Sustainable and cost-effective wastewater systems

for rural and peri-urban communities up to 10,000 PE

Low-tech, decentralized systems serving villages and towns with less than 10,000 population equivalents (PE) have decisive advantages in terms of sustainability and cost effectiveness. Ponds and constructed wetland systems are extensive wastewater treatment options which can meet the requirements of the EU Urban Waste Water Treatment Directive, even for sensitive areas.

This publication provides some easy-to-understand guidance on taking decisions in wastewater management in villages and small towns for decision-makers at ministerial and municipal level, for authorities and utilities, as well as consultants and NGOs working in the field of sanitation and wastewater management. This publication presents examples of sustainable sanitation and wastewater management from several EU countries, including centralized and on-site systems as well as innovative concepts.

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Guidance paper

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Sustainable and cost-effective wastewater systems for rural and peri-urban communities up to 10,000 population equivalents

Guidance paper

Claudia Wendland
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Scope of this Guidance Paper

The scope of this paper is to provide some easy-to-understand guidance on taking decisions in wastewater management in settlements and towns with up to 10,000 population equivalents (PE).

Specific aims of the guidance paper are :

- To inform about cost-effective and sustainable options for sanitation, wastewater collection and treatment
  - which meet the requirements of the Urban Wastewater Treatment Directive for agglomerations with 2,000 – 10,000 PE
  - for smaller agglomerations with less than 2,000 PE to improve the hygienic and environmental situation in the frame of the Water Framework Directive
- To give guidance to decision-makers how to select appropriate systems for sanitation and wastewater management with respect to relevant framework conditions, in particular to give decisive advantages and drawbacks of non-conventional systems, decentralized and semi-centralized systems, ponds and constructed wetlands as well as innovative concepts also for settlements without reliable water supply
- To show examples for sustainable and cost-effective solutions from different EU countries

The target group of this guidance paper are decision-makers on ministerial and municipal level, authorities and utilities, as well as consultants and NGOs working in the field of sanitation and wastewater management.

Waste stabilization pond, Travenbrück, Germany

Contents

1 Urban Wastewater Treatment Directive (UWWTD) Council Directive of Council Directive 91/271/EEC of 21 May 1991
2 Report of the MED-EUWI Wastewater Reuse Working Group 2007 http://ec.europa.eu/environment/water/water-urbanwaste/info/water_reuse.htm

1. The Regulatory Framework in the EU

Important constitutional principles of the treaty on the European Union do relate to the environment:

- Environmental protection aiming at high level of protection
- Precautionary principle
- Principle of addressing pollution at the source

The legislation on EU level addresses the topic of sanitation and wastewater treatment through the directives Urban Waste Water Treatment (UWWTD), the Water Framework Directive (WFD) incl. the daughter directives and indirectly the Drinking Water Directive (DWD).

1.1 Urban Wastewater Treatment Directive (UWWTD) [1]

The UWWTD is an emission-oriented directive which obliges the member states to collect the waste-water and install treatment plants in agglomerations with more than 2,000 people equivalent (PE). According to the UWWTD, agglomerations with 2,000-10,000 PE must set up appropriate treatment, as well as the agglomerations with less than 2,000 PE which already have a collection system (Article 7 of the UWWTD). Appropriate treatment is defined as primary and secondary treatment, nutrient removal as tertiary treatment is only required in case of eutrophication. Microbiological parameters are not considered. For agglomerations with less than 2,000 PE not having any collection system, there are no specific requirements. Any regulation on the management of wastewater from those agglomerations is left over to the EU member states.

The UWWTD sets the conventional wastewater collection and treatment systems as standard and seems to limit flexibility for looking at new sanitation concepts. Alternative solutions to centralized sewerage systems are however permitted even in urban areas, if same level of environmental protection is achieved.

In article 12, it says that "treated wastewater shall be re-used whenever appropriate", however no definition of appropriate or guidelines of best practice are given. An initiative by MED-EUWI Wastewater Re-use Working Group 2007 made an initiative to promote re-use of treated wastewater on EU level[2].

There is a guide published by the EU in 2001 "Extensive Wastewater Treatment Processes adapted to small and medium sized communities (500 – 5,000 PE)" [3] which promotes extensive and cost-effective wastewater treatment processes for smaller communities. This guide has not been translated to the languages of the new member states like Bulgarian and Romanian and is not very well known.

1.2 Water Framework Directive (WFD) [4]

The WFD requires the achievement of good water and groundwater status. How to achieve the good status is very flexible and must be set in river basin management plans and measures by the member states based on good governance including civil society participation. In rural regions, measures to prevent, enhance and control groundwater pollution should be adopted, including criteria for assessing good chemical status. The maximal acceptable value for nitrate is 50 mg/l, which is exceeded in many groundwater bodies. Beside the agricultural practices, the lack of adequate wastewater treatment can be identified as one of the causes. This is of predominant importance for public health as rural regions often rely on small scale water supply from ground waters. In this way, the agglomerations below 2,000 PE (which are not covered by the UWWTD) fall under the WFD and are supposed to set up appropriate sanitation and wastewater treatment to reach good water status and safe drinking water standard. The

3 Extensive Wastewater Treatment Processes adapted to small and medium sized communities (500 – 5,000 PE)" see http://ec.europa.eu/environment/water/water-urbanwaste/info/pdf/waterguide_en.pdf
4 Water Framework Directive. Council Directive 2000/60/EC of 23 October 2000 establishing a framework for community action in the field of water policy

requirements of the WFD concerning measures for providing wastewater collection and treatment are therefore very flexible. E.g. onsite sanitation with onsite re-use of water and nutrients could be a cost-effective option with diverse environmental benefits. If re-use of treated wastewater for irrigation can be an alternative for water-scarce regions, it is of importance not to remove the nutrients (N, P) and to meet a certain microbiological, hygienic standard.

1.3 Drinking Water Directive (DWD) [5]

The DWD applies to drinking water supply systems for >50 people or supplying >10 m^3 per day. It sets health-oriented quality standards (microbiological and chemical parameters) to ensure safe drinking water. The DWD obliges to regularly monitor drinking water quality and to inform citizens about the quality of their drinking water.
In 2010, the DWD will be revised. It was shown that esp. small water supplies are not always sufficiently protected and a guidance will be introduced based on the approach of water safety plans to protect drinking water in a more holistic way.

	Agglomerations with up to 2,000 PE	**Agglomerations with up to 2,000 PE having a wastewater collection system**	**Agglomerations with 2,000 – 10,000 PE**	**Agglomerations with 2,000 – 10,000 PE discharging to sensitive areas**
Urban Wastewater Treatment Directive *applies*	*no*	*yes*	*yes*	*yes*
Requirements		*Provision of a waste-water treatment system*	*Provision of a sewer-age and wastewater treatment system*	*Provision of a sewerage and wastewater treatment system*
		*Removal of Organic matter * (BOD, COD, SS)*	*Removal of Organic matter * (BOD, COD, SS)*	*Removal of Organic matter * (BOD, COD, SS) Nutrients** (N, P)*
Water Framework Directive applies	*yes*	*yes*	*yes*	*yes*
Requirements	*Setting up measures to achieve a good water and groundwater status to protect drinking water, implying provision of sanitation and wastewater treatment for communities*			

** BOD_5 = 25 mg/l O_2 (70-90 % percentage of reduction), COD = 125 mg/l O_2 (75 % percentage of reduction), SS = 35 mg/l (90 % percentage of reduction)*
*** Total phosphorus = 2 mg/l (80% percentage of reduction), Total nitrogen = 15 mg/l (70-80% percentage of reduction)*

Table 1: EU legislation related to wastewater collection and treatment

5 Drinking Water Directive. Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption

1.4 Situation in the new EU member states Bulgaria and Romania

When Bulgaria and Romania became member of the EU, the transition procedures were negotiated. To fulfil all the requirements of the UWWTD, Bulgaria and Romania set their final deadlines of transitional period by end of 2014 and 2018, respectively. The investment costs needed to build wastewater collection and treatment for agglomerations with more than 2,000 PE are estimated to be 2.1 Billion Euro for Bulgaria and 10.1 Euro Billion for Romania [6]. They are eligible for getting financial support by the EU cohesion funds.
In Bulgaria and Romania, almost 4 Mio people (2.1 Mio in Romania and 1.8 Mio in Bulgaria) live in villages in agglomerations with less than 2,000 inhabitants which usually do not have any wastewater collection or treatment and are not obliged to provide it in the near future by the UWWTD. These settlements often rely on local groundwater sources for their drinking water which are often insufficiently protected and polluted by human activities. Thus they are covered by the WFD and the related daughter directives. However, the measures set in the river basin management plans are not addressing sufficiently the problems of lacking sanitation and wastewater treatment in these settlements with less than 2,000 PE.

Constructed wetland for greywater treatment in Lübeck, Germany

Treated effluent of the constructed wetland in Lübeck, Germany

6 See Facts and Figures about Urban Waste Water Treatment. http://ec.europa.eu/environment/water/water-urbanwaste/implementation/factsfigures_en.htm

2. Sustainable and cost-effective wastewater treatment systems which meet the requirements of the UWWTD

Sanitation incl. wastewater collection and treatment systems for small communities are a matter of concern to every country. The number of treatment plants in rural areas is very high but they are small in size. They are commonly subjected to high seasonal and even daily variations in wastewater flow and load on the one hand. On the other hand, these treatment plants in rural areas need to be easy to manage and to operate.
Both wastewater collection and treatment should be considered within a regional planning process to ensure long-term sustainability under various conditions. Especially in rural/agricultural areas, treated wastewater that is provided in reliable quality and quantity is valued as a precious resource (agricultural re-use) and could contribute to an adaptation of the climate change
In this guidance, the settlements are not further classified, the systems presented here can be applied in communities up to 10,000 PE which are obliged to develop appropriate treatment under the UWWTD or WFD.
The main objective is to provide an overview of different wastewater collection and treatment systems, as well as to discuss their strengths and weaknesses with a focus on cost-effective and sustainable treatment technologies.

2.1 Definitions

2.1.1 Urban Wastewater

Urban wastewater is defined as the mixture of domestic and industrial wastewater and sewer infiltration water. Especially in rural areas with usually longer sewerage network, the sewer infiltration water increases significantly the quantity of urban wastewater to be treated in the treatment plant and must not be neglected. Rainwater (run-off rainwater) is sometimes also considered within the urban wastewater flow if combined sewers are applied. The quality and quantity arising from the different sources can significantly vary (see table 2).
Reducing wastewater flow as early as possible is naturally very cost-effective. Efficient water usage policy and demand management measures reduce water flow on domestic level through raising awareness for water efficient household installations (including water saving toilets) and cost-recovering prices. Industrial wastewater should be treated at source if possible to reduce the amounts and loads for the urban wastewater flow. The quantity of sewer infiltration water (e.g. ground water infiltration by leakages, illegal connections) is very difficult to keep low. The key is regular and proper monitoring and maintaining of the sewerage network. Run-off rainwater should be separately collected and treated accordingly.

Urban wastewater			**Sewer infiltration water**	**Run-off rainwater**
Domestic wastewater		***Industrial wastewater (Annex III of the UWWTD)***		
Toilet wastewater (Urine, brownwater (faeces + flush water))	*Greywater (Water from personal hygiene, kitchen and laundry, not from the toilets)*			
10,000 – 25,000 liter/ person/year depending on the type of toilet	*25,000 – 100,000 liter/person/year depending on the status of water saving devices in the households*	*Quantity depends on the industrial activities in the agglomerations and their wastewater management*	*Quantity is high (e.g. 100% of the domestic wastewater, especially in rural area)*	*Amount depends on the climate*

Table 2: Characteristic and definition of urban wastewater

2.1.2 Sustainability

Although the term sustainability is not explicitly mentioned in the EU legislation, it is key to implement wastewater systems, which are sustainable. Sustainability relates to 5 aspects as defined by the Sustainable Sanitation Alliance[7] . Sanitation in this respect includes wastewater management and discharge as well.
The main objective of a sanitation and wastewater treatment system is to protect and promote human health by providing a clean environment and breaking the cycle of disease. In order to be sustainable a sanitation system has to be not only economically viable, socially acceptable, and technically and institutionally appropriate, it should also protect the environment and the natural resources. When improving an existing and/or designing a new sanitation system, sustainability criteria related to the following aspects should be considered:

(1) Health and hygiene: includes the risk of exposure to pathogens and hazardous substances that could affect public health at all points of the sanitation system from the toilet via the collection and treatment system to the point of re-use or disposal and downstream populations.

(2) Environment and natural resources: involves the required energy, water and other natural resources for construction, operation and maintenance of the system, as well as the potential emissions to the environment resulting from use. It also includes the degree of recycling and re-use practiced and the effects of these (e.g. reusing wastewater; returning nutrients and organic material to agriculture), and the protecting of other non-renewable resources, for example through the production of renewable energies (e.g. biogas).

(3) Technology and operation: incorporates the functionality and the ease with which the entire system including the collection, transport, treatment and re-use and/or final disposal can be constructed, operated and monitored by the local community and/or the technical teams of the local utilities. Further-

7 SuSanA (Sustainable Sanitation Alliance) is an international coordination platform with more than 100 organisations (www.susana.org)

more, the robustness of the system, its vulnerability towards power cuts, water shortages, floods, etc. and the flexibility and adaptability of its technical elements to the existing infrastructure and to demographic and socio-economic developments are important aspects to be evaluated.

(4) Financial and economic issues: relate to the capacity of households and communities to pay for sanitation, including the construction, operation, maintenance and necessary reinvestments in the system.

(5) Socio-cultural and institutional aspects: the criteria in this category evaluate the socio-cultural acceptance and appropriateness of the system, convenience, system perceptions, gender issues and impacts on human dignity, compliance with the legal framework and stable and efficient institutional settings.

2.2 Wastewater Collection

The planning work should take a holistic approach to wastewater discharge, treatment and re-use. Any decision in favor of a specific technical option in the early planning phase will strongly influence the amount of both investment and operating costs. In this regard, it is important to know that wastewater collection conventionally accounts for 60 – 80% of the total costs for wastewater disposal.
Centralized wastewater management represents the conventional approach in many countries. It is characterized by the collection and removal of urban wastewater by a centralized sewerage to a centralized intensive treatment plant where the wastewater and sludge are treated and disposed of under controlled conditions. The overall advantages of this management concept are perceived to be the lower investment and operational costs incurred by a single large treatment plant as compared to several small-scale plants as well as a more effective control of quality standards and plant operation procedures.
However, a number of disadvantages entailed with this management concept are speaking against a centralized wastewater management option as the universally applicable solution especially when it comes to less densely populated areas: The costs/benefits ratio of central systems may be less favorable if the high and long-term construction and maintenance costs of the sewerage system are taken into account. If not adequately maintained, an extensive sewerage system may leak and cause contamination of soil and groundwater. Centralized treatment systems require (multiple) pumping stations which must be properly operated and maintained as well. And centralized municipal treatment plants reduce opportunities for water, nutrients and sludge re-use in local cycles, due to their high load of harmful substances, such as chemicals, heavy metals, and pathogens (especially when also industrial wastewater is collected in combined sewer).
This given, the selection of the suitable public sewerage and treatment system is not an easy task, especially as there is a variety of decentralized, semi-centralized and combined systems available (see table 3 and figure 1).
In recent years, increasing attention has been given to modern onsite, decentralized or semi-centralized wastewater management concepts that are already applied in many countries, particularly in rural and peri-urban areas. These concepts comprise collection, treatment and disposal/re-use of wastewater from small communities (from individual homes to portions of existing communities) integrated in settlement/village/town development projects. Such approaches consist of many small sanitation/wastewater treatment facilities designed and built locally.
Decentralized systems maintain both the solid and liquid fractions of the wastewater at or near the point of origin and, hence, minimize the wastewater collection network. This approach offers a high degree of flexibility, allowing modifying the design and operation of the system to fit to various site conditions and scenarios.

Decentralized or semi-centralized systems offer the following advantages:
- Save money in terms of investment costs and operation and maintenance costs regarding the sewerage system which is shorter
- Better protection of water resources, in case of failure small damage (risk minimization)
- Better adjustment to the individual grade of pollution
- Flexible (expandable) and adaptable to changing frame conditions, population, tourism, industries
- Provide tailor-made solutions for environmentally sensitive areas, can be implemented in a modular principle
- Can better fit into the landscape
- Re-use of treated wastewater and nutrients (Nitrogen and Phosphorus) is easier to manage

The main drawbacks of decentralization or semi-centralization of wastewater management are named as:
- Potential lower treatment efficiency (esp. for Nitrogen and Phosphorus)
- Need for education and correct usage
- Finding qualified personal for operating and maintenance is key
- Insufficient monitoring might occur
- Legal framework and institutional setting are more complex

These concerns must be taken seriously into consideration when planning the sanitation and wastewater system.

Type of collection system	***Characteristics***
A) Centralized system, combined sewerage (incl. rainwater) or separate sewerage (wastewater and rainwater sewers) *Treatment options: Intensive wastewater system (e.g. activated sludge), extensive wastewater treatment (e.g pond)*	*Different types of sewerage systems possible: high-tech like pressurized and vacuum sewerage or low-tech like free water level* *Sewerage system requires maintenance* *A number of pumping stations are required*
B) Combined on-site and centralized system *Collection and pre-treatment of wastewater on-site in septic tanks combined with settled or simplified sewerage and intensive or extensive secondary treatment*	*Combination of on-site and centralized system* *Sewerage (settled sewerage) less costly and less complex than conventional sewerage* *Advantageous if septic tanks have already been installed*
C) Semi-centralized system *Number of smaller, semi-centralized treatment plants serve one agglomeration*	*Advantageous if the agglomerations is clustered in several settlements* *Flexible, can be built modular* *Sewerage network is shorter*
D) Decentralized on-site system (no sewerage) household based *Treatment options: Intensive, extensive and innovative wastewater system possible*	*Advantageous in sparsely populated areas and/or difficult site conditions for sewerage* *No centralized sewerage required* *Operation and maintenance to be done on site by either the private owners or the public service* *Requires public and private rights and obligations properly identified* *Close of the local water cycle (on-site water and nutrient re-use)*

Table 3: Type of urban wastewater collection system and its characteristics

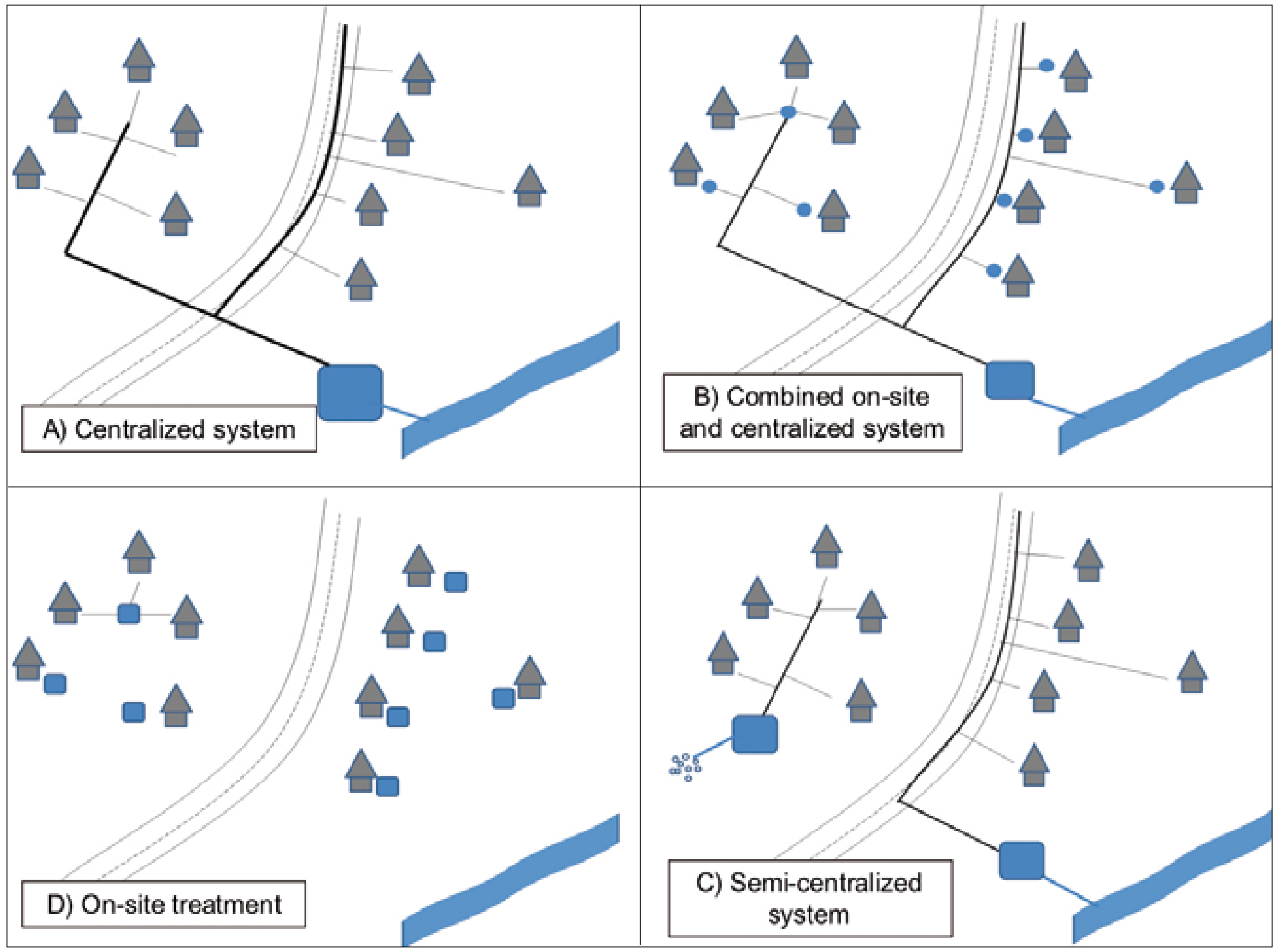

Figure 1: Technical possibilities how to provide an agglomeration with sanitation and wastewater treatment

Constructed wetland for greywater treatment in mountainous area, Vorarlberg, Austria

2.3 Wastewater treatment technologies

The wastewater treatment technology is rather independent from the collection system when talking about agglomerations up to 10,000 PE. Although any intensive and extensive technique is applicable at on-site as well as at big centralized scale, there are of course advantages and drawbacks for different technologies which are going to be explained here.

The most developed techniques at the level of urban wastewater treatment plants are intensive biological processes. Their principle is to operate with reduced space and to intensify the natural phenomena of degradation of organic matter and nutrient removal. The most developed and advanced is the activated sludge system with technical aeration which requires stable electricity supply and professional staff for operation and maintenance. There are also trickling filters or biofilters well established intensive treatment options. An overview about intensive and extensive options is given in table 4.

The activated sludge and biofilter systems are well known and often set as standard by professionals. That is why they are not further explained here. Only the anaerobic reactor is shortly mentioned here as it is an innovative development to apply the anaerobic system (UASB reactor or baffled reactor) for urban wastewater. The major advantage is that the anaerobic system does not need any aeration but produces energy in terms of biogas. It is an intensive treatment which requires good know how and some specific frame conditions (temperature, post-treatment, semi-centralized scale).

	Technology	Design criteria		Space demand	Energy demand	Nitrogen removal	Hygienic quality in the effluent	Removal organic matter	Advantages	Drawbacks
		m^2/PE	m^3/PE		kWh/PE/year					
Intensive treatment	**Activated sludge plant**	*0.2*	*0.5*	*low*	*40*	*good*	*elimination by factor 10-100*	*> 75% COD*	*good elimination of all pollutants (SS, COD, N, P)*	*relatively high capital and operation costs, sensitive to hydraulic and pollutant overload, energy intensive, high technical know-how required, high quantities of sludge to be treated and disposed*
Intensive treatment	**Trickling filter, rotating disc contactor**	*0.04-0.18*	*0.07-0.25*	*low*	*12*	*partly*	*factor 10-100 elimination*	*> 75% COD*	*simple operation requiring less maintenance and monitoring, lower sensitivity to load variations and toxins*	*rather high capital costs, large size structure for N removal necessary*
Intensive treatment	**Anaerobic plant followed by further treatment**		*2.5*	*medium*	*use of biogas*	*little*	*elimination by factor 10-100*	*> 75% COD*	*energy recovery of biogas*	*hig capital costs, effluent must be further treated, high technical know-how required, difficult in cold winters, stabilized sludge*
Extensive treatment	**Constructed wetland (horizontal flown)**	*5*	*6*	*high*	*only pumping*	*little*	*elimination by factor 10-100*	*> 75% COD*	*low capital costs and simple operation, minimum sludge management*	*limited denitrification*
Extensive treatment	**Constructed wetland (vertical flown)**	*3.5-4*	*3*		*only pumping*	*partly*	*elimination by factor 10-100*	*> 75% COD*	*low capital costs and simple operation, minimum sludge management*	*limited denitrification*
Extensive treatment	**Waste stabilization pond system (natural pond)**	*>11*		*high*	*only pumping*	*partly*	*elimination > factor 1000*	*> 75% COD*	*low capital costs and simple operation*	*high evaporation rate, quality of discharge varies according to season*
Extensive treatment	**Aerated pond**		*3 + 1*	*medium - high*	*> 10 (for aeration)*	*partly*	*elimination > factor 1000*	*> 75% COD*	*low capital costs and simple operation*	*high evaporation rate, quality of discharge varies according to season*

Table 4: Overview of intensive and extensive wastewater treatment options

	France 1998 Treatment plants for 1,000 PE [8]		Germany 2000 Treatment plants for 1,000 PE [9]
Treatment process	*Investment costs Euro/PE*	*Annual operational costs Euro/PE*	*Investment costs Euro/PE*
Intensive technical treatment			
Activated sludge system	*230 ± 30%*	*11.5*	*380*
Rotating biological contactor	*220 ± 45%*	*7*	
Biofilter	*180 ± 50%*	*7*	
Extensive treatment			
Imhoff tank + Constructed wetland	*190 ± 35%*	*5.5*	
Aerated pond	*130 ± 50%*	*6.5*	*320*
Waste stabilization pond	*120 ± 60%*	*4.5*	*200*

Table 5: Investment and annual operational costs of treatment plants

Looking at costs for the different technologies, it is always difficult to properly compare the conditions of the treatment plants. Table 5 gives a few figures for treatment plants (1,000 PE) in France and Germany. In relation, the extensive technologies have major advantages in terms of costs for both investment and operation. All of them are able to meet the requirements of the UWWTD. If nutrient removal is required in case of effluent discharge into sensitive areas, extensive technologies are also possible options when properly designed and operated.
A significant benefit is the performance of pathogen removal which is much higher than for the extensive systems. Although the hygienic criterium is not required by the UWWTD, it is important esp. for public health and re-use purpose. The extensive technologies have in common that they can be operated without electricity (exception is the aerated pond).
Based on the overview presented in table 4 and 5, the extensive treatment options as well as the anaerobic reactor can be considered as more sustainable in rural areas than the intensive options. The extensive techniques are going to be explained in more detail in the coming sub-chapters and case studies will be shown in the last chapter.

8 FNDAE technical document No 22, 1998, taken from Extensive Wastewater Treatment Processes adapted to small and medium sized communities (500 – 5,000 PE)" see http://ec.europa.eu/environment/water/water-urbanwaste/info/pdf/waterguide_en.pdf
9 Halbach (2000) Abwasserkosten für ostdeutsche Kommunen und Verbände, Institut für Abwasserwirtschaft Halbach

2.3.1 Wastewater Ponds

Wastewater treatment in ponds or lagoons is a well known technology. The extensive treatment process relies on suspended bacterial growth cultures. The purification is ensured thanks to long retention time which requires a lot of space compared to intensive systems. Pond systems are a high-performance, low-cost, low-energy (often zero-energy) and low-maintenance treatment process, especially suitable in warm climates.
Pond systems are well established technology in the EU and are widely used in the rural areas of most countries. In France, there are more than 2,500 waste stabilization pond systems in operation.
Two different systems are considered here: the waste stabilization pond and the aerated pond system.

Advantages	***Drawbacks***
• *Low cost technology* • *Low or no energy demand (in case of waste stabilization ponds)* • *Simple operation and maintenance* • *No electromechanical machinery (in case of waste stabilization ponds)* • *Adapts well to large variations in hydraulic load* • *Good elimination of pathogenic organisms in summer and winter and in winter* • *Partly removal of nutrients* • *Integrates well into the landscape* • *Absence of noise pollution* • *Sewage sludge to be taken out of the pond is well stabilized* • *Can be applied for on-site, semi-centralized and centralized concepts: storage of run-off rainwater is possible*	• *Much space required* • *Performance is less than in intensive processes with respect to organic matter. However the discharge takes place in the form of algae which has less adverse effects than dissolved organic matter. The discharge is low in summer which is the most unfavorable period for water courses* • *May generate odor* • *Energy consumption (in case of aerated ponds)* • *Elimination rate is reduced at cold temperature*

Table 6: Advantages and drawbacks of pond systems

Waste stabilization ponds (natural ponds)

The treatment in stabilization or natural pond systems is taking place in several water tight basins placed in series.

Design of the pond system

The system typically comprises three ponds in serie: one facultative pond (sized at 6 m^2 per PE) and two maturation ponds (each 2.5 m^2 per PE).
A serie of 3 ponds ensures a reliable removal of organic matter, partly removal of nutrients and partly disinfection. In order to achieve safe nitrogen removal or disinfection, additional ponds up to a serie of total 6 are required.
In front of the first pond, it is useful to install a device to remove floating solids. In smaller plants with less than 500 PE, it is possible to use a mobile suction barrier to retain floating solids. In bigger plants, a bar screen should be installed in front.

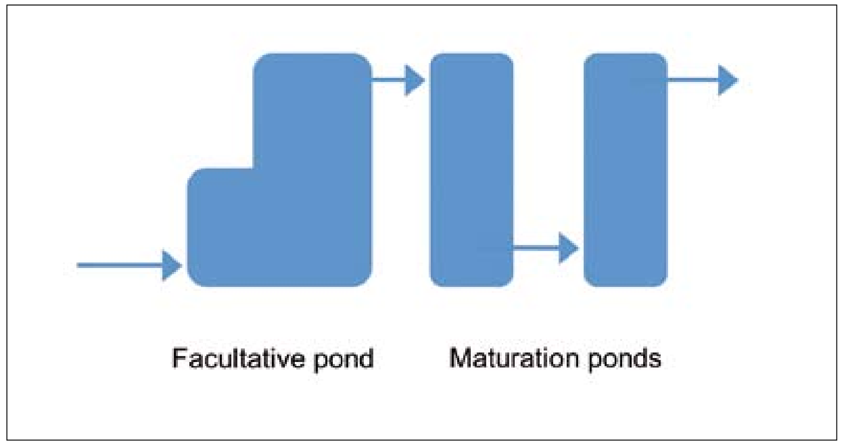

Figure 2: Schemativ top view on a waste stabilization pond system (drafted from: EU guide „Extensive wastewater treatment processes")

1. facultative pond

The first pond step is designed to remove the major part of organic matter. The design criteria of 6 m^2 per PE is commonly used which corresponds to a surface load of around 8 g/m^2 BOD. In case of varying seasonal loads e.g. due to tourism, the design should be made based on monthly peak flows. The depth of the first pond is 1-2 m.

As first pond, Mara (1998) also recommends an anaerobic pond which can be built more than 3 m deep. To avoid methane emissions, it must be covered and the generated biogas can be collected.

2. and 3. maturation pond

Maturation ponds are designed for the removal of nutrients (N and P) and pathogens. The design criteria are each 2.5 m^2 per PE. Depths of the maturation ponds are typically 1 m. The shape of the maturation ponds can be integrated into the landscape.

Performance of the waste stabilization pond system

The results in terms of organic matter achieve more than 75% COD removal which corresponds to a filtered COD concentration of less than 125 mg/l.

The concentrations in total nitrogen in the effluent are very low and can meet standards for sensitive areas in summer but due to low temperature the performance is reduced in winter. This is however also the case for intensive processes.

The reduction in phosphorus is higher than 60% in the first 10-20 years and might decrease due to release of phosphorus from the sediment (settled sludge) again.

Disinfection is important especially when discharging to small receiving waters in summer. The performance of more than factor 1000 is better than with intensive systems due to high retention time and UV radiation effects by the sun.

Reference for the design of waste maturation ponds:

- Mara, D.D. and Pearson, H.W. (1998) Design Manual for Waste Stabilization Ponds in Mediterranean Countries. Lagoon Technology International, Leeds
- Agences de Bassins (1979) Lagunage naturel et lagunage aéré: procédés d`épuration des petites collectivités, CTGREF d Aix en Provence.
- DWA A-201 (2005) Principles for the dimensioning, construction and operation of wastewater ponds, German Association for Water, Wastewater and Waste.

Aerated pond Schlamerdorf, Germany

Aerated ponds

To enhance the treatment, a technical aeration by surface aerator or air blower can be introduced into a pond system. The system is then very close to the intensive system of activated sludge reactor without sludge recycling. The energy consumption can be as high as for activated sludge systems.

Design of the pond system

This system typically comprises two ponds in serie and three ponds in total: one aerated pond

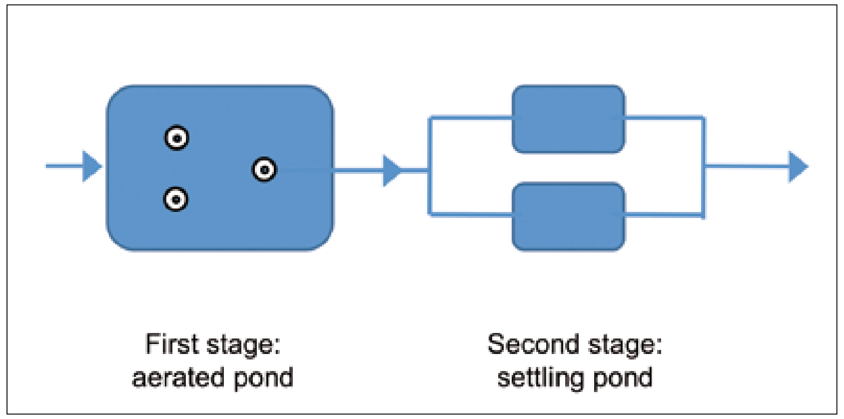

Figure 3: Schemativ top view on a aerated pond system (drafted from: EU guide „Extensive wastewater treatment processes")

Before the pond, it is useful to install a device to remove floating solids. In smaller plants with less than 500 PE, it is possible to use a mobile suction barrier to retain floating solids. In bigger plants, a bar screen should be installed in front.

1. aerated pond

In this main pond with technical aeration, the treatment is similar to an intensive treatment. However the density of bacteria is much lower and the retention time is longer with around 20 days. The total design volume is 3 m^3 per PE and the depth 2-3.5 m with surface aerator and more than 4 m with air blower. The requirement of oxygen is 2 kg O_2/kg BOD. In order to mix the volume and to prevent formation of micro algae it is necessary to use a power level between 3 and 6 kW/m^3.

2. and 3. settling ponds

Settling ponds serve as a secondary clarifier for sedimentation of the suspended solids. The settled sludge needs to be pumped regularly to ensure a clean effluent. The settling stage is constructed in a rectangular settling pond (length to width 3 to 1), best two parallel ponds, which can be by-passed for de-sludging. The design volume is 0.6 to 1 m^3 per PE for each settling pond.

Performance of aerated ponds

The performance in terms of organic matter is with more than 80% very high. For efficient nitrogen removal, a recirculation would be needed, otherwise only nitrification takes place.
Phosphorus removal is only very limited but could be introduced by addition of precipitation salts.

Reference for the design of aerated ponds:

- Agences de Bassins (1979) Lagunage naturel et lagunage aéré: procédés d`épuration des petites collectivités, CTGREF d Aix en Provence.
- DWA A-201 (2005) Principles for the dimensioning, construction and operation of wastewater ponds, German Association for Water, Wastewater and Waste.

2.3.2 Constructed Wetlands

Constructed wetlands are natural systems in which the wastewater flows through a planted soil filter where the biological and physical treatment takes place. The bed can have filling material like sand or gravel and is sealed to the ground (by natural soil or an artificial foil). The treatment relies on the bacterial activity taking place in the biofilm in the bed and the physical filter and adsorption effects. To enhance the process, the soil filter is planted with plants, typically reed, that is why they are often called reed bed filters as well.
Constructed wetlands were first used in Germany and have been used now over 40 years for the treatment of urban wastewater especially in rural areas in Austria, France, Greece and other countries. There are different types of systems, the predominantly use is the subsurface type in which the water level is maintained below the surface. It can be further categorized into two types based on the pattern of flow, one with horizontal subsurface and one with vertical subsurface flow.
Commonly the constructed wetland comprises a pretreatment step for sedimentation of solid organic matter to avoid clogging. Another type without pretreatment was developed successfully in France which applies raw wastewater on the soil filter.

On-site constructed wetland for domestic wastewater treatment, Poland

Advantages	***Drawbacks***
• *Low cost technology* • *Low or no energy demand (pump can be avoided if natural slope is enough)* • *Simple operation and maintenance* • *No electromechanical machinery (maybe pump)* • *Can be adapted to seasonal variations* • *Good elimination of pathogenic organisms* • *Partly removal of nutrients* • *Integrates well into the landscape* • *Absence of noise pollution* • *Possibility of treating raw sewage (French system)* • *Minimum sludge management* • *Recommended for semi-centralized concepts*	• *Much space required (less than for ponds)* • *May generate odor if designed without pre-treatment (French system)* • *If designed with pre-treatment, sludge handling is needed* • *Regular cutting of reed (yearly)*

Table 7: Advantages and drawbacks of constructed wetlands

Vertical and horizontal flown constructed wetlands with pre-treatment

A successful physical pre-treatment is necessary for a good performance of this type of constructed wetlands. Unsatisfactory pre-treatment may lead to build-ups in the inflow area, to odor nuisances, to clogging of the filter or to blockages of the soakage links. The pre-treatment can be realized as primary sedimentation in tanks, for small scale plants typically septic tanks are used. It is then needed to remove the primary sludge regularly (e.g. yearly). An Imhoff tank is an alternative option which reduces sludge production. Ponds can be a technological option for pre-treatment as well.
Commonly the constructed wetland comprises a pretreatment step for sedimentation of solid organic matter to avoid clogging. Another type without pretreatment was developed successfully in France which applies raw wastewater on the soil filter.

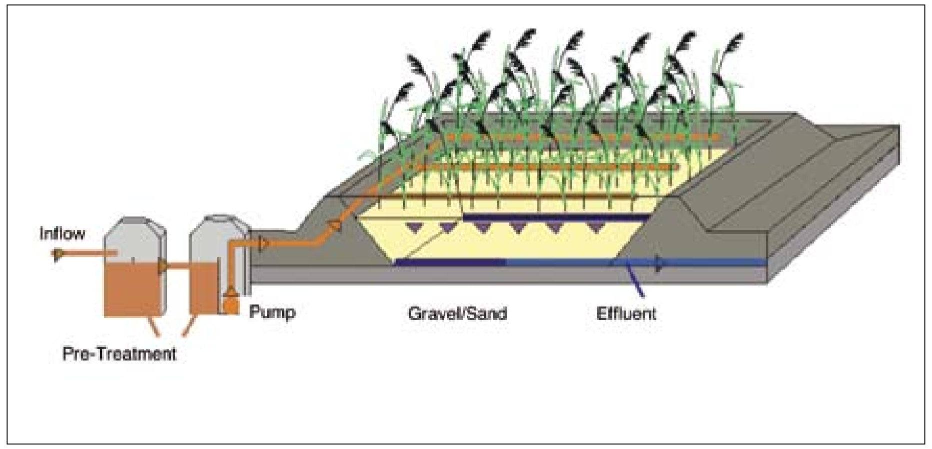

Figure 4: Vertical flown constructed wetland with pre-treatment (source: www.bodenfilter.de)

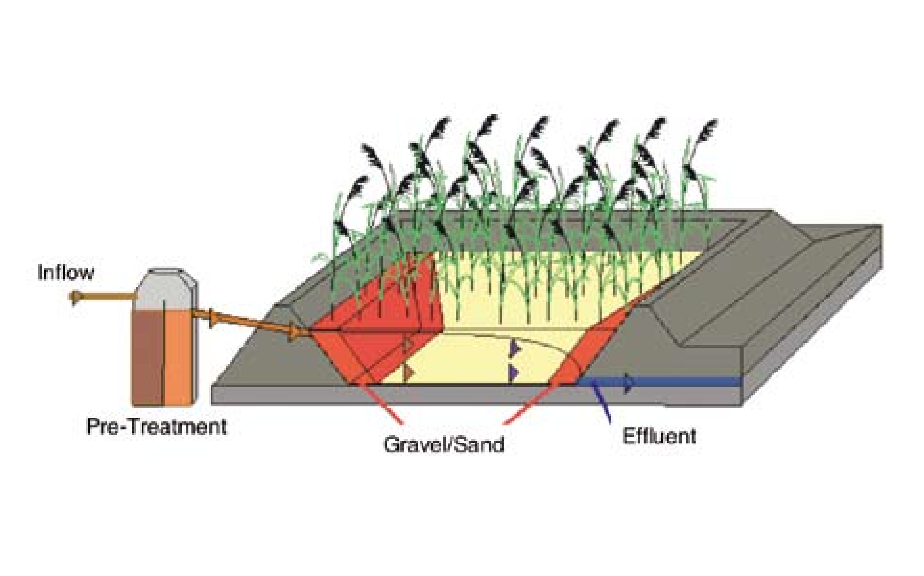

Figure 5: Horizontal flown constructed wetland with pre-treatment (source: www.bodenfilter.de)

Design of the constructed wetland

The soil filter after the pre-treatment can be one step process only, either vertical or horizontal flown. The influent should be fed intermittently to provide aerobic conditions in the filter.
Horizontal flown soil filter: design criteria are 5 m^2 per PE and max. 40 mm/day hydraulic surface load. The depth of the filter is 0.5 – 1.0 m. The filter contains a mixture of gravel and sand.
Vertical flown soil filter: design criteria are 4 m^2 per PE and 80 mm/day hydraulic surface load. The depth of the filter is 0.5 – 1.0 m. The filter contains a mixture of gravel and sand. At the bottom a drainage layer with drainage pipes made of plastic is implemented.

Performance

The results in terms of organic matter achieves more than 80% COD removal.
Due to aerobic conditions in subsurface flown systems, an efficient nitrification takes place but denitrification is limited. Only in two step soil filters an efficient nitrogen removal takes place and achieves requirements for discharge into sensitive areas.
The reduction in phosphorus depends on the adsorption capacity of the media and the age of the plant but is usually limited. Removal of pathogens is important especially when discharging to small receiving waters in summer. The performance is more than factor 10.

Reference for the design of constructed wetlands (German system):

- DWA (2006). A 262. Principles for the Dimensioning, Construction and Operation of Plant Beds for Communal Wastewater. German Association for Water, Wastewater and Waste

Vertical and horizontal flown constructed wetlands without pre-treatment ("French system")

The so called French system does not require any pre-treatment and feeds the soil filter with raw wastewater. For vertical flow, the flow of the influent must be greater than the infiltration speed in order to correctly distribute the sewage over the whole bed surface (intermittently). In case of horizontal flow, the influent is spread over the entire horizontal cross section inlet (continuously).

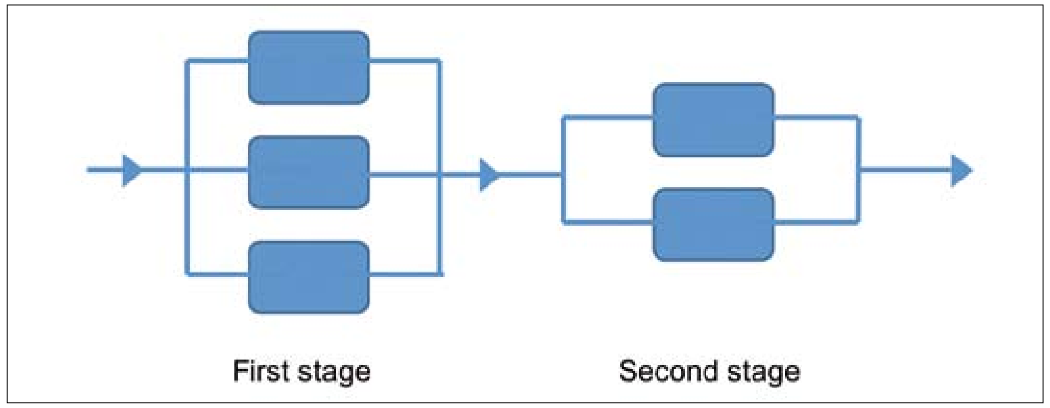

Figure 6: top view scheme of a serie of vertical flow constructed wetlands (French system) (drafted from: EU guide „Extensive wastewater treatment processes")

Design of the constructed wetland system without pre-treatment (French system):

First stage

The design of the French system comprises two stages each with parallel soil filters as seen in the figure. The first one has three parallel soil filters. If one is active, the other are in a resting phase. The design criteria is 1.2 - 1.5 m^2 per PE for this first stage. The media in the filter contains gravel in the upper layer to avoid clogging. The total depth is around 80 cm.

Second stage

The second stage is provided with two parallel soil filter which are fed intermittently as well. The design criteria is 0.8 m^2 per PE. The media in the filter is sand and the total depth is 80 cm.

Performance of the constructed wetland system without pre-treatment (French system):

The results in terms of organic matter achieves more than 80% COD removal.
This two step constructed wetland provides an efficient nitrogen removal and achieves requirements for discharge into sensitive areas.The reduction in phosphorus depends on the adsorption capacity of the media and the age of the plant but is usually limited. Removal of pathogens is with factor 100 similar to intensive systems.

Reference for the design of constructed wetlands (French system):

- Agence de l´Eau Seine Normandie (1999). Guides des procédés épuratoires intensifs proposés aux petites collectivités, Nanterre

2.4 Innovative Sanitation and Wastewater Concepts

The European region has for many years been a frontrunner in improving sanitation and wastewater systems. A key factor was the introduction of water-borne centralized systems for wastewater collection and treatment as a standard in urban areas. However, this does not mean that sanitation and wastewater management is no longer a challenge for Europe. In the last 20 years, it became transparent that the existing water-borne centralized systems have a number of drawbacks. They can often not meet the criteria for sustainability (given in chapter 2.1):
(1)In spite of the existing wastewater treatment systems and indisputable improvements for public health and the environment, the quality of many surface and ground waters is still negatively affected by nutrients, microorganisms and hazardous substances from discharged wastewater. (2) The need to recover nutrients from wastewater, especially phosphate as an ending fossil resource, which has now been realized by many countries calls for new concepts which allow a safe use of the nutrients[10]. (3) Centralized sewerage and treatment wastewater management is not the right answer to adapt to climate change as it requires much energy and does not close local water cycles. (4) The high costs for investment and operation, the consequential charges and their inflexibility make centralized systems unaffordable and difficult to handle.

Conclusions drawn by scientists as well as politicians including the governments in several European countries were that sanitary systems must be changed to allow decentralization, possibly to the level of a single family house or a group of single family houses. Water cycles should be closed locally and household nutrients should be made available for safe re-use in agriculture. Following this idea, decentralized and semi-centralized solutions were developed e.g. in the 1980ies in Sweden.
Basic principles of the innovative sanitation and wastewater concepts are the treatment of the flows at source, the recycling/re-use of water and nutrients (according to the WHO guidelines[11]) and the decentralization aspect. The trend to dry sanitation in Finland and Sweden belongs to the new innovative concepts. Especially in rural areas, many modern composting and urine-diverting toilets have been installed. Some case studies in chapter 3.3 show that modern dry sanitation combined with a simple greywater treatment provides an appropriate, affordable and safe technical solution for areas without reliable water supply.

Another trend is the gain of biogas and organic fertilizer from toilets within sustainable sanitation concepts in peri-urban areas in Germany (Lübeck) and the Netherlands (Sneek). The domestic wastewater (toilet wastewater, greywater, rainwater) is separated at the source. As the vacuum toilets produce only 5 litres of toilet wastewater per inhabitant per day, the drinking water consumption is very low with less than 80 litres per inhabitant per day. Kitchen refuse is collected at household level in bins and is transported manually to a central feeding unit. Other organic waste can also be added. The anaerobic digestion unit produces energy in the form of biogas and a nitrogen rich liquid fertilizer which in the case of Sneek is further processed to a dry fertilizer. Greywater is treated in constructed wetlands and locally infiltrated into the soil as well as the rainwater. Up-scaling of the systems is planned for the coming years in Hamburg as well as in Sneek.

10 The next inconvenient truth - Peak phosphorus http://www.thebrokeronline.eu/en/articles/Peak-phosphorus2 report of the MED-EUWI Wastewater Reuse Working Group 2007 http://ec.europa.eu/environment/water/water-urbanwaste/info/water_reuse.htm

11 WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater in Agriculture and Aquaculture, 3rd edition 2006. http://www.who.int/water_sanitation_health/wastewater/en/

3. Examples for sustainable and cost effective sanitation and wastewater management

3.1 Ponds

Natural pond for combined sewerage, Sören, Northern Germany

Project description

The wastewater treatment in the natural pond system serves 300 PE. Domestic wastewater together with rainwater from a combined sewerage network is the influent to the treatment plant. The system comprises three ponds.

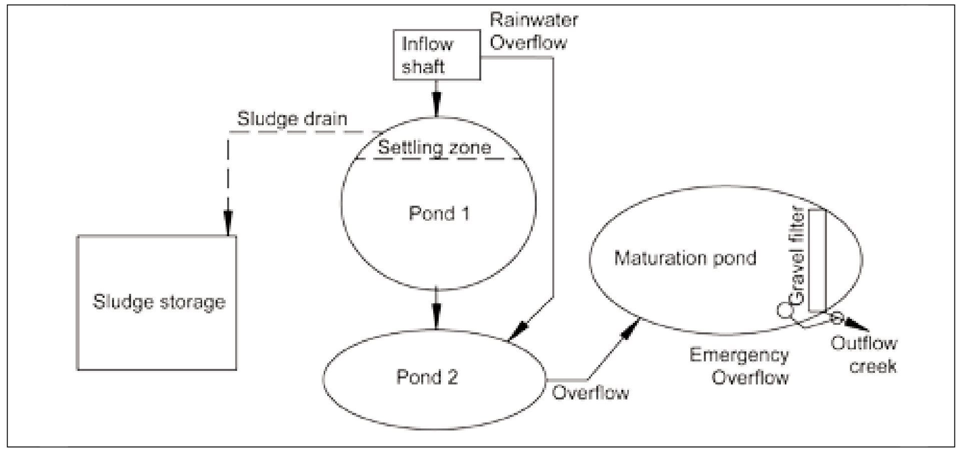

Figure. 7: Scheme natural pond system in Sören, Germany

First pond with settling zone

The treatment plant consists of a first pond with the settling zone (1,200 m^2) and a second stabilization pond (1,500 m^2). A third pond serves as maturation pond on the one hand and on it gives additional space for the storage of rainwater on the other hand (1,200 m^2).

Performance

The average effluent concentration is with 56 mg/l COD very low. In wintertime, the COD of the effluent is higher (about 90 mg/l COD) due to the cold climate but the standard can always be met. Nutrient removal is not required here as the treated wastewater is discharged into a creek nearby which is not a sensitive area.

Aerated pond for combined sewerage, Rethwisch, Northern Germany

Project description

The pond system serves a small village of 1,170 PE. As pre-treatment a screening unit was selected before the wastewater enters three aerated ponds in series. The surface area of the ponds is 3,500 m² for the aerated ponds and 250 m² the maturation pond. After the maturation pond, the effluent is discharged into a creek.

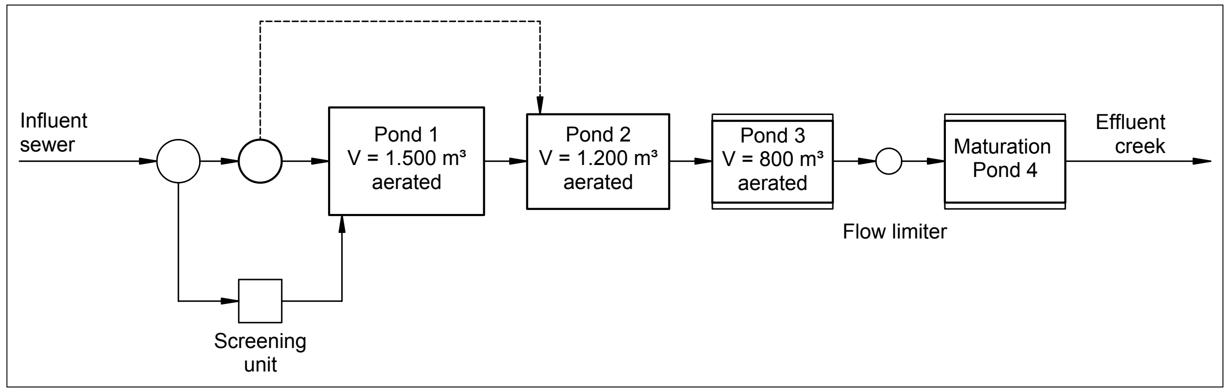

Fig. 8: Scheme of the aerated pond system

Aerated pond 1, in the background operation building (left) and building with screening unit inside

Aerated pond 3, surface aerator

Performance

The average effluent concentration was monitored to be always lower than 100 mg/l COD. Nutrient removal is not required here as the treated wastewater is discharged into a creek nearby which is not a sensitive area.

3.2 Constructed Wetlands

Wastewater treatment in combined ponds and constructed wetlands, Seevetal, Northern Germany

Project description

The constructed wetland system serves 550 PE. The wastewater derives partly from a small agro-industrial site (washing and packing of vegetables) and additional domestic wastewater from the homes of seasonal workers. The characteristic is similar to domestic wastewater. Due to the harvesting season, the wastewater has high fluctuations in terms of volume and load.

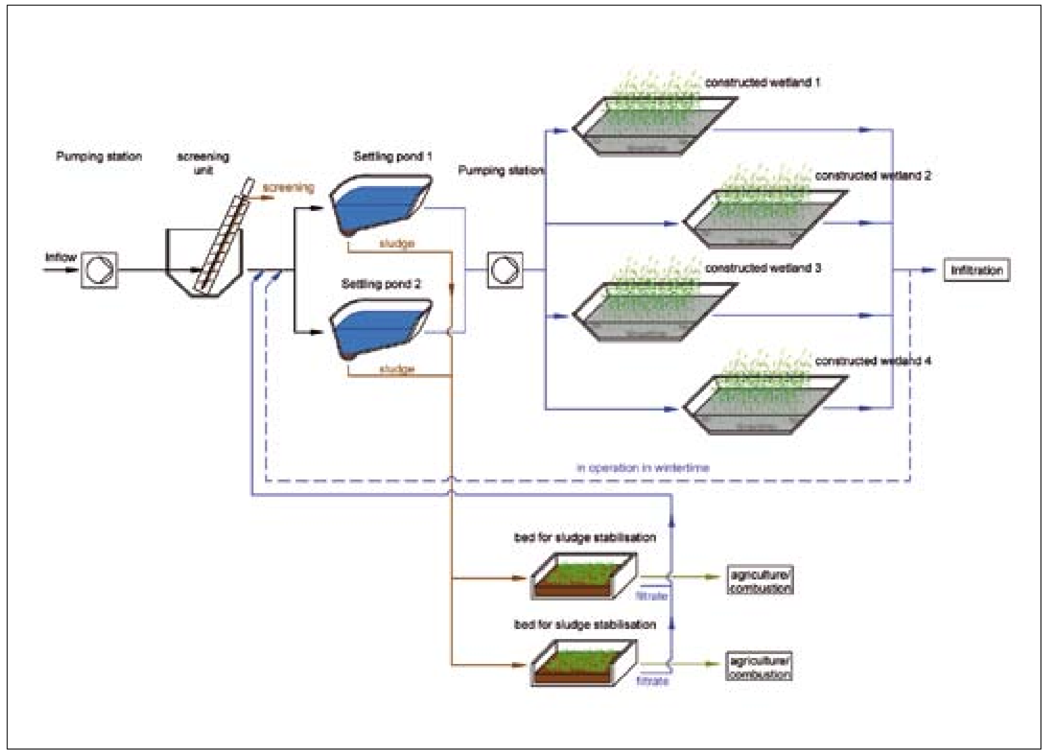

Figure. 9: Scheme of the constructed wetland with settling ponds as pre-treatment (source: Otterwasser)

The primary clarification consists of the screening unit and the settling ponds. The four constructed wetlands represent the biological step. The size of one constructed wetland is 450 m² (whole planted area: 1,400 m²).

The wastewater treatment plant was constructed in a modular system in several steps according to the needs and requirements. The implemented treatment modules can cope with the different seasonal variations of the influent load and volume. The single constructed wetlands can be taken out of operation, if they are not needed.

The treated wastewater is infiltrated into the ground (sandy soil).

Performance

The COD concentration in the effluent always below 100 mg/l. The construction has not been finished yet. Currently, the treatment is partly in operation, and works well. When the total constructed wetland system is in operation, a nitrogen concentration of 40 mg/l N_{tot} will be met.

Wastewater treatment with constructed wetlands in a combined on-site centralized system, Faulx, Northern France

Project description
The constructed wetland (French system) was built for the treatment of a settlement with 2.000 PE. In the settlement there were old septic tanks for single houses which were used in the new wastewater concept for on-site pre-treatment. The effluent of the septic tanks is going via the sewer to the constructed wetland. Due to the primary treatment on-site, the result is a reduction in the incoming load of the constructed wetland in comparison with conventional domestic wastewater.
The raw wastewater from a combined sewer system is pumped into the first beds intermittently. The wastewater passes the constructed wetland in two steps. The treated wastewater is discharged into a near creek.

Constructed wetland without pre-treatment

The raw wastewater is pumped alternating upon the first 3 beds (2,700 m²). Afterwards it is pumped on the second stage consisting of 2 beds (1,800 m²). The whole area of the constructed wetland beds is 4,500 m².

Performance
The elimination rate for BOD is 95% (2 mg/l), for COD is 86% (12 mg/l). Nutrient removal is not required.

3.3 Innovative sanitation and wastewater concepts

On-site sanitation and wastewater treatment for a seminar house, Holzwickede, Germany

Project description
The reason to look for an innovative sanitation concept for the seminar house in Holzwickede was that a connection to the sewer system was difficult and too expensive. Also the owner wanted to install a pilot project to demonstrate this new sanitation and wastewater system [12].
Urine diverting flush toilets and waterless urinals were selected and the urine is collected in a storage tank (6 m³) and then further applied as fertilizer in agriculture. The separately collected greywater and the flushed faeces (brown water) are separately collected and then treated together in a constructed wetland. The connected equivalents for the constructed wetland are 26 PE.

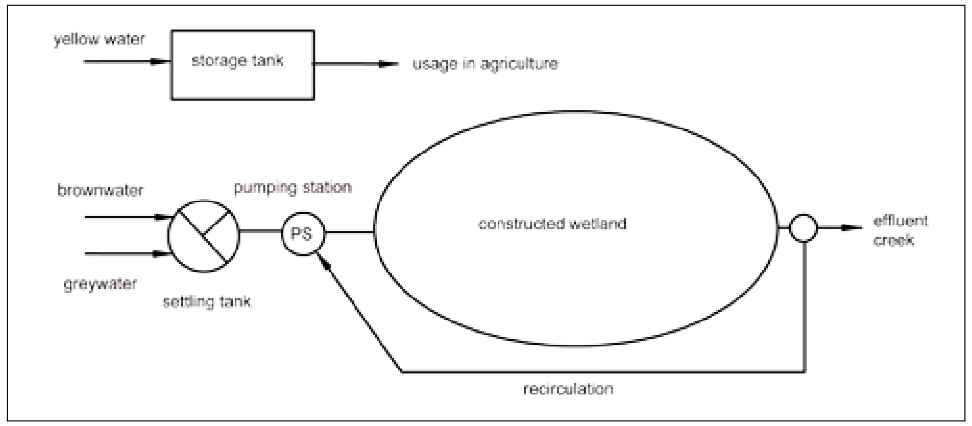

Figure. 10: Schema constructed wetland for treatment of brown- and greywater (source: Otterwasser)

Urine diverting low flush toilet

Toilet building from outside, and greywater treatment

Performance
The effluent concentration of the constructed wetland is max. 32 mg/l COD and 3 mg/l BOD and thus safely meets the requirements (140 mg/l COD and 40 mg/l BOD).

12 Teschner, B., Geisler, S., Drzisga, G. (2008): Der Emscherquellhof – neue Techniken im historischen Umfeld, KA Korrespondenz Abwasser 2009 (56) Nr. 12

On-site modern dry sanitation and greywater treatment, Sulitsa, Bulgaria

Project description

In Sulitsa, there is a community centre where village meetings, celebrations, amateur activities and other initiatives take place. Because of water shortages, it was decided to build dry toilets with urine separation. Two toilets and two waterless urinals have been installed.

Collected and stored urine should be used as fertilizer for backyard agriculture. Composted faeces can be used as soil conditioner.

The greywater from the sinks is treated in a small horizontal flow constructed wetland. The treated water infiltrates into the ground. The connected equivalent for the greywater treatment is 3 PE.

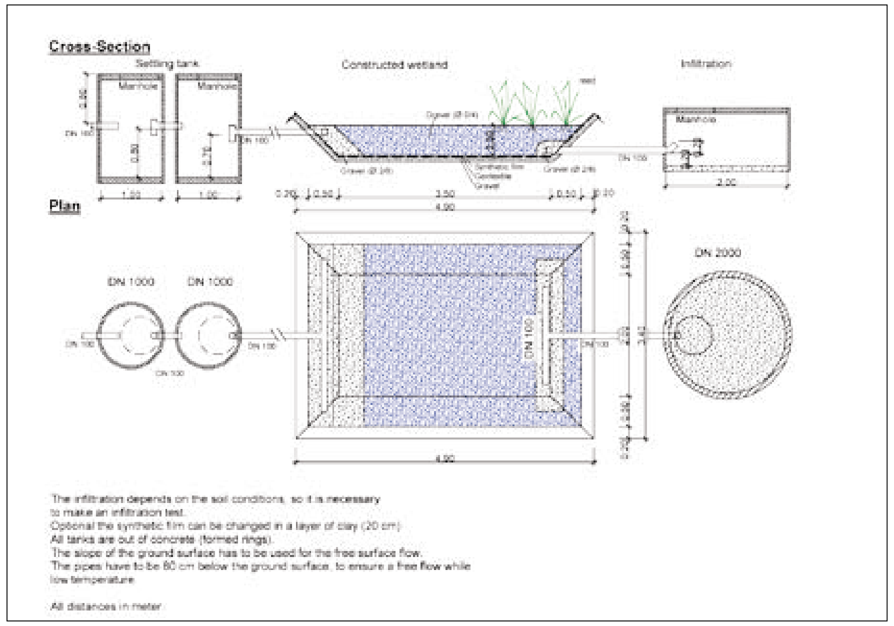

Figure 11: Scheme of the greywater treatment in Sulitsa (source: Otterwasser)

Constructed wetland in summer

Toilet building and greywater treatment in constructed wetland

Urine diverting dry toilet

Performance

Due to the dry toilets, there is enough water for activities in the community centre. The hygienic situation has been improved thanks to the hygienic toilets and handwashing facilities.

On-site modern dry sanitation and greywater treatment in a primary school, Vrata, Romania

Project description

In the village Vrata, Southern Romania, the people do not have central water supply but rely on private and public wells. As sanitation option, most people use an outdoor pit latrine. For the local primary school with 200 school children, an innovative toilet facility with hand wash basins attached to the school building was implemented [13]. The toilets are equipped with urine diverting toilet (UDD) squatting devices. Separately collected and stored urine is used as nitrogen rich organic fertilizer in garden and agriculture. Faeces are stored and sanitized in the separate chambers in the basement and can be applied as soil conditioner. This reuse of nutrients is not regulated on EU level but there are guidelines by the WHO [14] and in Sweden.

The design was made according to the WHO requirements:

The toilet-facility comprises 2 rooms for girls, 1 room for boys plus 2 urinals for boys and 1 room for handicapped people.

The urine from public places such as schools has to be stored at least 6 months to remove most of the pathogens. Two urine tanks made of PE were installed with a size of each 2 m^3. The faeces chamber in the basement are designed as double vault (2 m^3 for each toilet room) and ventilated by wind driven fans.

Performance

The installation of UDD toilets combined with hand wash basins leads to an immediate improvement of the hygienic sanitary and environmental situation. Due to the separation technology in the toilet device, these toilets do not smell or attract flies. Water resources are saved and protected by safe storage, treatment and reuse of excreta. Compared to conventional toilets, UDDTs offer the possibility to explain the pupils in combination with the hygiene education the inter-linkages between ecology, agriculture, nutrient- and water-cycles.

As no infrastructure such as central water supply or sewerage system is needed for the operation of the UDDT, the situation can be improved with fewer financial resources compared to the installation of water borne sanitation.

Attached toilet facility

Squatting slabs inside the rest room

13 *Deegener et al. (2008) Sustainable and Safe School Sanitation - How to provide hygienic and affordable sanitation in areas without a functioning wastewater system. http://www.wecf.eu/download/2009/august/2009_school_sanitation.pdf*

14 *WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater in Agriculture and Aquaculture, 3rd edition (2006). http://www.who.int/water_sanitation_health/wastewater/en/*

Glossary

Agglomeration	*An area where the population and/or economic activities are sufficiently concentrated for urban waste water to be collected and conducted to an urban waste water treatment plant or to a final discharge point*
BOD	*Biochemical oxygen demand. The measurement is carried out according to standardized test after 5 days of oxidation of the organic matter, hence the term* BOD_5
COD	*Chemical oxygen demand*
Eutrophication	*The enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned.*
Greywater	*Domestic wastewater coming from the house excluding toilet wastewater*
Industrial wastewater	*Any waste water which is discharged from premises used for carrying on any trade or industry, other than domestic waste water and run-off rain water*
Population equivalent (1 PE)	*The organic biodegradable load by one person (having a five-day biochemical oxygen demand (*BOD_5*) of 60 g of oxygen per day)*
Primary treatment	*Treatment of urban waste water by a physical and/or chemical process involving settlement of suspended solids, or other process in which the* BOD_5 *of the incoming waste water is reduced by at least 20% before discharge and the total suspended solids of the incoming waste water are reduced by at least 50%*
Secondary treatment	*Treatment of urban waste water by a process generally involving biological treatment with a secondary settlement or other process which meets the requirements*
Sensitive areas	• *Freshwater bodies, estuaries and coastal waters which are eutrophic or which may become eutrophic if protective action is not taken;* • *Surface freshwaters intended for the abstraction of drinking water which contain or are likely to contain more than 50 mg/l of nitrates;* • *Areas where further treatment is necessary to comply with other Council Directives such as the Directives on fish waters, on bathing waters, on shellfish waters, on the conservation of wild birds and natural habitats, etc.*
Sludge	*Residual sludge, whether treated or untreated, from urban wastewater treatment plants, primary sludge is sludge generated in the pre-treatment step - secondary sludge generated by biological treatment (in activated sludge processes)*
Urban wastewater	*Domestic waste water or the mixture of domestic waste water with industrial wastewater and/or run-off rain water*

Annex: Discussion paper

Earth Forever
Caring for the Future

WECF

How to Reach Sustainable and Cost-effective Wastewater Management in Rural Areas of Bulgaria and Romania (for agglomerations with less than 2,000 and 10,000 PE)?

Discussion Paper for the High Level Round Table
18 March 2010
Grand Hotel Sofia, Bulgaria

Wastewater pollution causes health and environmental problems

Proper sanitation and wastewater treatment are key challenges for a healthy environment in urban and rural settings. Unregulated run-off of raw wastewater poses a threat to public health and the environment. Children and vulnerable groups are particularly hit by cases of water borne diseases but also adults suffer consequently, which can significantly affect the economic development of a region. The environmental damage due to untreated wastewater is relevant as well. Groundwater as a major resource for drinking water is under increasing pressure from human activities.

Urban Wastewater Treatment directive addresses only agglomerations with more than 2,000 PE

The legislation at EU level addresses the topic of sanitation and wastewater treatment through two directives, the Urban Waste Water Treatment (UWWTD) and the Water Framework Directive (WFD). The UWWTD obliges the new member states to collect wastewater and install treatment plants in agglomerations with more than 2,000 people equivalent (PE). According to the UWWTD, agglomerations with 2,000-10,000 PE must set up appropriate treatment (biological treatment without nutrient removal), as well as the agglomerations with less than 2,000 PE which already have a sewerage network (Article 7 of the UWWTD). For agglomerations with less than 2,000 PE not having any sewerage network, there are no standards to meet.

Guide for Extensive Wastewater Treatment Processes needs an update and translation into Romanian and Bulgarian

For these smaller agglomerations, a guide has been published by the European Commission in 2001, which illustrates examples of extensive and cost-effective wastewater treatment processes for smaller communities.

Water Framework Directive requires proper wastewater treatment in order to protect water bodies

The WFD requires the achievement of good groundwater status and provides for the monitoring of groundwater bodies as well as for measures to protect and restore groundwater. WFD demands that measures to prevent and control groundwater pollution should be adopted, including criteria for assessing good chemical status. The maximal acceptable value for nitrate is 50 mg/l, which is exceeded in many groundwater bodies. Besides the agricultural practices, the lack of adequate wastewater treatment can be identified as one of the causes of excessive nitrate concentrations in groundwater.

3.9 Mio people in Bulgaria and Romania live in villages with less than 2,000 inhabitants and are not covered by the UWWTD

In Bulgaria and Romania, almost 4 Mio people (2.1 Mio in Romania and 1.8 Mio in Bulgaria) live in settlements with less than 2,000 inhabitants which usually do not have any wastewater collection or treatment and are not obliged to provide this in the near future. As they are not covered by the UWWTD, the agglomerations with less than 2,000 inhabitants are not eligible for getting financial support by the EU for setting up an adequate sanitation and wastewater system. Many of these settlements rely on local drinking water sources which are often polluted by human activities and insufficiently protected. The national priority is to build wastewater collection and treatment for the settlements with more than 2,000 PE as required by UWWTD in the coming years.

This project is funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the German Federal Environment Agency in the frame of the Advisory Assistance Programme for Environmental Protection in the Countries of Central and Eastern Europe, the Caucasus and Central Asia

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Umwelt Bundes Amt

Earth Forever
Caring for the Future

WECF

Conventional centralised and technical wastewater treatment systems are hardly affordable in small communities

Cost effective solutions which meet the EU requirements and protect public health and the environment are needed. The smaller the settlements, the more expensive centralised technical systems are per capita. Centralised sewerage and technical wastewater treatment become hardly affordable for small communities. The Western member states, e.g. some parts of Germany, suffer from high prices due to conventional technical planning not adapted to specific conditions. There is mostly a lack of financial, technical and natural resources in rural areas.

Communities below 10,000 and 2,000 PE need sustainable and cost effective tailor-made wastewater solutions

Bulgaria and Romania are two of the many countries already affected by climate change. Increased drought periods and higher temperatures are observed hence groundwater levels are decreasing. For successful adaptation to climate change, implementation of sustainable concepts and approaches for water saving and closing of the local water cycles are needed.

Institutional setting can be regionalised for higher efficiency

A regionalisation process in the institutional arrangement of the Romanian water and wastewater sector is in progress which is important for small communities to reach technical and financial capacity and economy of scale. Nevertheless, concerning technical solutions there is no need to regionalise/centralise wastewater collection and treatment as decentralised technical systems are usually more flexible, sustainable and more cost-effective. The implementation of extensive, decentralised and low-tech solutions, such as onsite systems, ponds and constructed wetlands adapted to the local conditions, are therefore recommendable.

School sanitation as a specific challenge in rural and peri-urban areas

Without reliable water supply and wastewater treatment, sustainable sanitation for schools is a particular challenge in the rural areas. Although there is a consensus that proper hygiene and sanitation play a key role for health, safety and wellbeing of children, school sanitation is a neglected issue in national budgets and public awareness as well as on the political agenda.

Guidelines neither on decentralised wastewater treatment systems nor on reuse of treated products are available

WECF and local partners carried out several demonstration projects for safe water and sanitation in rural areas of Romania and Bulgaria. Urine diverting dry toilets for public places such as schools, rural community centres and town hall, as well as for households have been constructed and successfully operated. Constructed wetlands and soil filters for the treatment of domestic wastewater were built. These technologies are well accepted and understood by the local citizens. Barriers in implementation of the on-site technologies include difficulties to get the required permit, as currently no guidelines or regulations exist on decentralised wastewater treatment systems and on reuse of treated products.

The following questions shall be of guidance for the Round Table:

1. Which sustainable and cost effective wastewater treatment concepts are appropriate and affordable for settlements with less than 10,000 PE and less than 2,000 PE?
2. What can be done to promote appropriate and affordable technologies in Bulgaria and Romania?
3. What funding instruments are available for agglomerations with less than 10,000 and 2,000 PE, respectively?
4. How can permit procedures for suitable sanitation and wastewater solutions be improved?
5. How can awareness for sustainable school sanitation be raised and the topic be put higher on the political agenda?

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