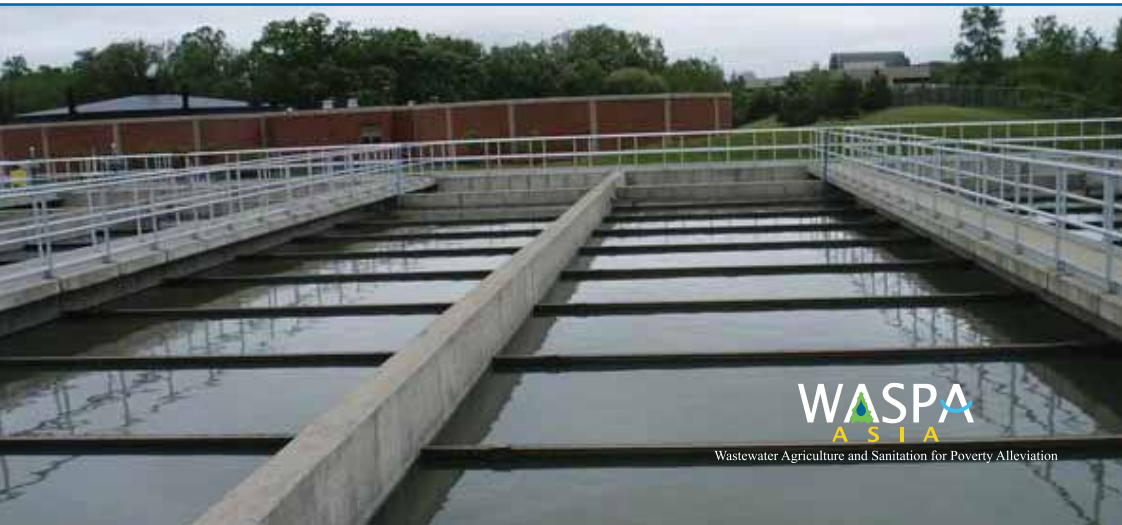
Guide to On-site Wastewater Management for Industrial and Commercial Establishments and other Institutions

Guide for Hotel and Restaurant Owners and Managers

Ineffective waste management is bad for business



WASPA ASIA

Wastewater Agriculture and Sanitation for Poverty Alleviation

Guide to On-site Wastewater Management for Industrial and Commercial Establisments and Other Institutions

Guide for Hotel and Restaurant Owners and Managers in Kurunegala, Sri Lanka

Ineffective waste management is bad for business

Effective wastewater treatment can prevent serious illness among guests and staff members, and limit the number of serious complaints from guests

Priyanka Dissanayake and Mangala Tennakoon

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More information about the project, including downloads of project documents, can be found at **www.iwmi.cgiar.org/waspa**

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CONTENTS

ABBREVATIONS and ACRONYMS

BOD	Biochemical Oxygen Demand
BMP	Best Management Practices
COD	Chemical Oxygen Demand
CP	Cleaner Production
CPHI	Chief Public Health Inspector
DO	Dissolved Oxygen
EMS	Environmental Management Systems
FOG	Fat, Oil and Grease
MC	Municipal Council
MLVSS	Mixed Liquor Volatile Suspended Solids
O&G	Oil and Grease
PHI	Public Health Inspector
RO	Reverse Osmosis
SS	Suspended Solids
TSS	Total Suspended Solids
WASPA	Wastewater Sanitation Agriculture for Poverty Alleviation in Asia

1. Introduction

The pollution of the canal water (in Beu Ela and Wan Ela) in the WASPA project area in Kurunegala can be attributed to both point and non-point source pollution including:

- Small-scale industrial effluent discharged to canals;
- Wastewater and sewage discharged into canals;
- Dumping of solid waste into canals;
- Open defecation on canal banks and in open areas that washes into canals;
- Urban runoff and rainwater; and
- Chemicals and other wastes from upstream agricultural lands.

The assessment phase of the WASPA project identified approximately 3000 industrial and commercial buildings, as well as institutions such as schools, in the catchment area of the two canals Wan Ela and Beu Ela. However there are no large scale industries in the project area that drain into the canals and most of the wastewater appears to be of domestic origin. The hospitals, vehicle service stations, slaughter houses and meat stalls, hotels and restaurants, schools, technical colleges and tuition classes were identified as significant sources that generate wastewater in

the area. The non-wastewater generating units were also catalogued as their other wastes, especially solid waste, can cause indirect pollution in the canals.

A centralized treatment system is in the process of being developed by the Greater Kurunegala Sewerage Project and should be operational in the next few years; however, the system will not be able to accommodate untreated wastewater from some sources, especially commercial units. Therefore in future, on-site wastewater management for pollutant load reduction will be a requirement prior to discharging.

To address the wastewater management issue of medium to small-scale industries and other commercial establishments and institutions the WASPA Project has developed a series of booklets for selected sectors. This booklet is written as a guideline on wastewater management for hotels and restaurants. It is intended to serve the reader as a reference in understanding how to manage the wastewater on-site. It provides guidelines on Best Management Practices (BMPs) and Cleaner Production (CP) options which can lead to a reduction of pollutant loads and cost savings to the owners or managers. Furthermore, it guides the owners and managers in selecting the treatment system that suits the wastewater characteristics of their businesses; and for those who already have a treatment system, it provides guidance on how to maintain the system without interruption.

A list of the names of wastewater treatment experts and commercial consultants and their contacts is provided at the end of the booklet. They can assist you by designing your treatment system and maintaining your treatment system once structurally in place and functioning.

Some of the pollution prevention measures could be applied without resulting in excessive effort and cost to the facility owner while wastewater treatment options require construction of treatment facilities, capital cost and cost of maintenance. The industries are therefore encouraged to start by implementing these measures as much as possible to minimize the investments required in end of pipe treatment of wastewater. Wastewater management at the source is vital as wastewater quality is expected to comply with the general standards for discharge of effluents into inland surface waters. This improves the potential for the effective reuse of wastewater discharged into the canals for agriculture and other purposes, as well as the aesthetic appeal of the canals for residents and visitors to Kurunegala.

2. Pollution Prevention or End of Pipe Treatment?

Up to about 20 years ago pollution control measures have concentrated on what is commonly referred to as “end-of-pipe” treatment, which focuses on what to do with the waste once it has been generated. Recently the focus has changed towards pollution prevention, which directs attention towards the elimination or reduction of pollutants within the process itself before treatment. Elimination and Reduction is generally achieved by **improvement of housekeeping procedures and modifications to the processes**, to reduce water and energy consumption and to segregate highly polluted streams for point source treatment. Best management practices for the most part are common sense, good housekeeping measures that can be implemented without resulting in excessive effort and cost to the facility owner or operator but which lead to the reduction of pollution.

2.1 What is Cleaner Production?

Cleaner Production is the continuous application of an integrated preventative environmental strategy to processes, products and services to increase eco-efficiency and reduce risks to humans and the environment.

- Production Process: Conserving raw materials and energy, eliminating toxic raw materials and reducing the quantity of toxicity of all emissions and wastes at the source.
- Products: Reducing negative impacts along the entire life cycle of a product, from design to ultimate disposal
- Services: Incorporating environmental concerns into designing and delivering services.

Cleaner Production requires changing attitudes, exercising responsible environmental management and evaluating technology options.

2.2 Benefits of Cleaner Production

The environmental benefits of pollution prevention and CP directly coincide with economical interests. In the long term, pollution prevention through waste minimization and CP is more cost effective and environmentally sound than traditional pollution control methods.

2.3 Source Reduction Techniques

Source reduction prevents the generation of wastes and environmental releases and conserves natural resources. There are six techniques that are most commonly used in source reduction: process efficiency improvements; material substitution; inventory control; preventive maintenance; improved housekeeping; and in-process recycling.

2.4 Cleaner Production in Sri Lanka

The National Cleaner Production Centre

The National Cleaner Production Centre (NCPC) in Sri Lanka is promoting CP in the country and as well as capacity building for the successful application of CP in industrial and commercial establishments and other institutions. The contact details of NCPC are given in Appendix B. The NCPC performs the following activities:

- In-plant assessment including integrated CP and Environmental Management System (EMS) assessment;

- Awareness raising;
- Training;
- Dissemination of technical Information;
- Promotion of CP investments; and
- Policy advice.

Industrial Services Bureau

The Industrial Services Bureau (ISB) of the North Western Province has been actively participating in energy and environmental management activities since its inception in 1990. As a natural extension to well established energy and environmental management activities, ISB is now actively engaged in the introduction of “Cleaner Production” to Sri Lankan industries, particularly those which are operating in the Kurunegala area in the North Western Province. The contact details of ISB are given in Appendix B.

3. What is on-site wastewater treatment?

Any treatment process that removes contaminants from wastewater at or near the point of generation, with dispersal of treated wastewater nearby, is considered “on-site”, whether it serves a single-family residence, a restaurant, an office building or a major resort. The most common type of onsite wastewater treatment system is the septic system. On-site wastewater treatment is also called decentralized wastewater treatment, to distinguish it from centralized treatment (at municipal sewage treatment plants).

3.1 Wastewater Treatment Methods and Processes

Wastewater can be treated in a number of different ways depending on the level of treatment required. These levels are known as preliminary, primary, secondary and tertiary or advanced. The contaminants in wastewater are removed by physical, chemical and biological means. The possible treatment levels and their sequence are presented schematically in Figures 1 and 2. A detailed description of important contaminants of concern in wastewater treatment, the treatment levels and processes are presented in Appendix A.

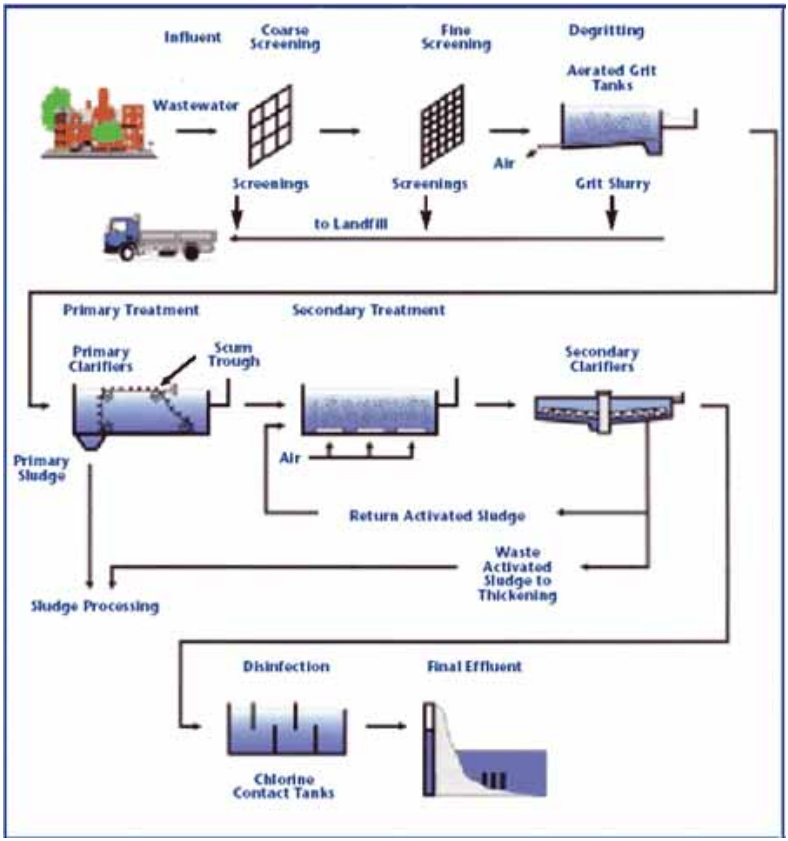

Figure 1. Treatment levels of a large scale facility

Source: Environment Canada www.ec.gc.ca

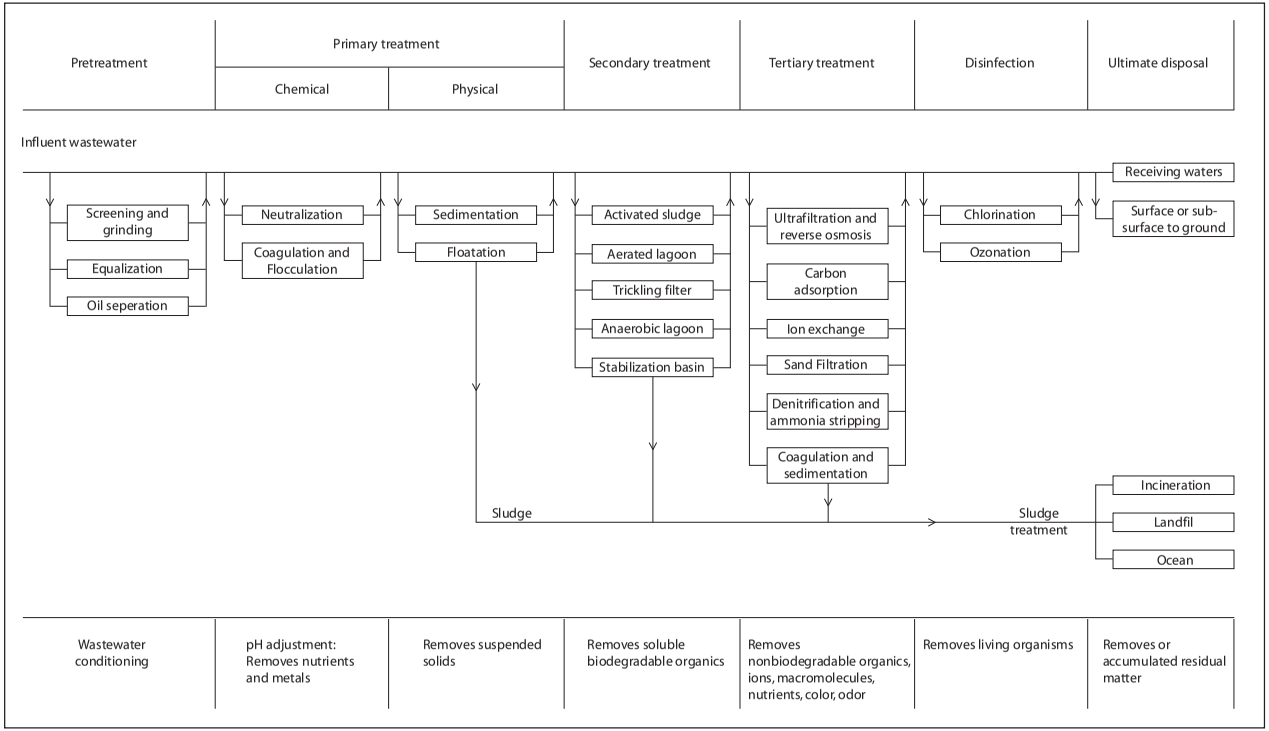

Figure 2. Possible Choice for Wastewater Treatment and Their Sequence

Source: EEAA

3.2 Septic Tanks

Septic tanks have been used in Kurunegala and across Sri Lanka for many years as the most suitable form of primary treatment of sewage. Septic tanks are used for wastewater with a high percentage of settleable solids, typically from domestic sources (mostly toilet wastewater). Private households and public buildings such as schools and hospitals currently use individual on-site and small-scale septic systems (up to about 50 households).

Septic tanks, when correctly designed and built, properly operated and regularly emptied, are a very effective device to treat wastewater. However, many of the septic tanks in the area are badly designed and are only serving the purpose of storing wastewater.

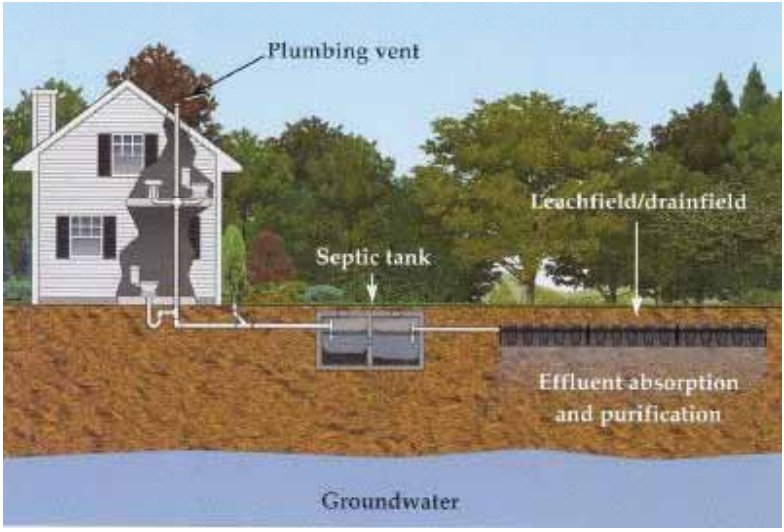

Figure 3. Components of a Septic System

Source: www. thenaturalhome.com

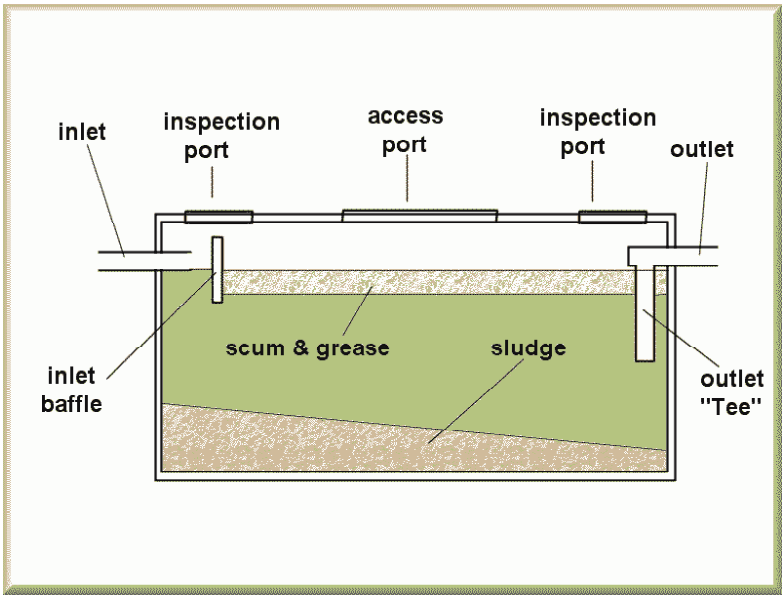

Figure 4. Components of the Septic Tank

Source: www.septictankinfo.com

3.3 Tips for Maintaining Your Septic System

A. Minimize the Liquid Load.

The less wastewater you produce, the less the soil will have to absorb. Water conservation is the cheapest and easiest way to protect your septic system. The volume of the septic tank must not be exceeded in any one day. This can be achieved by:

1. Repairing leaky fixtures.
2. Washing clothes only when you have a full load. Avoid doing several loads in one day. The septic system design includes the average use of the clothes washer (definition of average use–three to four loads per week).
3. Take short showers instead of baths. Do not turn the shower on all the way and turn off the water while lathering. Install a water-saving device in the shower system.

4. Use a water-saving device in your toilet tank and do not flush it unnecessarily.
5. Do not let water run while washing teeth, hands, vegetables, dishes, etc. Use a stoppered basin.
6. Many other ways of conserving water exist. Use water-saving devices where feasible. Be alert and institute other water-saving ideas.

B. Minimize the Solids Load

Do not use your septic system for anything that can be disposed of in some other way. The less material you put into your septic tank, the better the quality of the effluent going to the leaching system.

1. Collect grease in a container near the sink rather than pouring it down the drain.
2. Minimize the discharge of paper products. Non-degradable items, such as sanitary napkins and paper towels are especially harmful.
3. Basically three products should go into the septic tank: human wastes, toilet paper and water from toilets. Water from bathing fixtures, kitchen sinks and laundry washers may or may not go into the septic tank. In most cases the grey water goes into a soakage pit.
4. Ordinary use of household chemicals will not affect the bacteria in your system if not used in excessive amounts. Do not use your tank to get rid of oils, paints, insecticides or other poisonous liquids.

C. Additional Means to Protect the Installed Septic System

1. Do not plant large trees over the absorption system. Small feeder roots will enter the drain holes of the leachfield drain lines and form a mat within the drain line. This mat blocks the flow in the level drain line rendering the remainder of the line unusable. Large roots may displace the drain line.
2. Ideally the leachline or bed systems should be left in uncovered open sunny areas so as to be provided maximum evaporation. This is an important factor in these systems, but not applicable to seepage pits or dry wells.
3. Do not allow rain water or drainage water to pond over the leachfield. Maximum saturation and temporary failure may occur until the ponding dissipates.
4. Do not construct walkways, patios, swimming pools, permanent structures or parking lots, over or within the leachline or bed areas. This would prevent maximum evaporation, may cause damage to the system and may cause premature failure.

5. Keep vehicles off your leachline or bed system; driving over them repeatedly can damage underground pipes and soil porosity.
6. Your tank should be routinely pumped at least every three years or once a year if a commercial establishment. The duration of the pumping period can take longer, if you perform some preventative maintenance.

Emptying of the Septic Tanks in Kurunegala

The Kurunegala Municipal Council (MC) provides services for emptying and maintenance of septic tanks in the Kurunegala city limits. Anyone who requires this service should contact the Chief Public Health Inspector (CPHI) at the Kurunegala MC. The present CPHI is Mr. Upali Weerasooriya, who can be contacted on 037-2222272.

Sri Lanka Standards 745 of 2002 is the most comprehensive document in Sri Lanka regarding the on-site disposal of excreta related wastes and it is recommended that the MC refers to this in designing and maintenance of the septic tanks in the area.

Figure 5. Emptying of the Septic Tank

D. Steps to Consider if Your Leaching System Fails

If a competent professional (from the MC or elsewhere) has determined that your leaching system has failed the old system need not be abandoned completely. If your leaching system requires repair or replacement the MC can help you. The PHI may advise you to simply add a new seepage pit to the existing system. This is referred to as a “Series Connection”.

4. Guidelines for implementing a grease reduction program

4.1 Major Pollutants and Problems

Restuarants and hotels generally discharge wastewater that contains high concentrations of oil and grease as well as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS). This booklet focuses on oil and grease reduction as this is one of the most problematic group of pollutants for hotels and restaurants, and is difficult to treat.

Wastewater discharges from restaurants may require pretreatment for reduction of fats, oils, and greases (FOG) before discharge into the sewage collection system as it is difficult to treat FOG compared to other pollutants. Large amounts of oil and grease in the wastewater cause trouble in the collection system pipes and can hamper effective treatment in the wastewater treatment plant. There are many ways to cut down on your grease output and avoid costly maintenance and inappropriate disposal. By using common sense and good housekeeping practices and by reducing the accumulation of grease, you can minimize your impact on the sewer system and avoid costly cleanup of grease spills. **The pretreatment for FOG alone can significantly improve the characteristics of wastewater from hotels and restaurants.**

4.2 Methods to Reduce Grease Output

This section is based on guidance provided by the Interagency Resource for Achieving Cooperation and has been modified to be appropriate for the situation in Sri Lanka, particularly Kurunegala City.

Pretreatment methods

All pretreatment methods require a commitment to maintenance and, in most cases, a change in kitchen management policies. If you install a pretreatment device, remember that extremely hot water and solvents defeat the purpose of pretreatment devices by keeping the grease suspended in the grey water.

Recycle grease and oils when possible

When using deep fat fryers, or processes that produce large amounts of plant or animal byproducts, separate the oils and fats from the food products. Recycle the fat and food products through a local grease rendering company or food recycler if possible. If food recycling is not an option, dispose of food products in sealed containers with your solid waste. In the future there may be better options for composting food waste.

Install grease traps

These go inside the building near the sink and act as a holding facility for kitchen water before it is discharged into the sewer. Grease traps usually require constant cleaning (every day for many businesses), but when properly sized and maintained, they effectively remove grease from kitchen wastewater. More information is provided below.

Install a grease interceptor

A grease interceptor is a large tank or vault (usually 750 gallons or larger). It is installed outside the building and provides the most efficient way to remove grease and oils. It requires routine maintenance but the amount of maintenance depends on your use. Both grease interceptors and grease traps should be appropriately sized for your business. Suppliers can help you with this. More information is provided below.

Use bacteria (bugs)

These products may or may be not available in Sri Lanka but if available can be effective in breaking down (eating) FOG. Generally it is important to get permission from your local authority before using these products.

Grease removal devices

Several types of skimmers or dippers can mechanically remove grease from kitchen wastewater. They should be emptied and cleaned regularly.

Education and housekeeping

Periodic cleaning of the pretreatment device is imperative to insure that it is working properly. If no device exists, it is critical that kitchen staff understand how to clean dishes - that is, they must pre-scrape food waste into the solid waste, keep sink strainer baskets clean and replaced when necessary. Grease prevention procedures must be part of the standard training of new employees.

Good housekeeping is the first step in a good grease reduction program.

4.3 Tips to eliminate grease before it becomes a problem:

Fryers, grills, roasting pans: Put waste grease in a container then pour it into a barrel for recycling. Wipe the fryer down with paper and dispose of it with solid waste. Wash out the remaining the grease (there should not be much).

Gravy and sauce: Wipe greasy pans and dishes prior to washing, putting leftover material into a container. Residues should go out with the solid waste.

Butter and margarine: Scrape utensils and containers prior to washing and dispose of non-recyclable materials in the solid waste.

Meat scraps and trimmings: Wipe meat processing equipment clean with paper prior to cleaning and put meat trimmings into a waste container. Recycle floor sweepings or put them in the solid waste.

Sink strainers: Use a sink strainer to trap small food particles. Keep these clean and dispose scraps as solid waste.

Recycle unprepared food waste: Recycling is the preferred method of disposing of significant volumes of food waste. Most recycling companies provide rendering barrels or food waste barrels. Small quantities of food can be disposed in the solid waste if it is in a plastic bag or container. (See Appendix B for contractor list).

Maintain taps and interceptors: Small kitchen-sized traps should be cleaned at least weekly, sometimes more often. This can be done after hours, by kitchen staff. Larger vault-sized interceptors should be cleaned on a regular basis, depending on the amount of grease accumulated.

Spill Prevention and Cleanup:

- Store and transport liquids in containers with tight-fitting lids.
- Regularly inspect containers for leaks.
- Develop and implement an emergency spill prevention plan, which should be posted at appropriate locations in the building (near areas that have a high potential for spills).
- Put an emergency spill containment and cleanup kit near the spill prevention plan.
- Train all employees about the plan and kit.
- Clean up all spills properly and immediately.

4.4 Do I need a grease trap or interceptor?

Any establishment that introduces grease or oil into the sewage system in quantities large enough to cause line blockages or hinder sewage treatment should install a grease trap or interceptor. Grease interceptors are usually required for high volume restaurants (full menu establishments serving more than 40 meals per peak hour) and large commercial establishments such as hotels, hospitals, factories or school kitchens.

Grease traps are required for small volume (fast food or take-out restaurants with limited menus, minimum dishwashing or minimal seating capacity) and medium volume (full menu establishments operating 8-16 hrs/day and/or serving less than 40 meals per peak hour) establishments. Medium volume establishments may be required to install an interceptor depending upon the size of the establishment.

Grease traps – how they work

At present most hotels and restaurants in Kurunegala and other areas in Sri Lanka do not use grease traps for the removal of oil and grease from wastewater. However, a simple grease trap is adequate to treat the wastewater from small and medium scale hotels and restaurants. A trap is a small reservoir built into the wastewater piping a short distance from the grease producing area. Baffles in the reservoir retain the wastewater long enough for the grease to congeal and rise to the surface. The grease can then be removed and disposed properly.

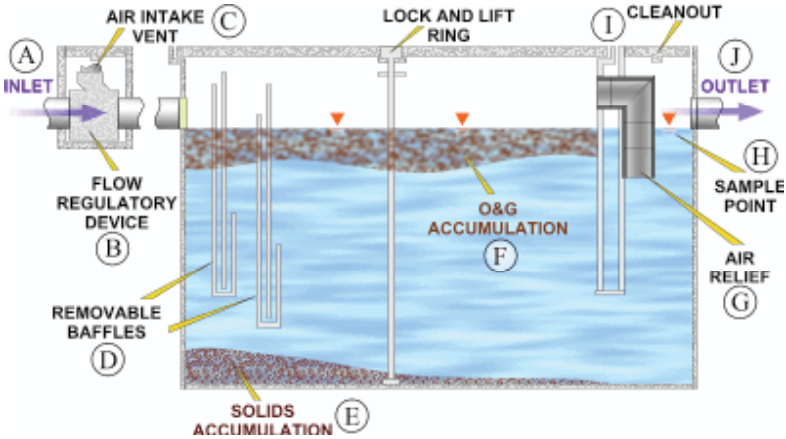

Figure 6. Grease Trap- How it works

Source: www.govlink.org

A Flow from the hotel or restaurants enters the grease trap.

B An approved flow control or restricting device must be installed to restrict the flow to the grease trap to the rated capacity of the trap.

C An air intake valve allows air into the open space of the grease trap to prevent siphonage and back-pressure.

D The baffles help to retain grease toward the upstream end of the grease trap since grease floats and will generally not go under the baffle. This helps to prevent grease from leaving the grease trap and moving further downstream where it can cause blockage problems.

E Solids in the wastewater that do not float will be deposited on the bottom of the grease trap and will need to be removed during routine grease trap cleaning.

F Oil and grease floats on the water surface and accumulates behind the baffles. The oil and grease will be removed during routine grease trap cleaning.

G Air relief is provided to maintain proper air circulation within the grease trap.

H Some grease traps have a sample point at the outlet end of the trap to sample the quality of the grease trap effluent.

I A cleanout is provided at the outlet or just downstream of the outlet to provide access into the pipe to remove any blockages.

J The water exits the grease trap through the outlet pipe and continues on to the grease interceptor or to the sanitary sewer system.

To properly maintain a grease trap:

1. Remove the accumulated grease from the interceptor and deposit in a watertight container.
2. Remove baffles if possible.
3. Scrape the sides, the lid, and the baffles with a putty knife to remove as much of the grease as possible, and deposit the grease into a watertight container.
4. Remove solids from the bottom with a strainer or similar device.
5. Replace the baffle and the lid.
6. Record the volume of grease removed on the maintenance log.
7. Arrange for grease to be recycled or collected for disposal. In the absence of such service discuss possible disposal options with the MC.

Grease interceptors – how they work

An interceptor is a vault with a minimum capacity of between 500 and 750 gallons that is located on the exterior of the building. The vault includes a minimum of two compartments and flow between each compartment is through a 90 degree fitting designed for grease retention. The capacity of the interceptor provides adequate residence time so that the wastewater has time to cool, allowing any remaining grease not collected by the traps time to congeal and rise to the surface where it accumulates until the interceptor is cleaned.

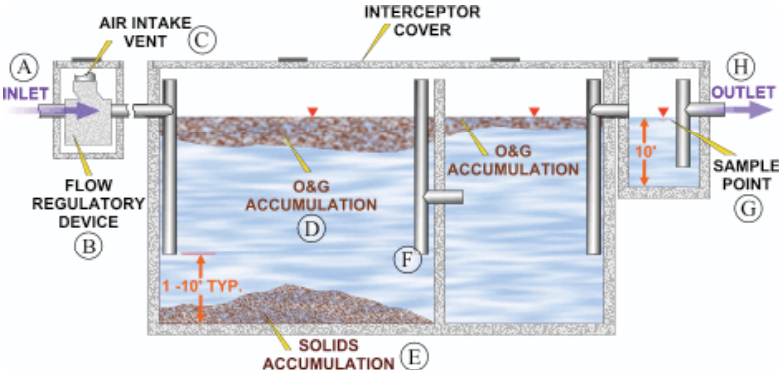

Figure 7. Grease Interceptor

Source: www.govlink.org

A Flow from hotel or restaurant enters the grease interceptor. Generally all flow entering the interceptor must enter through the inlet pipe.

B Optional not required in most cases.

C An air intake valve allows air into the open space of the grease interceptor to prevent siphonage and back-pressure.

D Oil and grease floats on the water surface and accumulates behind the grease retaining fittings and the wall separating the compartments. The oil and grease will be removed during routine grease interceptor cleaning.

E Solids in the wastewater that do not float will be deposited on the bottom of the grease interceptor and will need to be removed during routine grease interceptor cleaning.

F Grease retaining fittings extend down into the water to within 12 inches of the bottom of the interceptor. Because grease floats, it generally does not enter the fitting and is not carried into the next compartment. The fittings also extend above the water surface to provide air relief.

G Some interceptors have a sample box so that inspectors or employees of the establishment can periodically take effluent samples. Having a sample box is recommended but not required.

H Flow exits the interceptor through the outlet pipe and continues on to the sanitary sewer system.

Grease trap and interceptor maintenance

Many hotel and restaurant owners face the difficulty of the treatment system failing due to poor maintenance. Therefore, maintenance of the system is vital for the continued functioning of the treatment system.

Grease trap maintenance is generally performed by maintenance staff or other employees of the establishment. Grease interceptor maintenance, which is usually performed by permitted collectors or recyclers, consists of removing the entire volume (liquids and solids) and properly disposing of the material in accordance with the environmental laws. When performed properly and at the appropriate frequency, grease interceptor and trap maintenance can greatly reduce the discharge of FOG into the wastewater collection system. The required maintenance depends greatly on the amount of FOG a facility generates as well as any BMPs that the establishment implements to reduce the FOG discharged into its sewer system. In many cases, establishments that implement BMPs will realize financial benefit through a reduction in the frequency of required grease interceptor and trap maintenance.

WARNING! Do not use hot water, acids, caustics, solvents, or emulsifying agents when cleaning grease traps and interceptors.

Conventional grease traps may not be able to adequately remove the FOG from the hot wastewater streams.

Some hotels in Colombo sell their used cooking oil and grease from the traps. The contact details of the buyers can be obtained from the WASPA field office in Kurunegala or the Kurunegala Municipal Council. The Buyers generally buy large quantities (2000 liters or above) and the average rate is Sri Lanka Rupees 60 per liter of discarded oil. It is important that a used oil collection system is established in Kurunegala with the involvement of the Municipal Council.

5. Water Saving Options for Hotels and Restaurants

Saving water is an important cost reduction measure for hotels and restaurants as it reduces water bills as well as decreasing the quantity of wastewater that needs to be treated. It also has a positive impact on the environment. Some options to reduce water use include:

1. Build a tank inside the kitchen annexed to the pot washing area, to collect usable grey water with which to pre-wash the kitchen utensils.
2. If a hose is used to wash the floor, reduce the size and add a pressure nozzle to the user end.
3. Reduce leaks - make all valves leak proof and regularly check them.
4. The effective volume of the toilet cistern can be reduced without affecting the cleaning effect (e.g. reduce by one liter). This can be done through simple measures such as placing a brick in the cistern.
5. After treatment up to the proper control limits the water can be reused by passing it through a pipe line network to the garden, lawn, ornamental plants or ponds.
6. Install a complete set of water meters in main lines and subdivisions, to have a comprehensive water management system in the hotel and restaurant.
7. The final wash effluent from the laundry can be collected separately and reused for the pre-wash stage.

Examples from Kandalama Hotel, Dambulla, Sri Lanka

Low flush toilets and fixtures are in use.

Wastewater generated by the hotel is treated and recycled within a modern and well-maintained on-site wastewater treatment. This is then recycled for watering of the hotel compound.

Grey water from filters and softeners in the water treatment plant is collected and used to spray the gravel to reduce the distribution of dust.

Rainwater collection tanks have been introduced at Kandalama with a view to installing more in the future.

The contact details of the Kandalama hotel are given at the end of Appendix B.

APPENDIX A: Contaminants of concern in wastewater treatment, the treatment levels and processes

Contaminants	Reason for importance
Suspended solids	Suspended solids can lead to the development of sludge deposits and anaerobic (absence of oxygen) conditions when untreated wastewater is discharged in the aquatic environment.
Microorganisms	Some of them pose a danger to human health (pathogens); some of them are not harmful but create difficulties in water treatment (clogging of filters, taste and odour problems). Waterborne microorganisms can be responsible for diverse public health problems including bacterial diseases such as cholera and gastroenteritis, viral infections such as hepatitis, amoebic dysentery or diarrhea originating from protozoa, and parasitic helminthes (worms) infections.
Nutrients	Both nitrogen and phosphate, along with carbon, are essential nutrients for growth. When discharged to the aquatic environment, these nutrients can lead to the growth of undesirable aquatic life. When discharged in excessive amounts on land, they can also lead to the pollution of groundwater.
Priority pollutants	Organic and inorganic compounds selected on the basis of their known or suspected carcinogenicity, mutagenicity, teratogenicity, or high acute toxicity. Many of these compounds are found in wastewater.
Refractory organics	These organics tend to resist conventional methods of wastewater treatment. Example: agricultural pesticides.
Heavy metals	Heavy metals (E.g. mercury) can be discharged to wastewater from commercial and industrial activities and have to be removed if the wastewater is to be reused.
Dissolved inorganics	Inorganic constituents such as calcium, sodium, and sulfate are added to the original domestic water supply as a result of water use and may have to be removed if the wastewater is to be reused.

Source: Metcalf and Eddy 2003.

Source: Metcalf and Eddy 2003.

Treatment levels and Processes

Preliminary Treatment

Preliminary treatment protects equipment from large or abrasive objects in the influent stream (screening and grit removal) and, in some cases, conditions wastewater (by mixing and deletion) to ease subsequent operations. As industrial wastewater enters a plant for treatment, it flows through a screen, which removes large objects such as rags and sticks that might clog pipes or damage equipment. After wastewater has been screened, it passes into a grit chamber, where cinders, sand and small stones settle to the bottom.

Primary Treatment

Sedimentation is currently the most widely used primary treatment operation. In a sedimentation unit, solid particles are allowed to settle to the bottom of a tank under quiescent conditions. Chemicals may be added in primary treatment to neutralize the stream or to improve the removal of small-suspended solid particles. Primary reduction of solids reduces oxygen requirements in a subsequent biological step and also reduces the solids loading to the secondary sedimentation tank. After screening is completed and grit has been removed, sewage still contains organic and inorganic matter along with other suspended solids. These solids are minute particles that can be removed from sewage in a sedimentation tank. Primary treatment alone has proved to meet some industries demands for higher water quality in order to comply with environmental regulations for effluent discharge to various water bodies.

Secondary Treatment

Secondary treatment generally involves a biological process to remove organic matter through biochemical oxidation. The particular biological process selected depends upon such factors as quantity of wastewater, biodegradability of waste and availability of land. The principal secondary treatment techniques used are the activated sludge process and the trickling filter. In the activated sludge process, wastewater is fed to an aerated tank where microorganisms consume organic wastes for maintenance and generation of new cells. The resulting microbial floc (activated sludge) is settled in a sedimentation vessel called a clarifier or thickener. A portion of the thickened biomass is usually recycled to the reactor to improve performance through higher cell concentrations. Trickling filters (bio-filters) are beds packed with rocks, plastic structures, or other media. Microbial films grow on the surface of the packing and remove soluble organics from the wastewater flowing over the packing. The activated sludge process speeds up

the work of the bacteria by bringing air and sludge heavily laden with bacteria into close contact with sewage. After the sewage leaves the settling tank in the primary stage, it is pumped into an aeration tank, where it is mixed with air and sludge loaded with bacteria and allowed to remain for several hours. During this time, the bacteria break down the organic matter into harmless by-products. The sludge now activated with additional billions of bacteria and other tiny organisms can be used again by returning it to the aeration tank for mixing with air and new sewage. From the aeration tank, the partially treated sewage flows to another sedimentation tank for removal of excess bacteria.

Tertiary Treatment

Many industrial effluent standards require tertiary or advanced wastewater treatment to remove particular contaminants or to prepare the water for reuse. Some common tertiary operations are removal of phosphorus compounds by coagulation with chemicals, removal of nitrogen compounds by ammonia stripping with air or by nitrification – denitrification in biological reactors, removal of residual organic and color compounds by adsorption on activated carbon and removal of dissolved solids by membrane processes (reverse osmosis and electrodialysis). The effluent water is often treated with chlorine or ozone to destroy pathogenic organisms before discharge into the receiving waters (but the use of chlorine is not recommended). Tertiary treatment is intended primarily for upgrading the quality or polishing of effluent and to remove further the suspended solids, BOD_5 and excess nutrients. The various processes of tertiary treatment applied to industrial effluents are: coagulation and sedimentation; activated carbon adsorption; electro-dialysis; biological nitrification; ion exchange; and ultra-filtration. In general, tertiary treatment requires considerable sophistication in design, construction and operation and is unlikely to be required for hotels and restaurants.

Sludge Treatment

Selection of a treatment sequence for sludge depends upon the nature of the sludge, environmental factors and ultimate disposal options. Wastewater treatment processes generate significant quantities of sludge from suspended solids in the feed, biomass generated by biological operations and precipitates from added chemicals.

Sludge conditioning by chemicals or heat improves rates of dewatering. In dewatering operations, the water content of sludge is reduced to a level where they can be handled as damp solids. Vacuum filtration, centrifugation and sand beds are the most common dewatering methods. Thermal processes, such as heat drying and incineration are used to either dry the sludge or to oxidize its organic content. Residual sludge and ash from sludge treatment processes must be disposed of. Some of the options for ultimate disposal on land are landfill, land reclamation and crop fertilization.

APPENDIX B: Relevant Contacts

This is a list of available experts and companies in Sri Lanka. They are in no particular order and the WASPA project does not especially endorse any of them.

National Cleaner Production Center
No. 4, Charles Way, Off 5th Lane, Colombo 3
Tel: 011 2375730, 2375732, Email:ncpcsl@ncpcsrilanka.org
Contact: Mr.Sena Pieris or Mr.Samantha Kumarasena

National Engineering Research and Development Center (NERD)
2P/ 17 B, Industrial Estate, Ekala, Ja-Ela.
Tel: 011 2236284, 011 2233152, Fax: 94 11 535497
E-mail: red@nerdc.lk, wickramasinghe@nerdc.lk
Contact: D.A.Wickramasinghe, Head Department of Renewable Energy

Industrial Services Bureau
141, Kandy Road, Kurunegala. Sri Lanka
Tel: 037 2223721-3, Fax: +94 37 22223562, Email:isbnwp@slt.lk
Contact: Ms.Banduni Premarathne

Watercare Engineering (pvt) Ltd
73F, kandy Road, Dalugama, Kelaniya
94-112-911499, 94-112-811823, Fax 94-114-811823
Hot Lines 94-712-718516, 94-777-358017
Contact: Ms. Subashini Bandara

Thurul Safe Environment Research and Development Bureau
Priya sevana, Nainamadama
Tel:+94-776222992; Email:thurulenv@gmail.com, www.thuruls.com
Contact: Mr.Thurul

Chemical Industries (Colombo) Ltd Nalco Department
77, Sri Sasanajothi Mawatha, Ratmalana
Tel: 011-2610858, 011-2636818, Fax: 011-4204377
Email: fmohd@nalco.com
Contact: Mr.M.J.M.Fouz

A.K.K.Engineers (pvt) Ltd,
Water and Wastewater Treatment,
115, Parliament Road, Battaramulla
Tel: 011 4305662, Fax: 011 4305650

Puritas Limited Wastewater Treatment,
25, Foster Lane, Colombo 10
Tel: 011 2683963, Tel/Fax: 011 2687721, Fax: 011 2699630
puritas@haycarb.com
Contact: Mr. Dimuth Nawaratna

Enviro Water System (Pvt.) Ltd
512/5, Bokundara Road, Arewwala, Pannipitiya
Tel : 011 4319923, Fax : 0112848705
Email: envirows@envirows.com, www.envirows.com

Engineering Services Ltd
481, T B Jaya Mawatha, Col 10
Tel: 011 2665946, 2665947, 2665951, 4736981, 4736982, 4736984
Fax: 011 2665947, 2698489, Hot Line: 0777355691, 0777373862
Email: eslt@sltnet.lk, www.engsevltd.lk

Industrial Technology Institute (ITI)
363, Bauddhaloka Mawatha, Colombo 7
Tel : 011 2693807/9, 2698621/3, Fax : 2686567
Email : info@iti.lk, www.iti.lk
Contact: Mr. H.N.Gunadasa

Greater Kununegala Sewerage Project Office,
National Water Supply & Drainage Board, Kurunegala
194/4, Kandy Road, Kurunegala
Tel: 037-2233661
Contact: Ms.Mangala Tennakoon, Deputy Project Director

Laboratory, National Water Supply & Drainage Board, Kurunegala
Wathhimiya Road, Kurunegala
Tel: 037-2220839
Contact: Ms.Rupa Jayasinghe

Department of Civil Engineering
University of Moratuwa, Katubedda, Moratuwa.
Tel: 011 2650567/8, email: niranrat@civil.mrt.ac.lk
Contact: Prof. N. Ratnayake, Head Division of Environmental Engineering

Department of Chemical and Processing Engineering
University of Moratuwa, Katubedda, Moratuwa.
Tel: 011 2650301, 2650281, Fax: 2650 622, Email: ajith@cheng.mrt.ac.lk
Contact: Dr.Ajith De Alwis or Dr.Suren Wijeyekoon

For more information about Kandalama Hotel Wastewater Management you may contact

Mr.Rienzi Rambukwella
Kandalama Hotel P.O. Box 11, Kandalama, Dambulla.
Tel: 94-66 2284100 Fax: 94-66 2284109

Mr. Ravi de Silva – Environmenta Manager Kandalama Hotel
Aitken Spence Hotel Managements (Pvt) Ltd.
Vauxhall Towers, 315, Vauxhall St., Colombo 02.
Tel : 011-2308308

Glossary

Activated Carbon: highly absorbent carbon obtained by heating granulated charcoal to exhaust contained gases, resulting in a highly porous form with a very large surface area.

Activated Sludge: sludge that results when primary effluent is mixed with bacteria laden sludge and then agitated and aerated to promote biological treatment.

Advanced Wastewater Treatment: any treatment of sewage that goes beyond the secondary or biological water treatment stage and includes the removal of nutrients such as phosphorus and nitrogen and a high percentage of suspended solids.

Adsorption: an advanced method of treating waste in which activated carbon removes organic matter from wastewater.

Ammonia Stripping: process that removes ammonia from wastewater.

Anthracite: a filtration medium.

Baffles: static devices that regulates flow.

Biochemical Oxygen Demand: a water quality indicator of biologically degradable waste.

Biological Nitrification: biological process that converts Nitrogen from one form to another.

Carcinogenicity: ability to cause cancer.

Centrifugation: removal of solids by rotating motion.

Chemical Oxygen Demand: water quality indicator of chemically degradable waste.

Coagulation: a clumping of particles in wastewater to settle out impurities. It is often induced by chemicals such as lime, alum, and iron salts.

Coalesce: to grow together, fuse.

Comminution: to reduce to powder.

Disinfectant: a chemical or physical process that kills pathogenic organisms in water.

Effluent: a discharge of liquid waste.

Electrodialysis: chemical separation process.

Flocculation: the process by which clumps of solids in water or sewage are made to increase in size by biological or chemical action so that they can be separated from the water.

Gastroenteritis: infection or irritation of the stomach and intestine.

Greywater or sullage: washing water e.g. personal, clothes, floors, dishes.

Heavy Metals: metallic elements with high atomic weights, e.g. mercury, chromium, cadmium, arsenic and lead. They can damage living things at low concentration and tend to accumulate in the food chain

Hepatitis: a viral disease that spreads from wastewater and contaminated food.

Incineration: a special burning process that coverts the burned material into ashes.

Ion Exchange: a chemical separation process.

Landfill: a method of solid waste disposal in which refuse is buried between layers of soil. Waste is usually contained and efflement is collected and treated.

Mutagenicity: ability to cause changes to cells in the human body.

Nitrification and Denitrification: a processes that convert Nitrogen from one form to another.

Pathogen: an agent that causes disease.

Protozoa: one cell animals that is not visible to the naked eye.

Residence time: time the wastewater is held.

Sewage: wastewater that is contaminated with feces or urine, but is often used to mean any wastewater. “Sewage” includes domestic, municipal, or industrial liquid waste products disposed of, usually via a pipe or sewer or similar structure.

Sedimentation: letting solids settle out by gravity during wastewater treatment.

Settleable Solids: Materials heavy enough to sink to the bottom of a wastewater treatment tank.

Skimming: removing oil or scum from the surface of water.

Screening: Use of screens to remove coarse floating and suspended solids from sewage.

Sludge: semi-solid material such as the type precipitated by sewage treatment.

Storm drain: drains, usually along roads, that carry storm water.

Suspended Solids: small solid particles which remain in suspension in water.

Teratogenicity: the development of physical defects in the embryo (unborn child).

Total Suspended Solids: water quality indicator of solids.

Ultrafiltration: a special filtration process.

Wastewater Treatment Plant: a facility containing a series of tanks, screens, filters, and other processes by which pollutants are removed from water.

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International
Water Management
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ENVIRONMENT
INSTITUTE


IRC


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