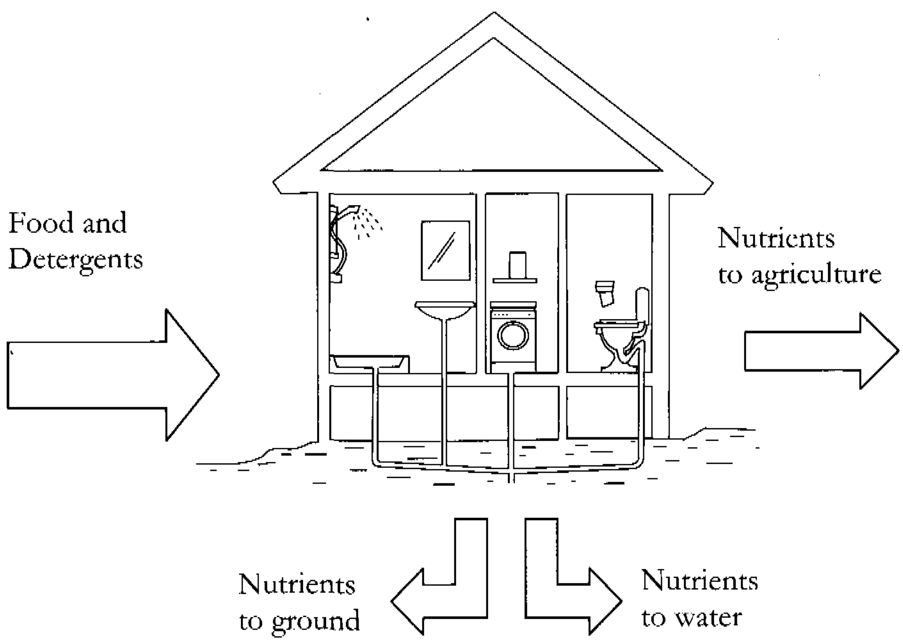
Coalition Clean Baltic

FOR PROTECTION OF THE BALTIC SEA ENVIRONMENT

SUSTAINABLE WASTEWATER TREATMENT FOR SINGLE-FAMILY HOMES



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Single-family homes in the countries around the Baltic Sea are one of the main sources of water pollution. Several new, small-scale systems have been developed that can provide sustainable solutions.

This brochure outlines why wastewater has to be treated and presents a number of on-site treatment techniques.

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1. Wastewater — a problem or a resource?

Single-family homes in most countries around the Baltic Sea often have inadequate wastewater systems, with treatment either nonexistent or limited to a septic tank. The untreated wastewater from these systems causes eutrophication in lakes, rivers and the Baltic Sea, and also constitutes a serious health risk. On a local scale, single-family homes are often one of the main sources of water pollution.

Treating wastewater on site is often cheaper than connecting to a centralised sewer system. Today, small-scale systems can, in an environmentally and economically sound way, reduce or eliminate problems stemming from wastewater. These on-site systems can give satisfactory sanitary treatment, reduce discharge of nutrients, and make it possible to recycle the nutrients in the wastewater. Many of these techniques can achieve a better level of treatment than a centralised sewer systems connected to a state-of-the-art treatment plant.

Different technologies are appropriate for different places. What is needed is a process for choosing the best technology in each case. Homeowners and local policy makers need more information about why wastewater needs to be treated, and about the different technologies available.

This brochure describes why wastewater needs to be treated, presents a number of on-site treatment techniques, and gives a strategy for selecting and managing wastewater treatment for single-family homes. It is important to mention that there are many other existing techniques for treating wastewater on-site than the ones described in this brochure.

2. Why treat wastewater?

Wastewater contains pathogens, organisms that cause disease. It also contains plant nutrients, primarily phosphorus and nitrogen, which stimulate algal production in the receiving waters. The algae eventually die and decompose, using up much of the dissolved oxygen in the water. Organic matter and ammonium in the wastewater, which also decompose, compound the problem of oxygen loss. The lowered oxygen levels in the water can weaken or kill fish and other aquatic organisms by suffocating them.

On the other hand, nutrients are a resource that can be used in agriculture, replacing chemical fertilisers. When we flush wastewater out into the lakes and rivers we are depositing these valuable plant nutrients in the wrong place, causing problems instead of utilising a resource. A sustainable solution must include a high degree of nutrient recycling.

Wastewater has been treated for different reasons at different times and in different places. In this booklet, we join with many modern researchers and practitioners who argue that the primary functions of wastewater treatment are to prevent:

- spreading of diseases
- pollution of recipient waters with nutrients and organic matter
- loss of agriculturally valuable nutrients

In a report published by Coalition Clean Baltic,[1] a small community in the countryside defined their primary goals for wastewater treatment. These goals are shown in Table 1, and could be

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[1] Wastewater treatment in a small village: Options for upgrading. SwedEnviro report 1999:1.

adopted in many other places. Specifying these goals gives a clearer view of the requirements for the planned treatment facility. The next step is to identify technologies that can meet the requirements. By considering a number of different technologies, it is easier to choose the one that is best for the particular location.

We will use these goals as standards throughout this booklet.

Table 1. The primary functions of wastewater treatment, Ridderstolpe 1999.

Function	Requirements
Public health	- Avoid sanitary nuisance, e.g., bad odour - Infectious disease control, i.e., the effluent is either swimming water quality or excluded from direct exposure to humans until it has achieved swimming water quality
Receiving water	- P: > 90% reduction (at most 0.1 kg/person annual discharge) - N: > 50% reduction (at most 2.5 kg/person annual discharge) - BOD: > 95% reduction
Recycling of nutrients and/or organic matter	- P: > 75% recycled - Other resources valuable for agriculture

Other important issues are economics, technical reliability and robustness, how well a technology fits in with the local situation, and formal requirements for responsibility and monitoring. For property owners, these aspects are often at least as important as the environmental and public health parameters emphasised by authorities.

3. What does domestic wastewater contain?

The volume and composition of domestic wastewater, i.e., wastewater from households, depend on how much time the residents spend at home, what kind of food they eat, which detergent they use, etc. For example, the phosphorus content in Swedish detergents has been reduced over the past fifteen years due to consumer demand for environmentally friendly, non-phosphate detergents. The amounts of organic toxins and heavy metals in wastewater also depend on the behaviour of the residents, and can be kept to negligible levels.

There is a distinct difference in the composition of wastewater from toilets, called "blackwater," and that from the rest of the household, "graywater." Figure 1 shows the result from studies conducted in Sweden and Norway to establish values for the nutrient content and volumes of different household wastewater flows. These values may vary between areas and households and should be seen as averages.

3.1 Urine

In mixed domestic wastewater, the main source of both nitrogen (80-90%) and potassium (90%) is the urine, which constitutes only about 1% of the total wastewater flow. The urine also contains more than 50% of the phosphorus. Therefore, simply separating the urine removes most of the nutrients from wastewater. The content of microorganisms and viruses is relatively low in urine from a healthy person. However, the complete separation from faeces is hard to achieve and contamination from diseases in urinary tract system makes it necessary for urine to be hygienically treated before recycled to agriculture.

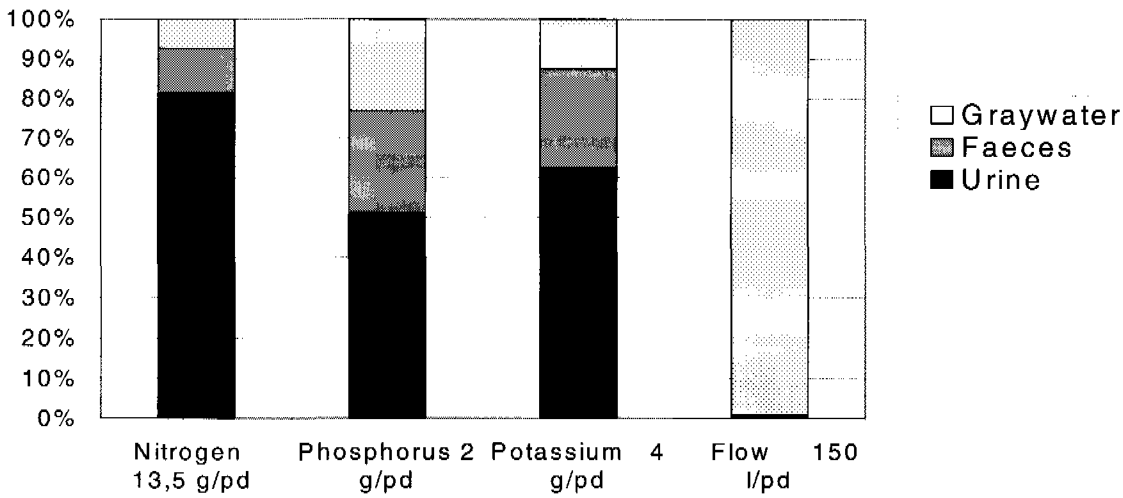

Figure 1 ***Diagram showing the nutrient percentage and the water in the different wastewater flows. (Flush water is not included. It can amount to 1-50 l/person and day, depending on choice of toilet)***

3.2 Faeces

The volume of this fraction depends on what type of toilet is used. The volume of the faeces themselves is very small. The water used for flushing the urine and the faeces in a normal WC amount to 20-25% of the total wastewater volume. The faeces contain approximately 25% of the phosphorus, most of the organic matter and almost all of the pathogens. Any product including faecal material (blackwater or mixed wastewater) needs hygienic treatment before use in agriculture.

3.3 Graywater

The graywater amounts to about 75% of the total flow. It does not contain a high volume of nutrients, if non-phosphate detergents are used. The sanitary quality of graywater is under debate in Scandinavia. Graywater has been found to have levels of pathogen indicator organisms as high as in mixed wastewater, but still people argue that the hygienic risk associated with graywater is limited. However, the graywater needs to be treated in any case, because of high levels of oxygen-consuming organic material (commonly measured as BOD, biological oxygen demand).

4. An overview of available systems

In this section a number of different techniques for on-site wastewater treatment that can fulfil the requirements in Table 1 are presented. Some solutions are comparatively cheap and low-tech but require changes in user habits, while others are less demanding for the household but more hi-tech and costly.

Four different methods are presented below, two focusing on interventions at the source and two at the outlet, for on-site treatment of wastewater. This booklet covers only systems suitable for single-family homes and not systems for larger residential areas or small villages.

4.1 Source separating systems

Source separation means separate collection of two or more of the various wastewater fractions. There are three different kinds of source separation, generally in use for domestic wastewater:

a) collecting urine in one place, faecal matter in another, and graywater somewhere else; (see section 7.1)
b) collecting urine separately from the rest of the wastewater; or
c) collecting urine and faecal material together but separate from the graywater (see section 7.2)

Any kind of source separation requires changing the physical waste collection system within the building. In many cases, a different toilet than the WC is used. And while some parts of the waste will be taken elsewhere for treatment, some of it, either the graywater or a mix of graywater and faecal matter, will still need to be treated on site.

a) Urine separation

As the urine contributes the most to the nutrient content in wastewater, the simplest way to capture nutrients is to separate the urine from the rest of the flow. This is done in a specially designed toilet with a separate collecting bowl. The urine is then flushed away with a small amount of water (1-2 dl) through a separate pipe or hose to an enclosed storage tank, to avoid ammonia loss to the air. The volume produced is approximately 0.5 m^3 per person per year. The urine needs to be stored for about six months, to achieve a sufficient pathogen die-off, before it is used in agriculture.

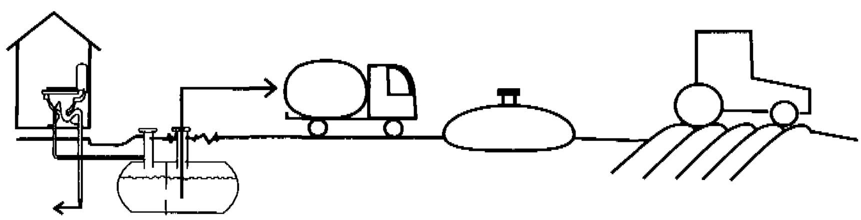

***Figure 2** Principle for a urine-separating system from house to field*

There are more than 20 different urine-separating toilets on the Scandinavian market. Most types are composting toilets made out of plastic (See section 7.1 for further information). These are mostly used in summerhouses. Some models (either with dry collection of faeces or flushing of faeces) are made out of sanitary porcelain and are suitable for permanent dwellings. The urine-separating toilets have been thoroughly tested over a number of years in Sweden. The major problem has been blockages in the trap on the toilet, the curved pipe that prevents gases from the urine sewer from entering the house. This can now be avoided by choosing the right type of trap and by cleaning the pipe with sodium hydroxide (soda).

b) Blackwater systems

In a system with blackwater separation, all the toilet waste is flushed and collected in a storage tank. This collects more than 75% of the phosphorus, more than 90% of the nitrogen, and a large portion of the BOD. Almost all nutrients from the wastewater can be recycled. This system uses either a water closet with an extremely low flush volume connected to gravity sewers, or a vacuum toilet.

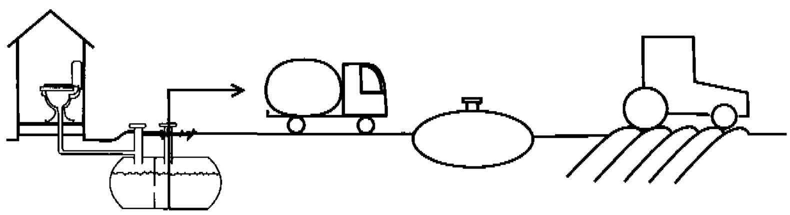

Figure 3 ***Principle for a blackwater system from house to field***

There are about 5-10 different blackwater systems available on the Scandinavian market, but only a few are designed for single-family homes. The system requires a separate pipe for transportation of the toilet waste. The less water used for flushing the faeces, the more concentrated the blackwater becomes. This is important, as it will reduce the tank volume, reduce the transportation cost, and make the end product more valuable for farmers. The blackwater contains high amounts of pathogens and therefore does need treatment, such as liquid composting, to reduce the content of pathogens.

4.2 Treating wastewater at the end of the pipe

In Scandinavia the most common small-scale techniques for treating domestic wastewater have been sandfilter beds and infiltration.

Despite the freedom to choose from many different systems, local authorities still focus primarily on these kinds of systems. Designed and constructed in a proper way, they do provide adequate treatment, but limit the possibility of recycling nutrients.

Many new systems have become available over the last ten years. The performance of some of these new techniques and products are not documented in a satisfactory way and one must mainly rely on information provided by the manufacturers. But there are two principal proven ways of reducing phosphorus and BOD in mixed wastewater from households, adsorption in a reactive filter bed and chemical precipitation.

a) *Adsorption of phosphorus in a reactive filter bed*

A reactive filter bed basically works in the same way as an ordinary sandfilter or infiltration system. The wastewater is pretreated to reduce the solids, for example in a septic tank, and then distributed evenly over the filter. A fine layer of bacteria, called a biofilm, grows on the filter medium and carries out most of the treatment. Phosphorus is adsorbed on a special medium that contains materials rich in iron, calcium, and/or aluminum. The filter bed can be constructed on site or purchased as a unit. There are a wide variety of designs available on the market.

The potential for phosphorus and BOD-reduction is very high if the right material is available and the system is designed and constructed properly. For example, results from Norway, where a special LECA® medium (a very porous, ceramic material) has been used in filters, indicate a >90% reduction of phosphorus, >75% reduction of BOD, and up to 40% reduction of nitrogen. (see Figure 9, section 7.3)

The LECA can also reduce the ammonium-nitrogen up to 80%, which is an advantage since this is a significant contributor to oxygen depletion in the receiving waters.

For recycling of nutrients, the phosphorus that is adsorbed on the filter media may be reused if the filter media is removed and spread on agricultural fields. There is too little information about how well this really works to know the technique's full potential for nutrient recycling.

b) *Chemical treatment*

Techniques for precipitating phosphorus with salts of iron, calcium, or aluminium have been in use in conventional wastewater treatment for decades. Phosphorus precipitation has been used to a limited extent in on-site treatment for single-family homes with varying results. In the past years, different manufacturers of sequential batch reactors and other types of package treatment plants have developed systems for single households. These are relatively expensive, both in the initial investment and the operating cost for service and chemicals. The reduction of phosphorus and BOD is good, but the hygienic quality of the effluent is uncertain.

A different approach, basically using the same technique, is to add the chemicals into an existing system (into the sewage pipes or into the septic tank) to increase phosphorous removal. Results from Sweden show a reduction of phosphorus by >80% and BOD by about 50% depending on the retention time, i.e., the average amount of time the water spends in the septic tank. If the water is filtered (for example, in a small filter bed), both the phosphorus and especially the BOD reduction will be even higher. The nitrogen reduction in this system is limited. One side effect of adding chemicals is that the volume of sludge becomes 2-4 times greater, and more frequent pumping of the septic tank is required. The sludge (as other products containing faecal material) needs treatment, such as storage or composting, to reduce the content of pathogens before use. (see section 7.4)

Neither the small "conventional" treatment plants nor the upgrading of an existing system by adding chemicals to the septic tank affects the buildings greatly, as the processes are located outside. Both systems require frequent service by professionals, which is one reason for their relatively high operating costs.

5. Graywater treatment

5.1 *Why treat graywater?*

There are different views on how much treatment is necessary for graywater. Many advocates of low-cost technologies say that little treatment is required. Others consider graywater to be as harmful to groundwater, lakes, and rivers as mixed wastewater, and insist that thorough treatment is necessary.

One of the major problems connected to graywater is that it contains high concentrations of organic matter that can cause foul odours. Another factor may be the content of phosphate, depending on what detergents are used. The hygienic risk of graywater is widely debated. Some sampling has shown that it can contain as many indicator organisms as mixed wastewater, which brings up the question of whether this is an indication of a high risk or whether the risk must be calculated in some other way. Almost all wastewater-spread diseases originate in the faecal material. If the faeces are taken care of separately, the graywater can be considered less dangerous from a hygienic point of view than a mixed wastewater, but this does not mean that it is harmless. Separation may not be complete; faecal matter can enter graywater through bathing or clothes washing, especially if there are very young children in the household.

5.2 *Primary treatment of graywater*

The first step in treating graywater is to remove solids and fats to avoid clogging the rest of the system. A septic tank promotes settling of particles and degradation of organic material. It is very important that the outlet is constructed in a way that fat and floating material, as well as settled substances, are blocked from leaving through the outlet. A filter on the effluent, for example a polyethylene screen, further increases the septic tank's efficiency in retaining suspended solids. The septic tank should be monitored every two to four years and emptied when necessary.

5.3 *Techniques for secondary treatment of graywater*

a) Resorption

A technique that has been in use for a long time, mostly in summerhouses, is the resorption system. This is a simple solution where graywater from a septic tank is horizontally spread in a soil layer and prevented from infiltrating. The water evaporates or is consumed by plants that grow in the soil. Particles, nutrients, and pathogens are either adsorbed onto the soil particles or degraded by microorganisms.

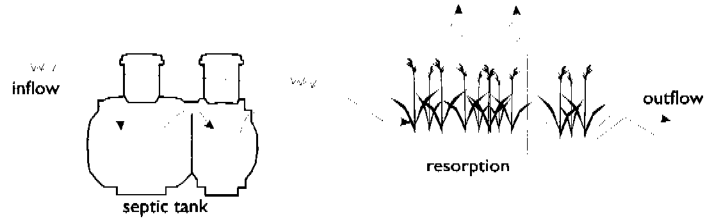

Figure 4 Principle for a resorption system for treating graywater.

The system can function very well in the summertime, with almost no loss of nutrients or pathogens to the environment. However, it is extremely temperature dependent, since at low temperatures the water may freeze and clog the flow. This system cannot be recommended for permanent residences in cold climates.

b) Compact filter beds

The filter bed can be constructed either as shown for the LECA filter (section 7.3), with a vertical flow followed by horizontal flow, or as shown below, with a vertical flow in a closed compartment. The filter medium may be LECA or something similar, or fine-grained sand. A compact filter uses a fine geo-textile, which forces the wastewater through tiny holes. This allows the beneficial microbes which live in a film on the surface of the textile to have close access to the organic matter and pathogens in the wastewater, enhancing the degradation of organic matter and the perdition of pathogens.

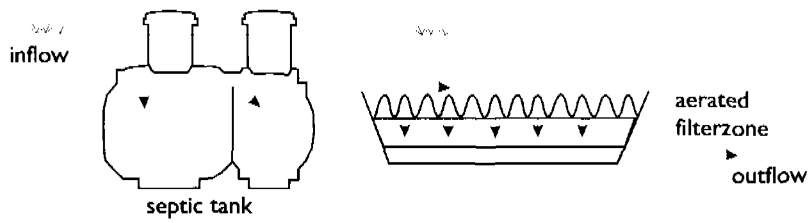

***Figure 5* Principle for a compact filter bed.**

c) Infiltration

One frequently used technique for treating wastewater is to infiltrate the wastewater into the soil. This can be used for graywater if local conditions allow, that is, if it will not cause pollution of the groundwater. A trained soils assessor will be able to determine whether there is risk of groundwater pollution, based on depth of soil to a limiting condition, e.g., bedrock or seasonal high water table, and soil type. If non-phosphate detergents are used, very small amounts of nutrients will be discharged.

6. What to do with the end products of wastewater treatment?

The conventional way of managing the end products of sewage treatment is to consider them problems that need to be taken care of as easily and cheaply as possible. This way of thinking can lead to the disposal of nutrient-rich materials like sludge on landfills, where the nutrients are a pollutant rather than an asset.

A more modern view is that the end products are a resource. Wastewater treatment is more ecologically sound when the nutrient-rich products - urine, concentrated blackwater, sludge from chemical treatment or phosphorus-rich filter media - are recycled as fertiliser. One option is to use them on the property, for domestic plant production. Few people, however, have enough domestic production to efficiently use all the nutrients from their wastewater. For this reason, the nutrients are usually spread on local farmland.

If the nutrients will be spread on local farmland, it is necessary to involve farmers and farm associations before deciding what type of treatment system to use. Farmers have many years of experience handling manure and similar products. If the farmers are not interested in using certain end products, this has to be considered in the planning process.

To get acceptance from the farmers, it is important that the end products are of good quality, the nutrient content is high, the concentration of toxic compounds is low, and the hygienic risk is limited.

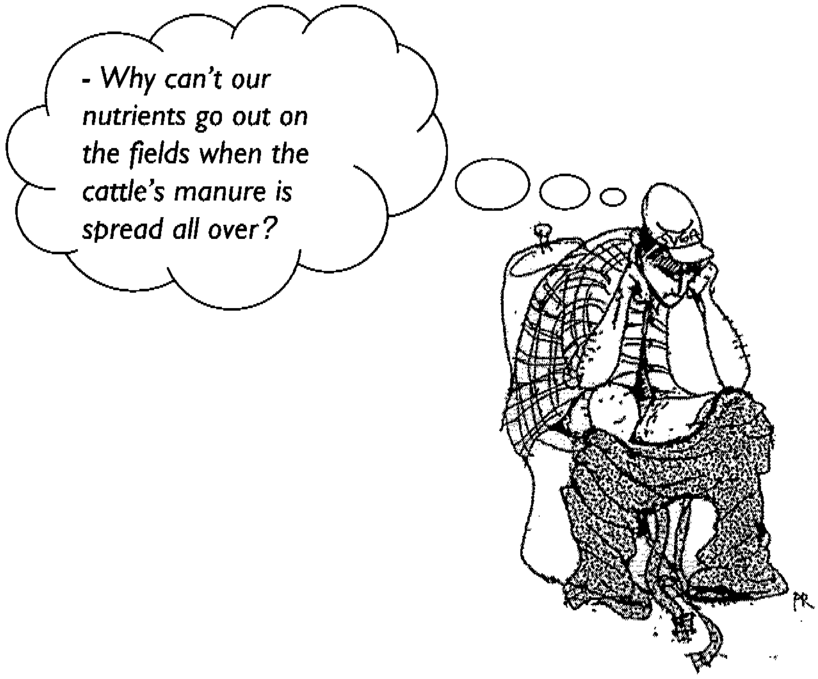

Figure 6 ***The farmer and his thoughts***

Techniques that have already been developed for storing and spreading animal manure can also be used for handling urine, sludge and so on. The human waste products are often very rich in nitrogen, which makes it important that techniques for storage and spreading minimise the risk of ammonia losses. This can be done by using air-tight tanks and by spreading the products close to or under the soil surface. The filter media and the sludge from chemical precipitation are less rich in nitrogen, which makes other methods for storage and spreading appropriate.

6.2 How to reduce public health risks

To enable the use of end products it is necessary to reduce the risk of spreading diseases. This can be done by storage of urine (6 months) blackwater, sludge and filter media (6-12 months) and when spreading the material, immediately mixing it into the soil. This is especially important for products with faecal content as the remaining pathogens are quickly out-conquered by the micoorganisms in the soil.

The hygienisation can also be done by dewatering and composting, anaerobic digestion or liquid composting of sludge and blackwater. The latter methods are expensive treatments that need a high volume of organic material, while the former could be done locally without high costs.

7. Examples of systems for single-family homes

In this section, we describe systems that can meet the goals for wastewater treatment given in Table 1. These systems have all been used on at least an experimental basis.

7.1 Urine separating, composting toilet

The simplest and cheapest solution is to use a urine-separating, composting toilet. This toilet uses a small amount of water for flushing the urine but no water for the faeces and toilet paper. It is used in many places, both in year-round dwellings and summerhouses, with good results and no problems with odours.

The principle for this toilet is to separate the different wastewater streams and use as little water as possible. The urine is flushed with 1-2 dl of water and is collected in a storage tank. Approximately 0.5 m^3 is produced per person annually. The faeces and toilet paper are collected in plastic containers (80 l each) and dried with help from a fan. The containers are replaced every 2-3 months.

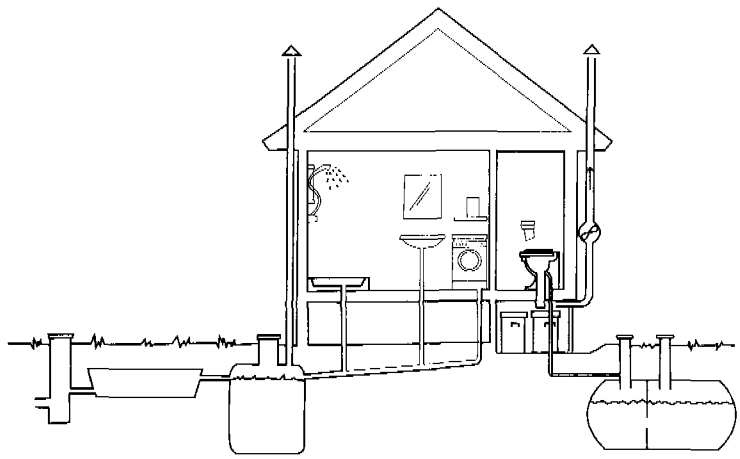

Figure 7 ***Urine separating, composting toilet + graywater treatment***

After the toilet waste has been dried, it is possible to compost it with household organic waste, producing an even better end product. The volume of the final compost is very small and is easily handled by the user. The finished compost should, for hygienic safety, be stored in a closed container for about six months before use in the garden or in agriculture. For treatment of graywater, see Section 5. The reduction of nitrogen, phosphorus, and BOD meets the requirements in Table 1, and the nutrients are in a form that facilitates recycling.

This type of system involves a small investment and a low operating cost. The system is suitable for summerhouses, year-round dwellings with motivated users, and also for tourist facilities and other places where the load is unevenly distributed over time.

Urine separating with composting toilet and graywater treatment						
Public health	***Reduction***	***Recycling***	***Investment****	***Resource use***	***Acceptance***	***Feasible for***
Local composting of faeces and storage is needed. Compost should be stored for 6 months	P: 80-90% N: 90% BOD: 90%	P: ~ 90% N: 90% K: > 90%	Toilet: 700-800 USD Urine tank: 800-1000 USD Graywater: 1,500-2,000 USD	Very small	Motivation and knowledge is needed from the users.	• Summerhouses • Permanent houses with motivated inhabitants • Where urine is accepted as fertiliser • Reducing load on old infiltration systems

* Price for toilet includes composting containers, fan etc. A composting vault will be more expensive. Graywater treatment: septic tank and compact filter bed

7.2 *Blackwater systems*

The most developed blackwater system for single households is the urine separating, low-flush vacuum toilet. This system is in use in many households in Sweden and is now also exported to other countries. There are other kinds of vacuum and low-flushing toilets on the market, but these have not been thoroughly tested.

The toilet is made out of porcelain and has a small bowl that separates the urine. The urine runs by gravity to a collection tank. The faeces and the toilet water is flushed by a vacuum system and run to the same collection tank. Only 0.5 – 1.0 litres of water is used per flush for the faeces and 0.1 - 0.2 litres of water for the urine. All together the total volume of blackwater can be kept as low as 0.5-1 m^3/person annually. It is possible to add organic household waste to the blackwater, which makes the blackwater more concentrated. For graywater treatment, see Section 5.

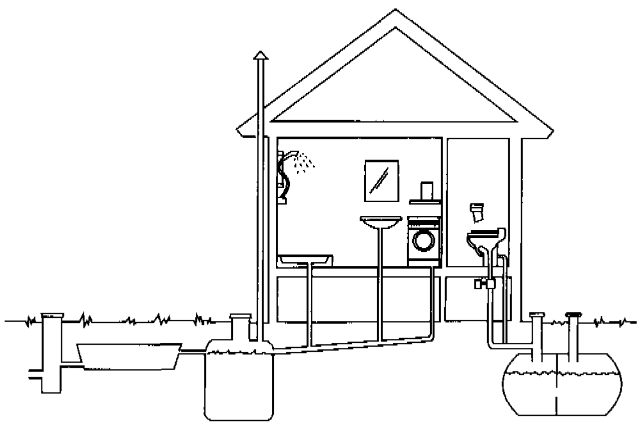

***Figure 8* The Ekovak system**

If a 3 m^3 tank is used, it does not have to be emptied more than 1-2 times a year for a household of 5 people. The blackwater could either be dewatered and composted locally, or transported to a treatment facility elsewhere. Alternatively, the blackwater could be used for biogas production or in a liquid composting reactor to reduce the pathogens and recover heat energy. These systems are very interesting, but experience with large-scale systems including transport, treatment (biogas or liquid composting), and usage in agriculture, is limited. On a smaller scale, with local composting of the blackwater, there are a number of systems operating, for example, a school in Kvicksund, Sweden and a dormitory in Aas, Norway. It is important to develop a local system with other households and farmers for reusing and treating the blackwater. It is difficult for a single household to organise and finance a system for treating the blackwater. Unless the property owner can use the end product, the local authorities and farming associations play a key role in this discussion.

The cost for constructing such a system depends on the existing system in the building, and on how many toilets are needed. The investment cost will be higher than in the previous example, but it gives a more conventional feeling to the user. The operating cost for sludge transport and treatment is at least twice that of an ordinary septic tank, but it can be kept down if the treatment is carried out locally.

Blackwater system with graywater treatment						
Public health	***Reduction***	***Recycling***	***Investment****	***Resource use***	***Acceptance***	***Feasible for***
The end product needs treatment to reduce pathogens.	P: 80-90% N: 90% BOD: 90%	P: ~ 90% N: 90% K: > 90%	Vacuum syst –3000 USD Graywater: 1500-2000 USD	Very small. Needs electricity.	• Functions like an ordinary toilet. • Vacuum toilets may be noisier than an ordinary toilet.	• Newly built houses in areas not suitable for infiltration. • Areas close to agriculture • Houses with existing closed tanks.

* Vacuum system: incl. toilet, piping and collection tank. Graywater: septic tank + compact filter bed

7.3 *Mixed wastewater treated in a filter bed*

A compact filter bed can reduce the area needed for treating wastewater to approximately 1-2 m^2 per person. The compact filter beds mentioned earlier are the most space efficient, while others, for example, ordinary sand filters, require more space. Treating mixed wastewater in a filter bed can give good results in terms of reduction of BOD, reduction of pathogens, and reuse of phosphorus if an appropriate filter media is chosen.

A filter bed can be installed in combination with any septic tank, whether it is connected to an ordinary water closet or not. As usual, the sludge in the septic tank should be monitored every year and collected when needed. The filter beds can be constructed in many different ways, but it is very important that the filter medium is carefully chosen and that the water is spread evenly over the filter. To monitor the treatment performance, the treated water should be collected in an effluent pipe, rather than infiltrated directly to the ground below.

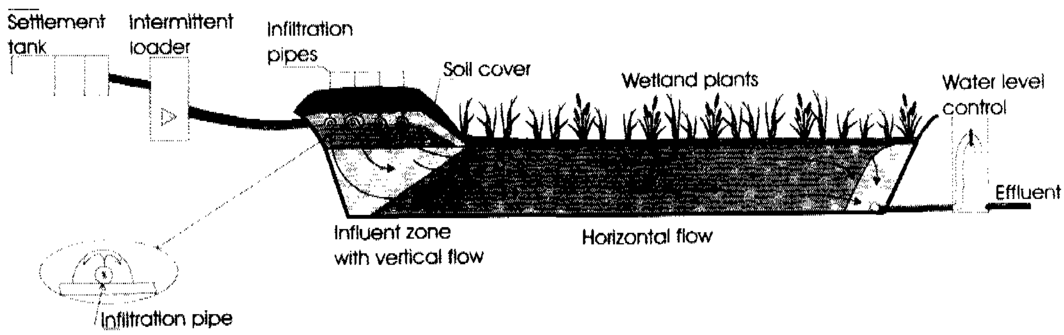

***Figure 9* Constructed LECA filter from Norway.** **(Maehlum, T. 1998)**

Another type of biofilm-based filter, called reed beds, uses horizontal, saturated flow and planted reeds or cattails as part of the design. Their litter provides insulation during the winter to the filter. The plants also add aesthetic value. Recent studies show that the reduction of BOD, phosphorus, and pathogens can be achieved without adding these plants to the system. The organic material and the nitrogen are reduced by the bacterial growth, and the phosphorus stays adsorbed to the filter medium. Therefore, the medium must periodically be excavated and applied to agricultural land, and then replaced with new material. The public health risk of spreading the filter medium on agricultural land is not known.

Compact filter bed for mixed wastewater						
Sanitation	***Reduction***	***Recycling***	***Investment****	***Resource use***	***Acceptance***	***Feasible for***
Very good.	P: 80-90% N: 30-50% BOD > 90%	P: ~ 90% N: very low K: very low	4-5 000 USD	Filter material must be changed every 5-10 years.	• No changes within the house	• Most houses with septic tanks. • Areas with long distance to farmland

* Excluding septic tank

The investment cost for a filter bed as described above is approximately 4000-5,000 USD. There are other types of compact filters that are less expensive, but their reduction efficiency has not been thoroughly tested. The operational cost is relatively low, as only the septic tank needs to be emptied. The cost for restoring the filter bed is not known but it should be much less than the initial investment cost.

7.4 On-site chemical phosphorus reduction

This system requires a septic tank. Adding chemicals to the wastewater in the discharge pipe, where they react with the organic matter and phosphorus to produce a sludge that settles in the septic tank, precipitates the phosphorus. The dosage of chemicals must correspond to the flow of wastewater for the system to operate well. The chemical use can be managed by software that doses in relation to the number of residents of the household and their habits. Another way of doing this is to add chemicals every time a toilet is flushed.

The only additional need for space is for a small box (0.5 x 0.75 x 0.5 m), containing dosing equipment for chemicals, inside the house, with connections to the house's effluent pipe.

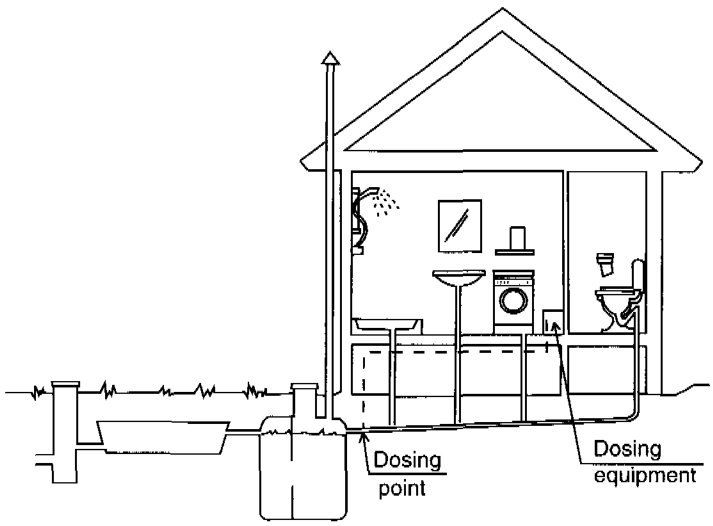

Figure 10 The Ekotreat system, small scale chemical precipitation.

The sludge production will increase compared to ordinary conditions, which may make it necessary to empty the septic tank 3-4 times a year.

Even though pathogenic organisms are reduced in this process, there is still need for additional treatment before discharge as with an ordinary septic tanc. Also, the large amounts of suspended solids in the discharged water require additional treatment, such as a filter bed. The system needs electricity and regular service by professionals.

The investment cost for this system in an existing building can be kept low, especially if there is an existing filter bed or other kind of treatment that can be used for polishing the water before discharge. On the other hand, the cost for transportation of sludge is at least doubled or tripled if the sludge cannot be treated on site. There is also an extra cost for service and chemicals that may amount to 100-200 USD/year, depending on the hydraulic load.

On-site chemical phosphorus reduction						
Public Health	***Reduction***	***Recycling***	***Investment***	***Resource use***	***Acceptance***	***Feasible for***
The end product requires pathogen reduction before use in agriculture. Filter beds or other treatment is needed after septic tank.	P: 80% (90% with filterbed) N: 20-40% BOD: 50-60% (90% with filter bed)	P: ~80% N: 20% K:?	Ekotreat system: Appr. 2 000-2500 USD Compact filter bed: 1500 USD	Use of chemicals and electricity. Extra transport of sludge.	Not different from a conventional system. Farmers must accept the sludge.	• Upgrading existing septic tanks or non-functioning soil filters.

This technique is the newest and least evaluated of the ones presented here. It has only been tested on a small scale in Sweden. The results so far are very promising, and this type of technique can provide a possibility for phosphorus reduction (and reuse) in existing residences at a low cost.

8. Summary

Discharge of wastewater from single-family homes is a main contributor to water pollution on both a local and regional scale around the Baltic Sea. In many places the public health dangers due to insufficient treatment of wastewater are significant. Therefore it is extremely important to apply better solutions for small-scale on-site treatment.

The basic requirements for wastewater treatment are:

- Sanitation
- Protecting the receiving waters
- Recycling of nutrients.

There are a variety of technical solutions and products available on the market that can fulfil these requirements. The systems for single-family homes that have been presented in this brochure are both environmentally favourable and less costly than building centralised sewers to treatment plants.

It is very important that farmers are included in the process when planning local systems for recycling of nutrients from wastewater. In many cases, locally adapted systems with low-tech solutions can have the lowest cost for both investment and maintenance.

The rapid development, which currently takes place, only confirms the need of affordable and reliable systems for single-family houses. It continuously brings out new products, expands the knowledge by new scientific findings and brings forth operational and user experiences from installed systems.

Definitions

Biofilm - A film of bacteria on the surface of a filter medium, where part of the treatment is carried out.

Blackwater - Water from the WC

Pathogens - Organisms that can cause disease.

BOD - Biological Oxygen Demand, the content of organic matter in water

Graywater - Water from bathing, washing dishes, etc

K - Potassium, a plant nutrient

N - Nitrogen, a plant nutrient

P - Phosphorus, a plant nutrient

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Coalition Clean Baltic

In Helsinki, February 1990, non-governmental environmental organisations from nine countries of the Baltic Sea Region united and established the Coalition Clean Baltic (CCB) in order to co-operate on activities for protection of the Baltic Sea environment. CCB is a politically independent, non-profit association. Currently CCB unites 24 member organisations from the Baltic countries. CCB gathers, produces and distributes information on environmental solutions for the Baltic Sea Region. CCB co-operation projects provides assistance to the member organisations in their efforts to restore the Baltic Sea. Eco-technology for wastewater treatment is a priority area for CCB.

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