampling made ◎ Yes ◎ No

E. Community Facilities for Sanitation / Environment

1. Communal Facility / Public Toilet

Usage Fee (Php)	Average revenue/day (Php)

2. Wastewater/Sewage Treatment Facility

Personnel *(enumerate positions directly involved in the facility)*	Estimated budget (P/mo.)

3. Water System & Facility

Ave. monthly electricity bill of a household (P/mo)	Ave. monthly water usage per household (m^3/mo)	Ave. monthly water bill of a household (P/mo)

4. Solid Waste Practices

◎ Collected by LGU ◎ Individual composting ◎ Burning in backyard ◎ Others, specify	Fee for hauling/disposal (P)	Frequency of collection per week

5. Street Cleaning

◎ By Barangay LGU ◎ Others, specify

TECHNICAL SURVEY OF RESIDENTIAL COMMUNITIES	SURVEY INSTRUMENT	1b

F. Organization/Management

Business Enterprises in the Community *(i.e., piggery, fish processing)*

Type of Business	Business Name

G. Organization/Management

Local construction materials available in the locality

◎ Bamboo ◎ Coco lumber ◎ Hollow blocks ◎ Sand & gravel ◎ Adobe / Stones

H. Remarks and Other Observations

Sketches *(use back pages for more space)*

Interviewed by	Date of Survey	Checked by:

TECHNICAL INVESTIGATION OF SMALL OR MEDIUM ENTERPRISE OR INDUSTRY

SURVEY INSTRUMENT 2

A. General

1. Entity Name		2. Barangay and Town/City	3. Province
4. Location or Address		5. Respondent's Name	6. Respondent's Position
7. Owner	8. Year of start of operations	9. Year of expansion	10. Description of expansion

Building Description

11. Type	12. Dimensions		13. Area (in sq. m.)		14. Other description
◎ Single storey	Length (m.)	Width (m.)	Floor area	Land area	
◎ Multi-level	15. Footprint area (sq. m.)		16. Photo taken? ◎ Yes ◎ No		

B. Area Physiography and Land Use

1. Topography *(Inspect area)*
   ◎ Flat ◎ Flat - sloping ◎ Rolling - multilevel ◎ Others, describe

2. Drainage condition *(Inspect area)*
   ◎ Open/covered canals ◎ Pipes ◎ No evident drainage

3 .Wet spots noted
   ◎ Yes ◎ No

4. Flooding experiences
   ◎ Every heavy rainfall ◎ During typhoons ◎ Rarely ◎ Others, describe

5. Wetlands nearby?
   ◎ Yes ◎ No

6. River or canal nearby?
   ◎ Yes ◎ No

7. Other water bodies nearby? *(describe)*

8. Surface soil condition
   ◎ Clayey ◎ Silty ◎ Sandy ◎ Gravelly

9. Topsoil depth (m.)

10. Geology *(Inspect area)*
   Any adobe/rock exposed nearby? ◎ Yes ◎ None Type (describe)

11. Water Table Condition *(check open well, canal, etc., in vicinity)*
   ◎ Shallow (less than 2 m.) ◎ Deep (over 2 m.) Depth of water from ground (m.):

Climate

12. When are the rainy months?	13. When are the dry months?	14. Condition during Survey	
		Temperature (°C):	◎ Dry ◎ Humid

15. Land use of vicinity area / zonal land use *(Inspect area)*
   ◎ Residential ◎ Industrial
   ◎ Subdivision ◎ Vacant lot
   ◎ Informal ◎ Others, specify
   ◎ Commercial

16. Accessibility of site
   ◎ Within poblacion
   ◎ Outside poblacion

17. Bounded by:
   ◎ National road
   ◎ Local main road

18. Typical traffic condition
   ◎ Light ◎ Moderate ◎ Heavy

C. Existing Condition of Water Supply and Sanitation

Water supply system

◎ 1. Hand pump	1a. Estimated monthly consumption (m^3/mo)			
◎ 2. Level II/Standpipe	If deepwell/tank is owned:			
◎ Deepwell/tank not owned ◎ Deepwell/tank owned	2a. Operating hours/day	2b. Water tank volume (m^3)	2c. Pump capacity (Hp)	2d. Estimated monthly consumption (m^3/mo)
◎ 3. Level III	If operated by water utility:			
◎ Privately owned ◎ Operated by water utility	3a. Average monthly bill (P)		3b. Average monthly consumption (m^3/mo)	

TECHNICAL INVESTIGATION OF SMALL OR MEDIUM ENTERPRISE OR INDUSTRY	SURVEY INSTRUMENT	2

C. Existing Condition of Water Supply and Sanitation

Sanitation condition / type

4. Individual Toilets			
4a. No. of toilets	4b. Type ◎ Squat ◎ Seat	4c. Water tank vol. (m^3)	4d. Bathing cubicle available? ◎ Yes ◎ No If yes: Quantity Length, m Width, m.
	4e. Flushing ◎ Pour ◎ Tank		
5. Communal Toilets			
5a. No. of toilets	5b. Type ◎ Squat ◎ Seat	5c. Water tank vol. (m^3)	5d. Bathing cubicle available? ◎ Yes ◎ No If yes: Quantity Length, m Width, m.
5e. No. of cubicles	5f. Flushing ◎ Pour ◎ Tank		
6. Sewage Treatment ◎ Septic tank	◎ Sewer line to treatment plant	7. Sewage treatment effluent discharged to: ◎ Canal	◎ Soak pit
8. Drainage / Discharge - Type of Storm Drain ◎ Open canal	◎ Covered canal	◎ Drain pipe	◎ No system

TECHNICAL INVESTIGATION OF SMALL OR MEDIUM ENTERPRISE OR INDUSTRY	SURVEY INSTRUMENT	2

D. Sanitation Practices

1. Wastewater disposal	2. Wastewater characteristics - Sampling obtained
◎ Drainage ◎ Sewer ◎ Septic tank	◎ No None to date ◎ Yes No. of samples taken/year:

3. Solid waste disposal

◎ Collect/Haul to Dumpsite	◎ Segregation	◎ Recycle/Re-sue	◎ Composting/Buried	◎ Others (specify)
Cost (P/month):	Cost (P/month):	Cost (P/month):	Cost (P/month):	Cost (P/month):
Frequency/week:				

D.1 Sanitation Practices in a Public Market

Market cleaning/wastewater disposal

5. Wet section cleaning by:	6. Dry section cleaning by:
◎ Water jetting ◎ Others, specify	◎ Sweeping ◎ Others, specify
Frequency in a week:	Frequency in a week:

D.2 Sanitation Practices in a Beach Resort

7. Swimming pool cleaning by:	8. Cottages/Huts cleaning by:	9. Beach area cleaning by:
◎ Water jetting ◎ Others, specify	◎ Sweeping ◎ Others, specify	◎ Sweeping/raking ◎ Protective net ◎ Others, specify
Frequency in a week:	Frequency in a week:	Frequency in a week:

D.3 Sanitation Practices in a Hospital

Wastewater Management Practice

10. Chemicals used in the Laboratory	11. Chemicals used in operations (specify)
◎ Formalin ◎ Alcohol ◎ Xylene ◎ Hydroxide	
◎ Mercury ◎ Silver ◎ Acids ◎ Solvents	

12. Disposal of laboratory/operation washings

◎ Drainage ◎ Septic tank ◎ Sewer ◎ Others, specify

E. Existing Water Pollution/Environment Situation

1. Observed pollution sources	2. Uses of water bodies within the area
◎ Poor drainage ◎ Poor solid waste disposal	◎ Drinking water source ◎ Washing ◎ Fishing
◎ Poor sanitary practice ◎ Others, specify	◎ Bathing ◎ Recreation ◎ Others, specify

3. Receiving water *(conduct visual inspection)*		4. General environment	
◎ Drainage canal	Color:	Aesthetics ◎ Poor	Health hazards ◎ Prevalent
◎ Creek	Odor:	◎ Fair	◎ Uncertain

TECHNICAL INVESTIGATION OF SMALL OR MEDIUM ENTERPRISE OR INDUSTRY	SURVEY INSTRUMENT	2

F. Usage and Revenue

F.1 For a Public Market

1. Market Time	Everyday: From ______ am to ______ pm		Other days: From ______ am to ______ pm	
2. Usage	No. of Stalls	Area, sq. m.	Fees/Rental Rate/mo.	Total Revenue/mo.
Wet (fish, meat) section			P	P
Dry goods section			P	P
Eateries/Refreshments			P	P
Parking			P	P
Others			P	P
Total				P

Public toilet

3. Fee per use:	4. Average number of users	5. Average revenue per month
P	per day	P

F.2 For a Beach Resort

6. Usage	Quantity	Average Usage Rate/week	Fees/Rental Rate/day	Total Revenue/mo.
Sheds			P	P
Cottages			P	P
Function Rooms			P	P
Canteen			P	P
Others			P	P
Total				P

7. Entrance fee per person: P	8. Average persons - per day: per week:

F.3 For a Hospital

8. Hospital type	◎ Primary	◎ Secondary with major OR	◎ Tertiary (all)
9. Bed capacity (number)	Ward:	Pay beds:	Charity beds:
10. Average occupancy rate per year, % :	Ave. no. of patients per year-	In-patient:	Out-patient:

G. Organization/Management/Operation and Maintenance Costs

1. Organization/Management Set-Up

Private (e.g. BOT scheme)	LGU-run	Unit/Dept. in-charge:
On lease Starting year:	Others, specify	

2. Staffing, Costs	No. of Management Personnel	No. of Technical Personnel	O&M Cost per Year (P)	Annual Budget for Adm. (P)	
Administration					
Medical (for hospitals only) Nursing				Personnel ,%	O&M,%
Ancillary					
Water supply					
Wastewater management					
Solid waste management					
Hazardous waste management					

3. Cite problems relating to organization/management of enterprise particularly on wastewater/sanitation management.

4. What problems/difficulties have you encountered in the O&M of the existing sanitation system/facility?

◎ Lack of funds ◎ Lack of skilled personnel ◎ Lack of tools/ spare parts ◎ Lack of as-built plans ◎ Others, specify ◎ None

TECHNICAL INVESTIGATION OF SMALL OR MEDIUM ENTERPRISE OR INDUSTRY	SURVEY INSTRUMENT 2

H. Demand for the Sanitation Facility

1. Current / proposed programs for expansion / rehabilitation / improvement	Budget

2. Does this include wastewater/sanitation facilities?
◎ Yes ◎ No
If yes, specify

3. If a soft loan is available for sanitation facilities/improvement, will you avail of it?

◎ Yes
Why?

◎ No
Why?

4. If given the necessary funds, how would you implement O&M?

◎ Sub-contract ◎ Supplier ◎ In-house ◎ Others, specify

5. Which of the following government agencies with regulatory/ monitoring functions on sanitation compliance have you been in contact with recently?

◎ DENR-EMB ◎ DOH

◎ LGU ◎ Others, specify

6. Are you aware of any of their rules and regulations?
◎ Yes ◎ No
If yes, specify

7. Besides solid waste disposal, are you aware of any regulations / restrictions, laws on wastewater disposal?

◎ Yes ◎ No If yes, which one:

◎ Clean Water Act ◎ Sanitation Code ◎ LLDA regulations ◎ LGU regulations

I. Remarks and Other Observations

Sketches *(use back pages for more space)*

Interviewed by	Date of Survey	Checked by:

ANNEXES 2 - 4

LIST OF ORGANIZATIONS PROVIDING INFORMATION AND ASSISTANCE ON SANITATION

LIST OF SELECTED WEB-BASED RESOURCES ON SANITATION AND HYGIENE PROMOTION

CREDIT - FUNDING FACILITIES FOR SANITATION PROJECTS IN THE PHILIPPINES

ANNEX 2 LIST OF ORGANIZATIONS PROVIDING INFORMATION AND ASSISTANCE ON SANITATION

NAME	DESCRIPTION	CONTACT DETAILS
A. GOVERNMENT DEPARTMENTS		
Department of Environment and Natural Resources (DENR)	Conservation, management, development and proper use of the country's environment and natural resources thru government's programs and projects. Licensing and regulation resources utilization	Visayas Avenue, Diliman, Quezon City, Philippines (02) 929-6626 www.denr.gov.ph (also provides regional offices details)
Department of Health (DOH)	Improvement of health and sanitation condition thru programs and projects. Regulation of providers of health goods and services	San Lazaro Compound, Sta. Cruz, Manila, Philippines (02) 743-8301 to 23 www.doh.gov.ph (also provides regional offices details)
Department of Interior and Local Government (DILG)	Supervise the functions of local government units and implementation of the plans and programs on local autonomy	A. Francisco Gold Condominium II, EDSA corner Mapagmahal St., Diliman, Quezon City, Philippines (02) 925-0330 to 31 www.dilg.gov.ph (also provides regional offices details)
Department of Public Works and Highways (DPWH)	Planning, design, construction and maintenance of infrastructures that are safe for public use	A. Bonifacio Drive, Port Area, Manila, Philippines (02) 304-3000 www.dpwh.gov.ph (also provides regional offices details)
B. LOCAL AUTHORITIES ON ENVIRONMENT, WATER, AND SANITATION		
Environmental Management Bureau (EMB-DENR)	Formulates Implementing Rules and Regulations (IRRs) for environmental laws. Regulates/monitors compliance to IRRs	Visayas Avenue, Diliman, Quezon City, Philippines (02) 927-1517, 928-3742, 928-3782 www.emb.gov.ph
Laguna Lake Development Authority (LLDA)	Promotion, development and maintenance of Laguna de Bay and its watershed with precautionary measures so as not to disturb, deteriorate and pollute the ecological systems	Rizal Provincial Capitol Compound, Shaw Boulevard, Pasig City, Philippines (02) 637-3250 www.llda.gov.ph
Local Water Utilities Administration (LWUA)	Water resources and supply in provincial cities and urban communities	MWSS-LWUA Complex, Katipunan Road, Balara, Quezon City, Philippines (02) 920-5449, 920-5581 www.lwua.gov.ph
Metropolitan Waterworks and Sewerage Systems (MWSS)	Water supply and sewerage services in Metro Manila	4/F Administration Building, MWSS Complex, Katipunan Road, Balara, Quezon City, Philippines (02) 922-3757, 922-2969, 920-5560 www.mwss.gov.ph
National Water Resources Board (NWRB)	Development of the country's water resources, formulation and implementation of utilization policies, supervision of utilities and franchises, and regulation of water rates	8/F NIA Building, EDSA, Diliman, Quezon City, Philippines (02) 928-2365 www.nwrb.gov.ph
C. LOCAL ORGANIZATIONS		
Center for Advanced Philippine Studies (CAPS)	Conducts relevant researches and projects in the areas of integrated waste management (ISWM), solid waste management and ecological sanitation, and makes the results available to national and local leaders for sound decision making	Rm. 202 Loyola Heights Condominium, E. Abada St. cor. F. dela Rosa St., Loyola Heights, Quezon City, Philippines (02) 929-8429 www.caps.ph
Committee on Ecology, House of Representatives	Jurisdiction over legislation on ecosystem management including pollution control, which covers the areas of air and water quality management, waste management, environmental impact assessment and global environmental concerns	3/F Annex Bldg., House of Representatives, Quezon City, Philippines (02) 931-5346 or 931-5001 loc. 7136 www.congress.gov.ph/committees/search.php?d=A501
Philippine Association of Water Districts Inc. (PAWD)	Provides ways to forge linkages between and among water districts throughout the country	2/F LWUA Bldg., Katipunan Road, Balara, Quezon City, Philippines (02) 920-5453 or 927-5032
Philippine Center for Water and Sanitation (PCWS)	Works for the awareness, appreciation, protection and conservation of resources, and offers technical assistance and consultancy services in environment and sanitation, policy advocacy, action researches, trainings, appropriate for water supply	Penthouse 3 Minnesota Mansion, 267 Ermin Garcia St., Cubao, Quezon City, Philippines (02) 912-0531 or 421-9470 www.itnphil.org.ph

C. LOCAL ORGANIZATIONS		
Philippine Ecosan Network (PEN)	Promotes awareness, appreciation and the practice of ecological sanitation in the Philippines	5/F Francisco Gold Condominium II EDSA cor. Mapagmahal St. Diliman, Quezon City, Philippines (02) 927-1875 www.ecosan.ph
Philippine Institute of Civil Engineers (PICE)	Promotes and enhances the practice of civil engineering thru improved and more advanced studies, education, knowledge and research	Unit 701, 703, 705, Futurepoint Plaza, Cond. I, 112 Panay Avenue, Quezon City, Philippines (02) 448-7487 to 90 www.pice.org.ph
Philippine Institute of Environmental Planners Inc. (PIEP)	Promotes the physical, economic, socio-cultural, aesthetic, and environment-friendly development of regions, cities and municipalities	Ground Floor, SURP Building University of the Philippines Diliman, Quezon City, Philippines (02) 920-9705
Philippine Society Of Sanitary Engineers Inc. (PSSE)	Enhances sanitary engineering profession thru studies and research. Provides information on sanitation	418 Capinpin Avenue, Camp Aguinaldo, Quezon City, Philippines Telefax: (02) 9114606
Philippine Water Partnership (PWP)	Promotes good practices, disseminates information, and engages its members in a dialogue to discuss issues and provides recommendations concerning the country's water resources management	National Hydraulics Research Center UP College of Engineering Building Diliman, Quezon City, Philippines (02) 927-7149 or 76
Philippine Waterworks Association (PWWA)	Encourages close relations among those engaged in the waterworks industry. Disseminates information for the improvement of water service	PWWA Bldg., Katipunan Road, Balara, Quezon City, Philippines (02) 920-7145
D. INTERNATIONAL ORGANIZATIONS AND AGENCIES WITH OFFICES IN THE PHILIPPINES		
Asian Development Bank (ADB)	Provides financial and technical assistance to government projects that reduce poverty, provides basic education and healthcare, and promotes healthy environment	6 ADB Avenue, Mandaluyong City, Philippines (02) 632-4444, 683-1000 www.adb.org
Australian Agency for International Development (AusAID)	Plans and coordinates poverty reduction activities, programs and policies with developing countries	Australian Embassy, Level 23 Tower 2 RCBC, 6819 Ayala Avenue, Makati City, Philippines www.ausaid.gov.au
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)	Provides technical information which focuses on health, environment, water, and wastes	PDCP Bank Center, 9/Floor V.A. Rufino cor. L.P. Leviste Streets Makati City, Philippines (02) 812-3165 www.gtz.de
Japan Bank for International Cooperation (JBIC)	Grants financial assistance for the stability and development of the economies and societies of countries, and closer and stronger ties between Japan and the rest of the world	31/F Citibank Tower Valero St. cor. Villart St. Makati City, Philippines (02) 848-1828, 752-5682 www.jbic.go.jp/english
United Nations Development Programme (UNDP)	Advocates for change and connects countries to knowledge, experience and resources to build and share solutions to a better life	30/F Yuchengco Tower, RCBC Plaza 6819 Ayala Ave. cor. Sen. Gil J. Puyat Ave. Makati City, Philippines (02) 901-0100 www.undp.org
US Agency for International Development (USAID)	Provides economic assistance on sustainable environmental management and improves the health and nutrition conditions	8/F PNB Financial Center Pres. Diosdado Macapagal Boulevard, Pasay City, Philippines (02) 552-9900 www.usaid.gov
World Bank (WB)	Provides loans, policy advice, technical assistance and knowledge sharing services which include water supply, water resources management, and sanitation to low and middle income countries	8/F PNB Financial Center Pres. Diosdado Macapagal Boulevard Pasay City, Philippines (02) 917-3000, 637-5855 www.worldbank.org

E. PARTNERSHIPS, PROJECTS AND PROGRAMS		
BORDA–Basic Needs Services (BNS) Partnership	Promotes and implements demand-oriented decentralized wastewater treatment systems (DEWATS) and sanitation services for community based sanitation, small and medium enterprises, and LGUs	103 Minnesota Mansion, 267 Ermin Garcia Street, Cubao, Quezon City, Philippines (02) 913-0806 www.borda.de
Environmental Engineering Graduate Program University of the Philippines	Administers the courses for Masters of Science in Environmental Engineering and the Doctor of Philosophy in Environmental Engineering. Conducts research on wastewater treatment, solid waste management and sanitation systems	317 National Engineering Center, University of the Philippines, Diliman, Quezon City, Philippines (02) 926-7087 www.engg.upd.
GTZ Water and Sanitation Programm	Promotes Integrated Water Resources Management (IWRM) and supports the enhancement of water supply and sanitation in rural areas. Develops institutions and corresponding coordination mechanisms on all levels of government administration with key focus on development of policies and strategies as well as its implementation, empowerment of sector institutions and training of trainers.	DILG-WSSPMO 5/F Francisco Gold Condominium II EDSA cor. Mapagmahal St. Diliman, Quezon City, Metro Manila, Philippines (02) 927-1875 www.watsansolid.org.ph
Local Initiatives for Affordable Wastewater Treatment (LINAW)	Identifies and develops solutions to wastewater pollution. Technical and site visit assistance, planning workshops, information and resource materials on technology and financing options, public awareness campaigns, and project results in both local and national forums	11/F Ayala Life - FGU Center, 6811 Ayala Avenue, Makati City, Philippines (02) 843-6336 www.usaid-ph.gov/oee_urban_linaw.php
Partnership in Environmental Management for the Seas of East Asia (PEMSEA)	Aims to abate the negative impacts of pollution and minimize the potential conflicts that arise from the tremendous development phase in the region.	DENR Compound, Visayas Avenue, Quezon City 1101, Philippines (02) 920-2211; 926-3752
Philippines Environmental Governance Project (ECOGOV)	Helps partner LGUs in Mindanao, Central Visayas, and Northern Luzon to develop wastewater management programs, particularly in assessing, promoting, managing, and regulating wastewater from public markets, slaughterhouses, and public hospitals	Unit 2401 Prestige Tower, F. Ortigas Jr. Road Ortigas Center, Pasig City (02) 636-3189; 634-0620; 635-6260; 635-0747
Sustainable Coastal Tourism in Asia - Philippines (SCOTIA)	Pursues a collaborative program to promote sustainable coastal tourism that will protect the long-term viability of delicate coastal and marine areas. Aims to strengthen capability of local governments to safeguard the sustainability and tourism value of their marine and coastal ecologies. Offers technical assistance on coastal resource management and environmental management to local governments and resort operators with special emphasis on solid waste management and sanitation in six project areas.	12/F Export Bank Plaza, Gil Puyat Ave. cor. Don Chino Roces, Makati City (02) 816-6576
USAID Environmental Cooperation-Asia (ECO-Asia) Program	Provides technical assistance to the United States Agency for International Development (USAID) Regional Development Mission/Asia (RDM/A) to: (1) improve access to clean water and sanitation for the urban poor; (2) improve environmental governance and transboundary cooperation; and (3) provide overarching program support to RDM/A. Being implemented by the Planning and Development Collaborative International, Inc. (PADCO), an AECOM company.	USAID Environmental Cooperation-Asia (ECO-Asia) Program PADCO|AECOM (USAID Contractor) Suite 4022, Golden Rock Bldg., 168 Salcedo Street Legaspi Village, Makati City 1229 Tel/Fax (632) 819-0688
US-Asia Environmental Partnership (US-AEP)	Issues of water supply and quality, solid and hazardous waste, and environmental governance in Asia	8/F PNB Financial Center Roxas Boulevard, Pasay City, Philippines (02) 552-9830 www.usaep.org

Water and Sanitation Program (WSP)	Sustained access of poor people to water supply and sanitation services	20/F The Taipan Place, F. Ortigas Jr. Road, Ortigas Center, Pasig City, Metro Manila, Philippines (02) 917 3143 www.wsp.org
Water Supply and Sanitation Performance Enhancement Project (WPEP)	Enhances projects on adequate water and sanitation services to be more accessible to the under-served rural and urban poor	20/F The Taipan Place, F. Ortigas Jr. Road, Ortigas Center, Pasig City, Metro Manila, Philippines (02) 917-3000; 917-3143 www.wpep.org
F. PRIVATE SERVICE PROVIDERS		
INCA Plastics Philippines, Inc.	Designs, markets, and manufactures products made of virgin polyethylene resins and compounded with UV stabilizers for maximum outdoor use protection. Utilizes the process of rotational molding for production	Bldg. 4 Philcrest Compound, km 23 West Service Rd., Cupang, Muntinlupa City, Philippines (02) 809-3380 www.inca.cjb.net
JV Baring Consultants and Allied Services	Offers consultancy, environmental impact assessment, environmental audits, pollution prevention and control designs, and retainership services. Products include variations of rotating biological contactors (RBC) and fiber reinforced plastics	JV Baring Bldg., Banilad, Cebu City, Philippines (032) 345-0890 www.jvbaring.com
Radian Consulting, Inc.	Prepares feasibility studies, master plans, preliminary and detailed designs on land development, urban storm drainage and flood control, water supply and sanitation, and lifesafety and fire protection projects. Also provides project/ construction management and capacity-building/training	18/F Herrera Tower, V.A. Rufino St. cor. Valero St., Salcedo Village, Makati City, Philippines (02) 8450907 to 09 www.radian.com
Watercare Technologies Corporation	Offers low-cost wastewater treatment systems. Makes septic tanks called SEPTICure Fiberglass Tanks	#2 Madrid St. cor. Bismarck, Provident Village, Marikina City, Philippines (02) 941-8329, 997-0809, 528-0088

ANNEX 3 — LIST OF SELECTED WEB-BASED RESOURCES ON SANITATION AND HYGIENE PROMOTION

NAME	DESCRIPTION	CONTACT DETAILS
INTERNET INFORMATION NETWORKS		
Business Partners for Development-Water and Sanitation Cluster	Access to BPD's internal and external publications and links related to water and sanitation in depressed communities. Publications include research papers, newsletters, annual reports, and sectoral analysis	www.bpd-waterandsanitation.org
ELDIS Gateway to Information Sources on Development and the Environment	Provides online documents and organizational directory of development-related internet services	www.ids.ac.uk/eldis
Environmental Health Project (EHP)	Provides access to expertise in environmental health	www.ehproject.org
Global Applied Research Network (Garnet)	Makes the exchange of information on water supply and sanitation possible	www.lboro.ac.uk/garnet
Global Water Partnership (GWP)	Offers a library containing technical papers, brochures, and links to information about water management	www.gwpforum.org/servlet/PSP?chStartupName=_library
GTZ Ecosan - Ecological Sanitation	Transfers information and knowledge among parties involved in ecosan-related projects and offers an opportunity for the cooperation partners to get in contact with each other	www.gtz.de/ecosan/english
Hesperian Foundation	Access to Hesperian Foundation's published books and newsletters for community-based health care	www.hesperian.org

International Development Enterprises (IDE)	Provides links, newsletters, and publications on water technologies for small-scale irrigation and safe drinking water	www.ideorg.org
Institute of Development Studies (IDS)	Links to papers, book chapters, and journals on health issues	www.ids.ac.uk
International Water and Sanitation Centre (IRC)	Provides news and information, advice, research and training on low-cost water supply and sanitation in developing countries to achieve better support from governments, professionals and organizations	www.irc.nl
InterWATER	Links to organizations and networks in the water supply and sanitation sector	www2.irc.nl/interwater
Lifewater International	Links to documents related to water supply, hygiene and sanitation	www. lifewater.org
London School of Hygiene & Tropical Medicine	Links to program related to health and diseases	www.lshtm.ac.uk
Department of Water and Sanitation in Developing Countries (SANDEC)	Lists publications in the following fields: strategic environmental sanitation planning, solid waste management, rural and peri-urban water treatment, material flux analysis, faecal sludge management, decentralized wastewater treatment and urban agriculture	www.sandec.ch/Publications/PublicationsHome.htm#FSM
SANICON-Environmental Sanitation Network	Access to information on technologies, institutions and financing of sanitation systems	www.sanicon.net
School Sanitation and Hygiene Education	Provides an overview of initiatives related to hygiene, sanitation and water in schools, web portals and mailing lists.	www.irc.nl/sshe
Swedish International Development Cooperation Agency (SIDA)	Contains a publications database for easy research on SIDA's information materials and reports	www.sida.se/Sida/jsp/Crosslink.jsp?d=107
United Nations Children's Fund (UNICEF): Water, Environment and Sanitation (WES)	Links to UNICEF's publications and partner institutions, agencies or services in the water, environment and sanitation sector	www.unicef.org/wes
Water Aid	Provides publications, technology notes, and links to sites related to sanitation and hygiene	www.wateraid.org.uk
Water, Engineering and Development Centre (WEDC)	Links to WEDC's projects and publications on emergency water supply and sanitation, enterprise development, environment and health, institutional development, knowledge management, urban services, and water and sanitation	wedc.lboro.ac.uk
Water Supply and Sanitation Collaborative Council (WSSCC)	Lists a catalogue of reports and tools produced by WSSCC or its working groups, networks and task forces. Also provides links to organizations in water and sanitation sector.	www.wsscc.org
World Health Organization (WHO)-UNICEF Joint Monitoring Programme for Water Supply and Sanitation	Hosts information which includes worldwide data related to water supply and sanitation	www.wssinfo.org

ANNEX 4 — CREDIT FUNDING FACILITIES FOR SANITATION PROJECTS

	LOAN FACILITY/CONTACT PERSON	EXECUTING AGENCY	FUND SOURCE	CLOSING DATE	ELIGIBLE BORROWERS	ELIGIBLE PROJECTS/ SECTOR	MINIMUM LOAN AMOUNT (PhP)	MAXIMUM LOAN AMOUNT (PhP)	INTEREST RATE p.a.	GRACE PERIOD (yrs.)	REPAYMENT PERIOD (yrs.)	EQUITY	SECURITY REQUIREMENT	DOCUMENTATION REQUIREMENT
1.	**Local Government Support Credit Program (LGUSCP)** Eduardo C. Manlapat Program Officer Project Management Department 1598 MH del Pilar St. cor. Dr. J. Quintos St. Malate, Manila Tel, (02) 522-0000 loc. 278, 2785 E-mail: PMO-WDDP@mail.landbank.com	LBP	JBIC	Dec-06	- LGUs with medium to high credit worthiness	Water Supply - Levels 2 & 3 Sanitation & Sewerage - Toilet & Septic Tank Upgrade - Collection System - Treatment Facilities - Disposal Facilities	None	Borrowing Capacity	11% - 11.5% (FS) 11% - 13% (Investment)	2 2	15 15	10% of Project Cost	Assignment of IRA	Sanggunian Resolution Sub-Loan Agreement
2.	**Water Districts Development Project** Eduardo C. Manlapat Program Officer Project Management Department 1598 MH del Pilar St. cor. Dr. J. Quintos St. Malate, Manila Tel, (02) 522-0000 loc. 278, 2785 E-mail: PMO-WDDP@mail.landbank.com	LBP	WB	Dec-06	- LGUs outside Metro Manila	Water Supply - Level 3 Sanitation & Sewerage - Toilet & Septic Tank Upgrade - Collection System - Treatment Facilities - Disposal Facilities	None	Borrowing Capacity	12%	3	15	10% of Project Cost	Assignment of IRA	Sanggunian Resolution Sub-Loan Agreement
3.	**Mindanao Basic Urban Services Project** Generoso David Program Officer Project Management Department 1598 MH del Pilar St. cor. Dr. J. Quintos St. Malate, Manila Tel, (02) 522-0000 loc. 278, 2785 E-mail: PMO-WDDP@mail.landbank.com	LBP	ADB	Jun-08	- LGUs in Mindanao				11% - 13%	3	15			
4.	**Cooperatives Lending** Lending Centers (36 Nationwide) LandBank of the Philipipines, Manila Headquarters 1598 MH del Pilar St. cor. Dr. J. Quintos St. Malate, Manila Tel, (02) 522-0000	LBP			Cooperatives Rural & Barangay Water Assn.	Water Supply Sanitation & Sewerage Relending to members for consumer loans (housing upgrades, etc)		Up to 80% of project cost	12%	3 years or based on cash flow of project	based on financial projections of pay back period		Real estate or chattel mortgage	Certificate of Registration with CDA Core Management Team Audited Financial Statements Capital Build-up & Savings Program
5.	**Environmental Infrastructure Support Credit Program 2 (EISCP II)** Florinio Diloy Asst. Vice-President Development Banking Sector Sen. Gil Puyat Ave. cor, Makati Avenue, Makati City Tel. (02) 8189511 E-mail:	DPB	JBIC	Mar-06	- Filipino citizens - Corporations with at least 70% Filipino capitalization	Water Supply - Level 1, 2 & 3 Sanitation & Sewerage - Toilet & Septic Tank Upgrade - Collection System - Treatment Facilities - Disposal Facilities	1.0 Million	Borrowing Capacity	9%	2	15		LGU Guaranty Assignment of IRA Mortgage of real property Assignment of project income	Audited Financial Statement Capital Build-up & Savings Program
6.	**Local Government Finance and Development Project (LOGOFIND)** Hermie C. Debuque Program Officer Development Banking Sector Sen. Gil Puyat Ave. cor, Makati Avenue, Makati City Tel. (02) 813-7349 E-mail: hcdebuque@devbankphil.com.ph	DBP	WB	Jun-06	- LGUs provided with PSP - WDs	Water Supply - Level 3	None	Borrowing Capacity of LGU	9%	3	15	10% of Project Cost	Assignment of IRA Assignment of project income	Letter of Intent Sanggunian Resolution 3-year Financial Statements LGU Information Report Bio-data of Mayor & Treasurer
7.	**Local Government Finance and Development Project (LOGOFIND)** Leilani O. Magdamo Project Director, LOGOFIND Municipal Development Fund Office - Department of Finance Podium Level, DOF Building Bangko Sentral ng Pilipinas Complex Roxas Blvd., Manila 1004 E-mail: logofind@eudoramail.com	DOF	WB	Jun-06	- Low-income LGUs (3rd to 6th LGU income class) - 1st and 2nd income class LGUs on case-to-case basis, especially for social and environmental subprojects like sanitation	Municipal Water Supply Sanitation/Public Toilet and Combined Sewer			12%	3	15	10% of Project Cost		Letter of Intent Sanggunian Resolution Project Description / Feasibility Study (if available) Latest Financial Statements Certification of Oustanding Loan Obligation of the LGU

GLOSSARY OF TERMS

Activated sludge	• production of an activated mass of micro-organisms capable of stabilizing waste aerobically. (Metcalf & Eddy) • biologically active solids in an activated-sludge process wastewater treatment plant. (Water Environment Federation) • sludge particles produced by the growth of organisms in the aeration tank in the presence of dissolved oxygen.
Aerobic	• condition characterized by the presence of free oxygen. (Water Environment Federation)
Adsorption	• the process of collecting soluble substances that are in solution on a suitable interface. The interface can be between a liquid and a gas, a solid, or another liquid. (Metcalf & Eddy)
Aerated pond/lagoon	• a natural or artificial wastewater treatment pond in which mechanical or diffused air aeration is used to supplement the oxygen supply. (c/o CGE)
Ammonia	• a compound of hydrogen and nitrogen that occurs extensively in nature. Chemical formula is NH3. (Water Environment Federation)
Anaerobic	• condition characterized by the absence of free oxygen. (Water Environment Federation)
Anaerobic digestion	• involves the decomposition of organic and inorganic matter in the absence of molecular oxygen. (Metcalf & Eddy)
Anaerobic lagoon	• a wastewater or sludge treatment process that involves retention under anaerobic conditions. (c/o CGE)
Bacteria	• microbes that decompose and stabilize organic matter in wastewater. (Water Environment Federation)
Biochemical Oxygen Demand	• quantity of oxygen that will be required to biologically stabilize the organic matter present. (Metcalf & Eddy)
Bioconcentration	• the net increase in concentration of a substance that results from the uptake or absorption of the substance directly from the water and onto aquatic organisms. (Water Environment Federation)
Biodegradable	• term used to describe organic matter that can undergo biological decomposition. (Water Environment Federation)
Biodigester	• tank used for aerobic or anaerobic digestion of sludge.
Biosolids	• solid organic matter recovered from municipal wastewater treatment that can be beneficially used, especially as a fertilizer. Biosolids are solids that have been stabilized within the treatment process. (Water Environment Federation)
Bucket latrine	• a type of toilet wherein the feces with or without separation of urine are collected in a pail or bucket.
Burial	• a system of disposal for small volumes of feces, sludge or other solid wastes by digging a pit and covering it with earth.
Carbohydrates	• include sugars, starches, cellulose, and wood fiber. Carbohydrates contain carbon, hydrogen, and oxygen. The common carbohydrates contain six or a multiple of six carbon atoms in a molecule, and hydrogen and oxygen in the proportions in which these elements are found in water. (Metcalf & Eddy)
Carbon dioxide	• a noncombustible gas formed in animal respiration and the combustion and decomposition of organic matter. Chemical formula is CO2. (Water Environment Federation)
Chemical precipitation	• involves the addition of chemicals to alter the physical state of dissolved and suspended solids and to facilitate their removal by sedimentation. (Metcalf & Eddy)

Chlorination	• the addition of chlorine to wastewater for the purpose of disinfection. (Water Environment Federation) • the application of chlorine or chlorine compounds to water or wastewater, generally for the purpose of disinfection, but frequently for chemical oxidation and odor control. (c/o CGE)
Clarifier	• a large circular or rectangular sedimentation tank used to remove settleable solids in water or wastewater. A special type of clarifier, called an upflow clarifier, uses flotation rather than sedimentation to remove solids. (c/o CGE)
Coagulation	• the destabilization and initial aggregation of finely divided suspended solids into coagulated particles by the addition of a polyelectrolyte or coagulant.
Collection System	• system of conduits, generally underground pipes, that receives and conveys sanitary wastewater and/or stormwater. (Water Environment Federation)
Colloidal solids/Colloids	• finely divided solids that will not settle but may be removed by coagulation, biochemical action, or membrane filtration; they are intermediate between true solutions and suspensions.
Comminution	• treatment process that cuts up solids into a smaller, more uniform size for return to the flow stream for removal in the subsequent downstream treatment operations and processes. (Metcalf & Eddy)
Compost	• the product of the thermophilic biological oxidation of sludge or other materials.
Composting	• stabilization process relying on the aerobic decomposition of organic matter in sludge by bacteria and fungi. (Water Environment Federation)
Contamination	• the introduction into water of micro-organisms, chemicals, wastes, or wastewater in a concentration that makes the water unfit for its intended use.
Denitrification	• biological process in which nitrates are converted to nitrogen.(Water Environment Federation)
Desludging	• removal of sludge or settled solid matter from treatment tanks such as septic/ Imhoff tank, aquaprivy, interceptor tank or sedimentation tanks.
Digestion	• See anaerobic digestion.
Disposal	• discharge, deposit, injection, dumping, spilling, leaking, or placing of any liquid or solid waste on land or water so that it may enter the environment.
Dissolved Oxygen	• the oxygen dissolved in a liquid. (Water Environment Federation)
Dissolved solids	• solids in solution that cannot be removed by filtration. (Water Environment Federation)
Domestic wastewater	• wastewater derived principally from dwellings, business buildings, institutions, and the like. It may or may not contain groundwater, surface water, or stormwater. (c/o CGE)
Domestic septage	• either liquid or solid material removed from septic tank, cesspool, portable toilet, and treatment works that receives only domestic sewage.
Domestic sewage	• waste and wastewater from humans or household operations.
Drying	• the process of hygienization of wastes (sludge, feces or urine) by subjecting it to the heat of the sun.
Dry weather flow	• (1) the flow of wastewater in a combined sewer during dry weather. Such flow consists mainly of wastewater, with no stormwater included.
Ecological sanitation	• sanitation whose design builds on the concept of protecting ecosystems, and which excreta as a valuable resource to be recycled. (Sanitation and Hygiene Promotion)

Effluent	• wastewater or other liquid, partially or completely treated or in its natural state, flowing out of a reservoir, basin, treatment plant, or industrial treatment plant, or part thereof. (c/o CGE)
Electrodialysis	• in the electrodialysis process, ionic components of a solution are separated through the use of semipermeable ion-selective membranes. (Metcalf & Eddy)
Eutrophication	• nutrient enrichment of a lake or other water body, typically characterized by increased growth of planktonic algae and rooted plants. It can be accelerated by wastewater discharges and polluted runoff.
Excreta	• faeces and urine. (Sanitation and Hygiene Promotion)
Fats	• triglyceride esters of fatty acids. (Water Environment Federation)
Feces	• excrement of humans and animals. (Water Environment Federation)
Filterable solids	• solids that can be separated physical such as filter sand or filter cloth or membrane.
Filtration	• the process of contacting a dilute liquid suspension with filter media for the removal of suspended or colloidal matter, or for the dewatering of concentrated sludge.
Flotation	• a treatment process whereby gas bubbles are introduced to water and attach to solid particles, creating bubble-solid agglomerates that float to the surface where they are removed. (Water Environment Federation)
Gas	• of the three states of matter, the state having no fixed shape or volume and capable of expanding indefinitely. (Water Environment Federation)
Grit removal	• a preliminary wastewater treatment process to remove grit from organic solids. (Water Environment Federation)
Groundwater	• water found below ground level in the sub-soil. (Sanitation and Hygiene Promotion) • subsurface water found in porous rock strata and soil. (Water Environment Federation)
Groundwater table	• the level at which the subsoil is saturated. (Sanitation and Hygiene Promotion)
Hydrogen sulfide	• is formed from the anaerobic decomposition of organic matter containing sulfur or from the reduction of mineral sulfites and sulfates. This gas is a colorless, inflammable compound with the characteristic odor of rotten eggs. (Metcalf & Eddy)
Hypochlorination	• the use of sodium hypochlorite ($NaOCl2$) for disinfection. (c/o CGE)
Inorganic matter	• substances of mineral origin, not containing carbon, and not subject to decay. (Water Environment Federation)
Ion	• an electrically charged atom, molecule, or radical. (Water Environment Federation)
Ion exchange	• is a unit process in which ions of a given species are displaced from an insoluble exchange material by ions of a different species in solution. (Metcalf & Eddy)
Lagoon	• any large holding or detention pond, usually with earthen dikes, used to contain wastewater while sedimentation and biological oxidation occur. See also anaerobic lagoon.
Landfill	• a land disposal site that employs an engineering method of solid waste disposal to minimize environmental hazards and protect the quality of surface and subsurface waters. (Water Environment Federation)
Micro-organisms	• very small organisms, either plant or animal, invisible or barely visible to the naked eye. Examples are algae, bacteria, fungi, protozoa, and viruses.

Nitrate (NO_3)	• a stable, oxidized form of nitrogen having the formula NO3-. (Water Environment Federation) • an oxygenated form of nitrogen.
Nitrification	• biological process in which ammonia is converted first to nitrite and then to nitrate. (Water Environment Federation)
Nitrite (NO_2)	• an unstable, easily oxidized nitrogen compound with a chemical formula NO_2-. (Water Environment Federation) • an intermediate oxygenated form of nitrogen.
Nitrogen (N)	• an essential nutrient that is often present in wastewater as ammonia, nitrate, nitrite, and organic nitrogen. The concentrations of each form and the sum (total nitrogen) are expressed as milligrams per liter (mg/L) element nitrogen. Also present in some groundwater as nitrate and in some polluted groundwater in other forms.
Nutrient	• any substance that is assimilated by organisms to promote or facilitate their growth. (Water Environment Federation)
Off-site sanitation	• system of sanitation where excreta are removed from the plot occupied by the dwelling and its immediate surroundings. (Sanitation and Hygiene Promotion)
On-site sanitation	• system of sanitation where the means of collection, storage and treatment (where this exists) are contained within the plot occupied by the dwelling and its immediate surroundings. (Sanitation and Hygiene Promotion)
Organic matter	• solids derived from both animal and plant kingdoms and the activities of man as related to the synthesis of organic compounds.
Oxidation	• the conversion of organic materials to simpler, more stable forms with the release of energy. This may be accomplished by chemical or biological means.
Ozonation	• the process of using ozone in water or wastewater treatment for oxidation, disinfection, or odor control. (Water Environment Federation)
Pathogen	• highly infectious, disease-producing microbes commonly found in sanitary wastewater. (Water Environment Federation)
Permeability	• (1) the property of a material that permits appreciable movement of water through it when it is saturated; the movement is actuated by hydrostatic pressure of the magnitude normally encountered in natural subsurface water.
Pesticides	• these chemicals are not common constituents of domestic wastewater but result primarily from surface runoff from agricultural, vacant, and park lands. (Metcalf & Eddy)
pH	• the reciprocal of the logarithm of the hydrogen ion concentration in gram moles per litre. On the 0 to 14 scale, a value of 7 at 25°C (77°F) represents a neutral condition. Decreasing values indicate increasing hydrogen ion concentration (acidity), and increasing values indicate decreasing hydrogen ion concentration (alkalinity). (Water Environment Federation)
Phenols	• organic pollutant also known as carbolic acid occurring in industrial wastes from petroleum-processing and coal coking operations. (Water Environment Federation)
Phosphorus	• a nutrient that is essential element of all life forms. (Water Environment Federation)
Pit latrine	• latrine with a pit for collection and decomposition of excreta and from which liquid infiltrates into the surrounding soil. (Sanitation and Hygiene Promotion)
Pour-flush latrine	• latrine that depends for its operation of small quantities of water, poured from a container by hand, to flush away faeces from the point of defecation. (Sanitation and Hygiene Promotion)

Priority pollutants	• hazardous substances. (Water Environment Federation)
Proteins	• are the principal constituents of the animal organism. They occur to a lesser content in plants. Proteins are complex in chemical structure and unstable, being subject to many forms of decomposition. Some are soluble in water, others are insoluble. The chemistry of the formation of proteins involves the combination or linking together of a large number of amino acids. (Metcalf & Eddy)
Protozoa	• small one-celled animals including amoeba, ciliates, and flagellates.
Recycle	• to return water after some type of treatment for further use; generally implies a closed system.
Refractory organics	• organic substances that are difficult or impossible to metabolize in a biological system. (Water Environment Federation)
Retention time	• the length of time that water or wastewater will be retained in a unit treatment process or facility. (Water Environment Federation)
Reverse osmosis	• is a process in which water is separated from dissolved salts in solution by filtering through a semi permeable membrane at a pressure greater than the osmotic pressure caused by the dissolved salts in the wastewater. (Metcalf & Eddy)
Sanitation	• interventions (usually construction of facilities such as latrines) that improve the management of excreta. (Sanitation and Hygiene Promotion). The WHO Study Group in 1986 defines sanitation as "the means of collecting and disposing of excreta and community liquid wastes in a hygienic way so as not to endanger the health of individuals and the community as a whole."
Screening	• a preliminary treatment process that removes large suspended or floating solids from raw wastewater to prevent subsequent plugging of pipes or damage to pumps.
Sedimentation	• removal of settleable suspended solids from water or wastewater by gravity in a quiescent basin or clarifier. (Water Environment Federation)
Septage	• sludge produced in individual on-site wastewater-disposal systems, principally septic tanks and cesspools. (Metcalf & Eddy)
Septic tank	• a tank or container, normally with one inlet and one outlet, that retains sewage and reduces its strength by settlement and anaerobic digestion. (Sanitation and Hygiene Promotion)
Sewer	• a pipe or other conduit that carries wastewater from more than one property. (Sanitation and Hygiene Promotion)
Settleable solids	• that matter in wastewater that will not stay in suspension during a preselected settling period, such as 1 hour, but settles to the bottom.
Sewage	• see Wastewater. (Water Environment Federation)
Sewage sludge	• a solid, semi-solid or liquid residue generated during the treatment of domestic sewage in treatment works. Sewage sludge includes, but is not limited to domestic septage, scum or solids removed in primary, secondary, or advanced wastewater treatment processes.
Sewerage	• the entire system of wastewater collection, treatment, and disposal. (Water Environment Federation)
Sludge	• accumulated and concentrated solids generated within the wastewater treatment process that have not undergone a stabilization. (Water Environment Federation)

Sullage	• dirty water that has been used for washing, cooking, washing clothes, pots, pans, etc.) (Sanitation and Hygiene Promotion) • see Greywater. (Water Environment Federation)
Surfactants	• or surface-active agents, are large organic molecules that are slightly soluble in water and cause foaming in wastewater treatment plants and in the surface waters into which the waste effluent is discharged. (Metcalf & Eddy)
Suspended solids	• insoluble solids that either float on the surface of, or are in suspension in, water, wastewater, or other liquids.
Total Suspended Solids	• the measure of particulate matter suspended in a sample of water or wastewater
Toxic	• capable of causing an adverse effect on biological tissue following physical contact or absorption. (Water Environment Federation)
Trickling filter	• consists of a bed of a highly permeable medium to which microorganisms are attached and through which wastewater is percolated or trickled. (Metcalf & Eddy)
Turbidity	• suspended matter in water or wastewater that scatters or otherwise interferes with the passage of light through the water. (Water Environment Federation)
Ultrafiltration	• are pressure-driven membrane operations that use porous membranes for the removal of dissolved and colloidal material. Applications for ultrafiltration include removal of oil from aqueous streams and the removal of turbidity from color colloids. (Metcalf & Eddy)
Ultraviolet (UV) radiation	• light waves shorter than the visible blue-violet waves of the spectrum.
Viruses	• smallest biological structures capable of reproduction; infect its host, producing disease. (Water Environment Federation)
Wastewater	• liquid or waterborne wastes polluted or fouled from households or commercial or industrial operations, along with any surface water, stormwater, or groundwater infiltration. (Water Environment Federation)
Wet weather flow	• the flow in a combined sewer during storm or and rain events.