

Lesson 1

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TYPES OF DOMESTIC SEWAGE TREATMENT PLANTS AND MATERIALS USED TO MAKE THEM

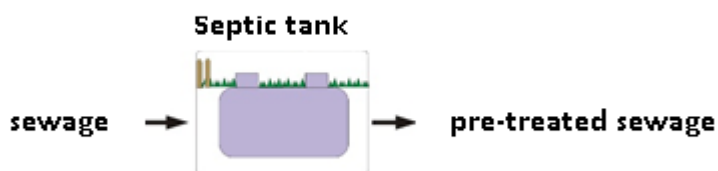
The processes taking place in each treatment plant can be divided into two main stages: without and with oxygen. Figure 1 shows the first stage of wastewater treatment. Figure 2 shows the second stage and a list of different types of household sewage treatment plants together with possible receivers.

The first stage - pretreatment consists of mechanical separation of impurities through sinking and outflowing processes, as well as processes associated with sludge fermentation, in which anaerobic bacteria dominate. These processes occur in the first tank of each treatment plant, i.e. a septic tank.

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Figure 1. The first stage of wastewater treatment

1st stage of wastewater treatment - anaerobic



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The second stage of wastewater treatment is associated with aerobic cleaning. In this case, aerobic microorganisms play a decisive role.

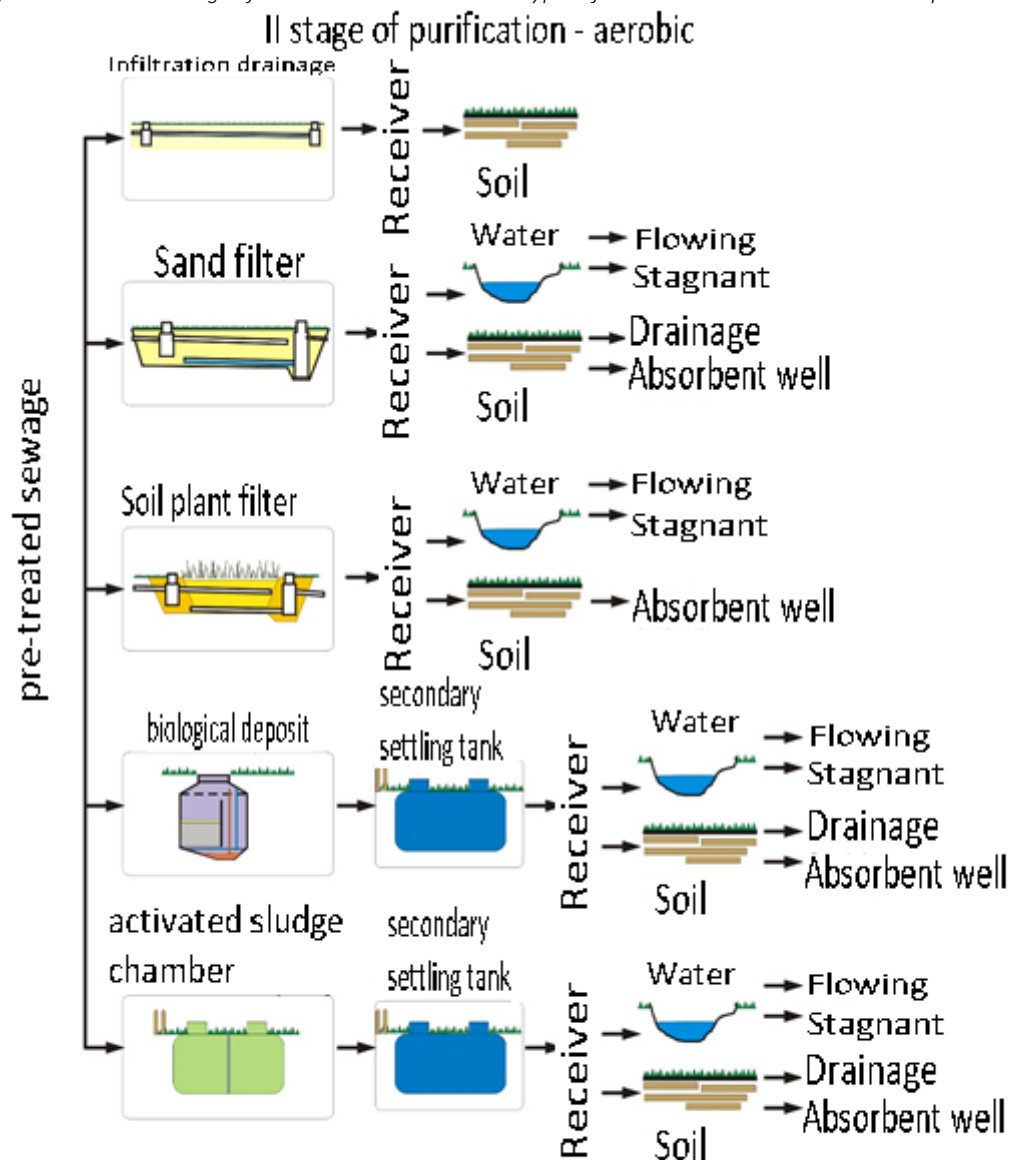
These processes can be further intensified by the use of aeration devices.

This stage can take place in drainage, in sand or soil-plant filters, in compact devices using a biological deposit or activated sludge.

Wastewater treated in this way is introduced into the receiver. It can be flowing or standing water, or soil; then it is done through a small pond, an absorbent well or an infiltration drainage.

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Figure 2. The second stage of wastewater treatment and types of household wastewater treatment plants



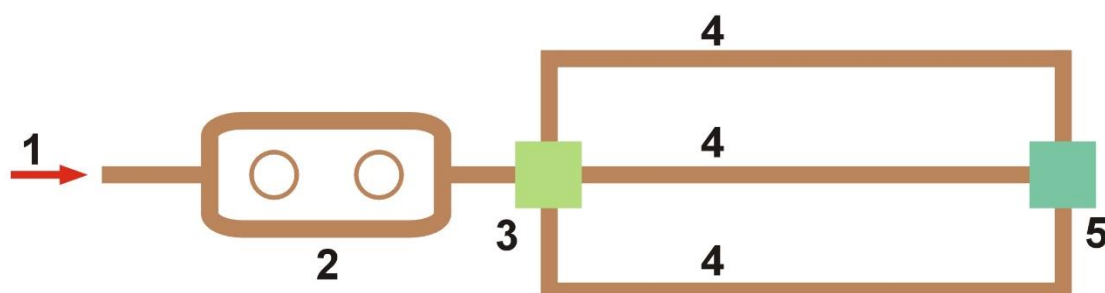
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Sewage treatment plants with infiltration drainage

A drainage sewage treatment plant is the simplest type of treatment plant. The schematic diagram is presented in Figure 3. Sewage effluent from the building (1) goes to a septic tank equipped with a filter basket (2). In special cases, there is a grease separator in front of the settler. After initial pre-treatment, the wastewater is evenly distributed to the individual drainage threads (4) using a separation well (3). Then the sewage is infiltrated into the ground (4), where aerobic cleaning takes place. All drains can connect with a collecting pipe and a collecting well whose function is to aerate all drains (5). Solutions in which each drainage thread has its own aeration are also common.

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Figure 3. Construction scheme of a drainage sewage treatment plant with a collecting well

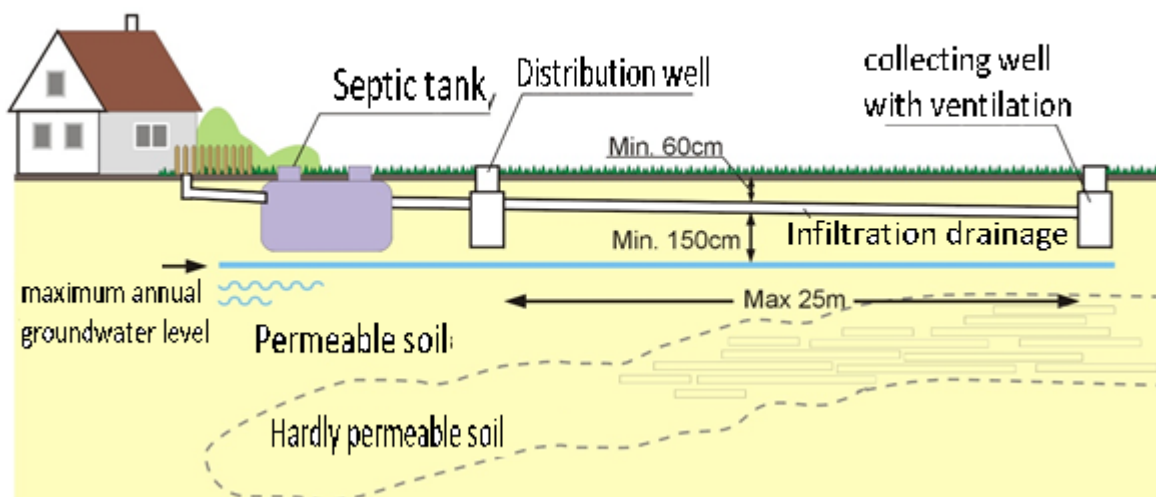


Description: 1 - sewage inflow, 2 - septic tank, 3 - distribution well, 4 - drainage threads, 5 - collection well.

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The construction of the drainage sewage treatment plant is shown in Figure 4. It lists the most important minimum and maximum sizes associated with the elements of the sewage treatment plant.

Figure 4. Drainage sewage treatment plant



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Septic tank

Sewage from the building goes to the septic tank. It is a closed, sealed tank in which preliminary wastewater treatment processes take place. The most commonly used are plastic settlements tanks, mainly of high density polyethylene.

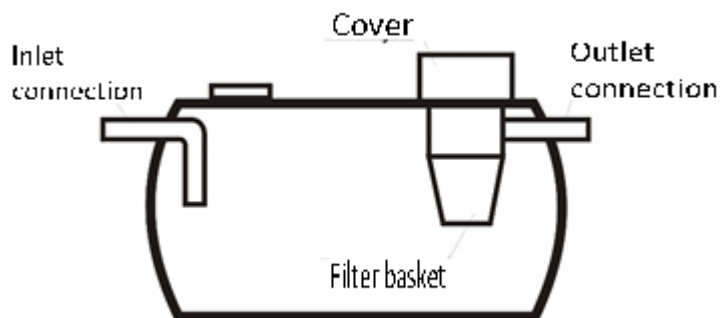
Settlement tanks can also be made of concrete. They are available on the market as prefabricated elements (they are delivered to the construction site as one element) or require joining two or more elements.

The settlement tank may be composed of one or more chambers. Tanks with a one-, two- or three-chamber structure are most often used for the assembly of household sewage treatment plants.

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The most important elements of the sedimentation tank construction are presented in figure 5. Waste water is lead into the tank through the inlet connection.

Figure 5. Construction of a single-chamber septic tank



Inside the septic tanks, septic tank filters are used, which in short are called filters. They are filled with polyethylene fittings and prevent sewage solids from entering other treatment plant components.

In the septic tank, sewage should be kept for 2-3 days. Shorter retention periods do not ensure an adequate level of pre-treatment, and too long retention causes adverse development of putrefactive processes.

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Figure 6 shows the diagram of processes taking place in the septic tank.

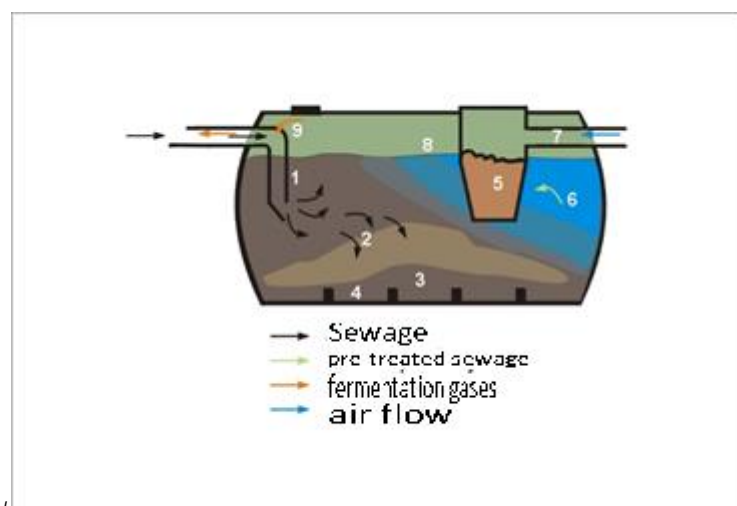


Figure 6. Pre-treatment processes in a septic tank

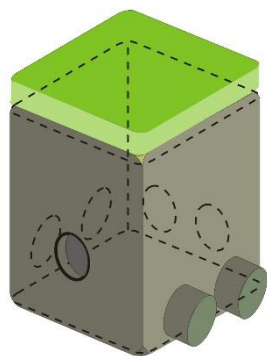
Description of processes occurring in the settling tank: 1 - flotation (rising) of impurities, 2 - sedimentation (sinking) of the sludge, 3 - sludge, 4 - bottom of the settling tank, 5 - filter, 6 - inflow of sewage to the filter, 7 - outlet of treated sewage and air inflow, 8 - fermentation scum, 9 - fermentation gas outlet.

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Distribution well

Its task is to evenly distribute inflowing sewage to individual drainage threads. Figure 7 illustrates the construction of a distribution well.

Figure 7. Examples of distribution well



a) picture of a cuboid-shaped well, b) picture of a cylindrical well

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Infiltration drainage

It is a system of pipes connected in parallel, which are designed to evenly distribute treated sewage in the ground.

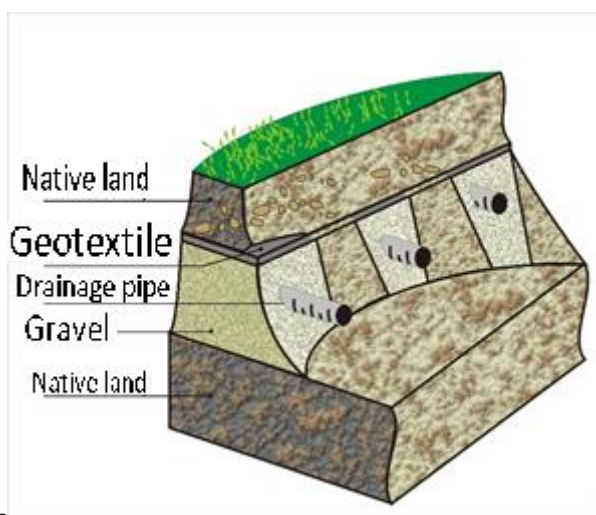


Figure 8. Cross-section through the infiltration drainage

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For infiltration drainage, PVC pipes with a diameter of 110 mm are used, with holes in the form of cuts.

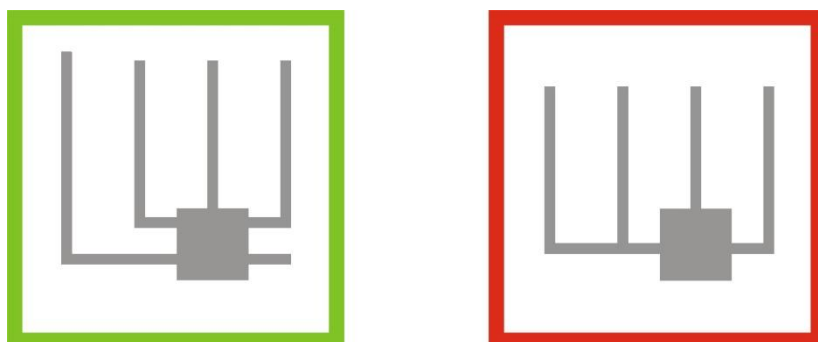
Excavations for individual pipes are approx. 50 cm wide.

The upper part of the drainage pipe should be protected with a non-woven geotextile about 0.3 - 0.5 mm thick, which protects the drainage against silting and root growth.

The filtration layer under drainage should be made of 16 - 32 mm gravel.

Correct siphoning of the infiltration drainage from the distribution well consists of connecting each drainage thread to one outlet in the well. Figure 9 shows the correct (green) and incorrect (red) connection method.

Figure 9. Diagram of drainage connection to the distribution well



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When laying drainage pipes, the slope should be 0.5%.

The distances between individual drainage threads should be 1.5 m, while their maximum depth in the ground should be 1.0 m.

Due to the fact that aerobic microorganisms develop on the filtration layer under the drain, it is definitely not advisable to set the drains too deep; the deeper, the smaller the amount of oxygen needed for microorganisms.

In the case of high groundwater levels, a sand embankment is used to achieve the required distance of 1.5 m from drainage to the level of the water table. With this solution, the infiltration drainage is laid in the built embankment. An additional element of the treatment plant will be a pumping station, which will pump sewage onto the embankment.

The maximum length of one drainage thread is 20-25 m. At greater distances to the final sections, the sewage will not flow correctly. Recommended minimum length 6 - 8 m.

Cars should not drive on the area where the drainage is laid. Most often it is covered with grass.

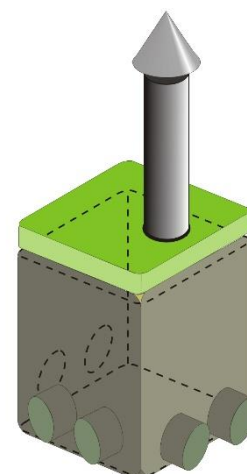
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Ventilation

It is very important to ensure ventilation of the filter bed (aggregate layer under drains). For this purpose, "high" ventilation and "low" ventilation are used. "High" ventilation is a PVC pipe with a diameter of 110 mm, which should be led out min. 50 cm above the roof ridge.

"Low" ventilation is a collecting well (Figure 10) with an additional ventilation chimney, which is 50 cm above the surface. Another solution is to use a separate ventilation chimney for each drainage thread.

Figure 10. Diagram of a collecting well



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Pumping station

The pumping station is a sealed tank (usually made of plastic or concrete), in which a pump is placed, which periodically pumps sewage.

In the case of home sewage treatment plants, they are required for the deep outlet of the sewer pipe from the building. If it is necessary to pump raw sewage (e.g. to the settler), it is necessary to have raw sewage pumps, which may have so-called shredders (rotors, equipped with sharp "knives" from the bottom of the pump, i.e. where the sewage is sucked).

The pump to raise the pre-treated sewage in the septic tank to a higher level is called dirty water pump.

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The main advantages of drainage treatment plants:

- simple design,
- low purchase costs,
- requires no specialized knowledge or supervision (practically maintenance-free),
- high resistance to irregularities in the sewage inflow,
- low operating costs; the potential cost may be the purchase of special biopreparations supporting the purification processes,
- low failure rate,

The main disadvantages of a sewage treatment plant with infiltration drainage:

- relatively large plot area necessary for its installation,
- lack of efficiency control (the effects) due to the fact that the drains are laid in the ground, it is very difficult to collect samples for testing the effectiveness of treatment,
- requires the use of biopreparations to maintain the appropriate quality of bacterial flora,

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TYPES OF DOMESTIC SEWAGE TREATMENT PLANTS AND MATERIALS USED TO MAKE THEM cont.

Sewage treatment plant with a sand filter

Sewage treatment plants with a sand filter are used for poorly permeable soil. The first element of such a solution is a septic tank, in which the first stage of purification takes place. Then the wastewater is pumped through a pumping station to a sand filter. Direct gravity flow (without pumping station) with a distribution well is very rarely used.

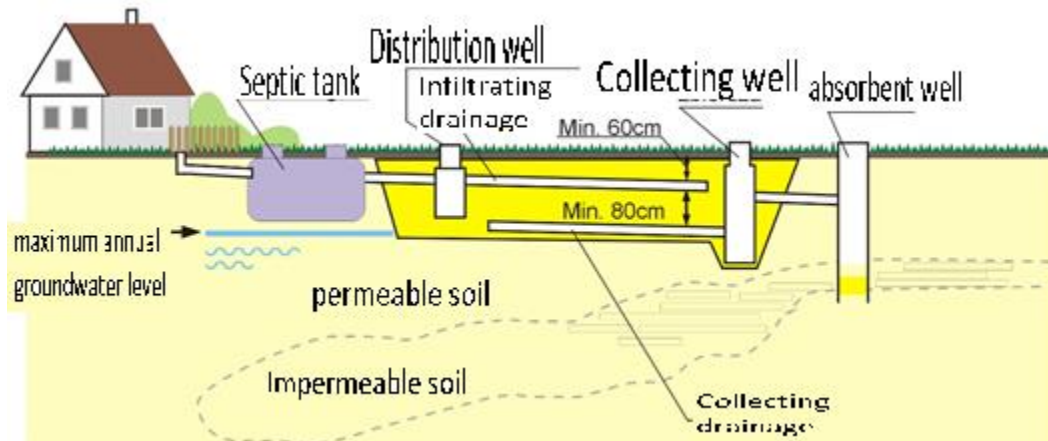
In the sand filter, wastewater is evenly distributed through the infiltration drainage. The second stage of purification is biological. Aerobic bacteria and other microorganisms develop in the sand, which is not only the main filter, but also responsible for the cleaning process.

Filtered wastewater is discharged through collecting drains to a collective well and from there to the receiver (variants: absorbent well, infiltration drainage, water reservoir).

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The principle of operation and construction of the sewage treatment plant is shown in Figure 11. The example uses a direct gravitational flow to the filter and drainage of treated wastewater through an absorbent well.

Figure 11. Sewage treatment plant with a sand filter



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The first elements of the sewage treatment plant; the settling tank, pumping station or distribution well are analogous to those for other types of sewage treatment plants.

The wastewater cleaning phase takes place in a sand filter. It is a filter layer sealed with foil. Infiltrating drainage is made of PVC pipes with a diameter of 50 mm.

The fill of the sand filter is most often gravel (grains 8 - 16 mm) and sand (grains 0 - 2 mm). The total thickness of the layers is 0.9 - 1 m. The total filter area is determined based on the number of users (2 - 5 m² per person).

Treated sewage gets through the collecting drain to the collecting well and then to the absorbent well, the infiltrating drainage or the pond.

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The main advantages of a sand filter plant:

- high level of sewage treatment,
- simple design,
- high resistance related to unevenness in the sewage inflow,
- low operating costs (possibly, if there is a pumping station - costs of electricity related to the operation of the float pump),
- the possibility of economic use of treated sewage (eg. for watering the lawn, car washing, etc.).

The main disadvantages of a sand filter plant:

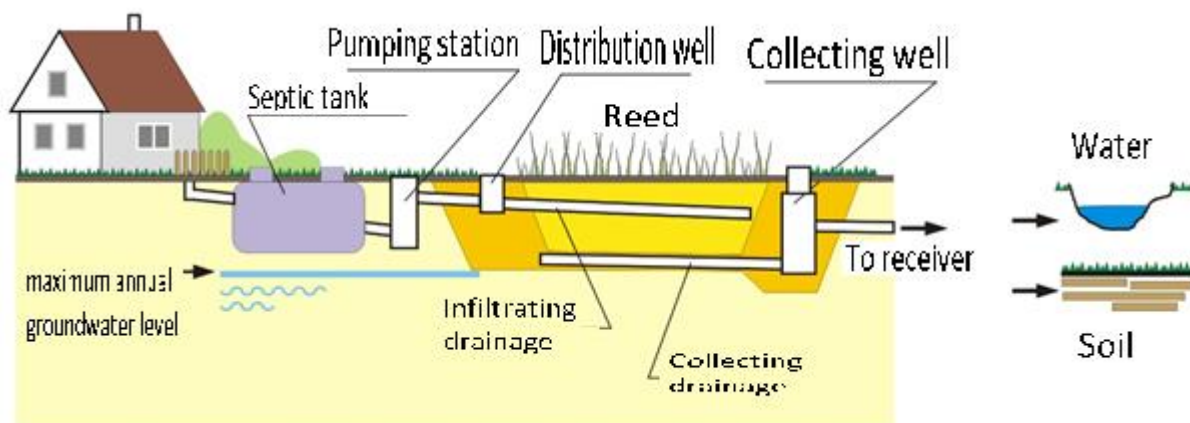
- relatively large area necessary for its installation,
- higher costs and more work involved in making a sand filter and pumping station.

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Plant and soil treatment plants

Plant and soil treatment plants are objects that can be described as artificial swamp ecosystems. It's a very complex ecosystem, in which plants, mineral substrates and a large species diversity of microorganisms play an important role in the efficiency of wastewater treatment.

Rysunek 12. Plant and soil treatment plant



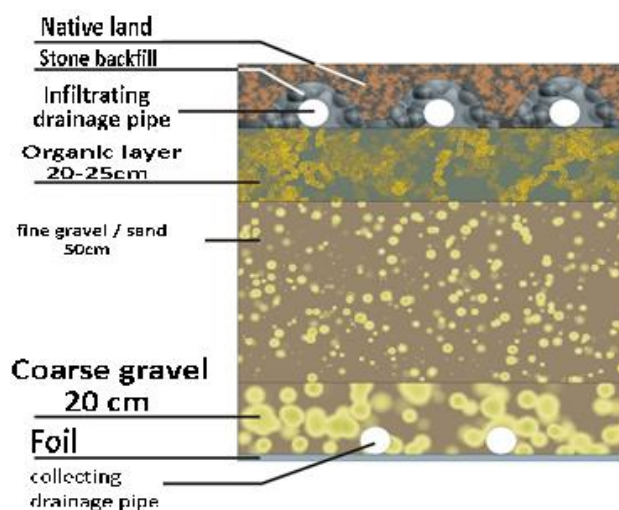
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The soil-plant filter has several layers, e.g.

- a bottom layer which is about 20 cm thick, made of washed gravel with a grain size of 8 - 16 mm, in special cases 8 - 32 mm from the bottom it should be sealed with foil with a minimum thickness of 0.5 mm,
- middle layer which is about 50 cm thick, composed of sand or fine gravel with a grain size of 2 mm,
- an upper layer, 20-25 cm thick, made of sand and well-drained soil with the addition of organic components, e.g. wood chips, straw or bark in a ratio of 4: 1 or 3: 1 (soil to organic ratio).

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Figure13. Cross-section through a soil-plant filter



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The use of plants characteristic of wetland ecosystems is strongly recommended on the soil and plant filter, e.g:

- Common reed (*Phragmites communis*)
- Water stick (*Typha* sp.)
- *Juncus* sp.
- Sedge (*Carex* sp.)
- *Glyceria maxima*
- Yellow iris (*Iris pseudocorus*)

After cleaning in the filter, the wastewater is collected by drainage. These are usually drainage pipes with a diameter of 100 mm and are further discharged to the receiver.

Treated wastewater can reach the ground via a pond, an absorbent well or an infiltrating drainage.

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The main advantages of plant and soil treatment:

- simple design,
- very high efficiency (pollution reduction),
- the possibility of using (developing) the filter as a decorative element on the plot,
- the possibility of using local swamp vegetation,
- high resistance to irregularities in the wastewater inflow,
- the possibility of using an existing septic tank (if it is sealed),
- the possibility of economic use of treated wastewater.

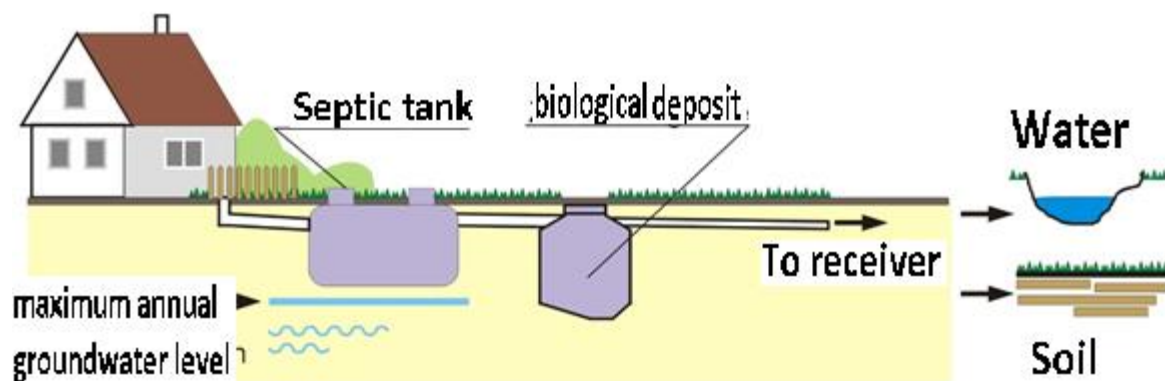
The main disadvantages of plant-soil treatment:

- relatively large area necessary to make the filter,
- high cost of purchasing film, pump, filter fill.

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Biological sewage treatment plants

Biological deposits are devices in which natural, aerobic pollution decomposition processes are carried out on a special filling for wastewater treatment.



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From the septic tank, pre-treated sewage is gravity fed to a second tank with a biological deposit.

The structure of the biological deposit is shown in Figure 15.

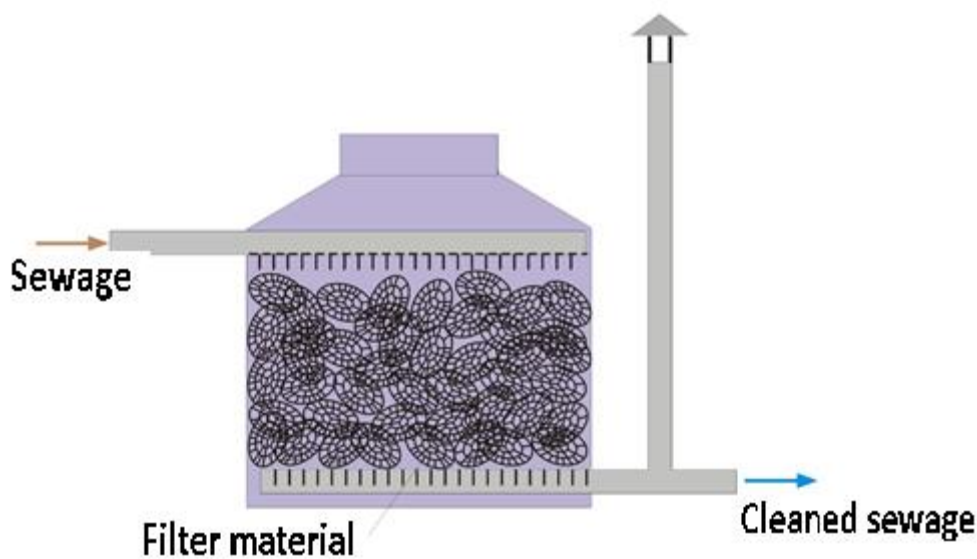
The main element of the deposit is a special filling, usually made of plastic, on the surface of which a biological membrane develops (a set of microorganisms consisting mainly of bacteria that take part in wastewater treatment).

Wastewater should be evenly distributed (most often it happens by using a pipe with cuts or a splash disc). Waste water at the top seeps slowly through the deposit. Bacteria and other microorganisms break down filtering wastewater.

After cleaning on the deposit, treated wastewater can be discharged into the environment.

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Figure 15. Sprinkled bed



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The most important advantages of a biological treatment plant over other solutions are:

- high resistance to irregularities in the sewage inflow,
- high stability of biological processes taking place in the deposit,
- high pollution reduction (over 95%),
- low operating costs; the potential cost may be the purchase of special biopreparations supporting the purification processes in special circumstances,
- a small area needed to mount the biological bed.

The main disadvantage of a biological treatment plant is the need to clean the bed fill or replace mechanical parts.

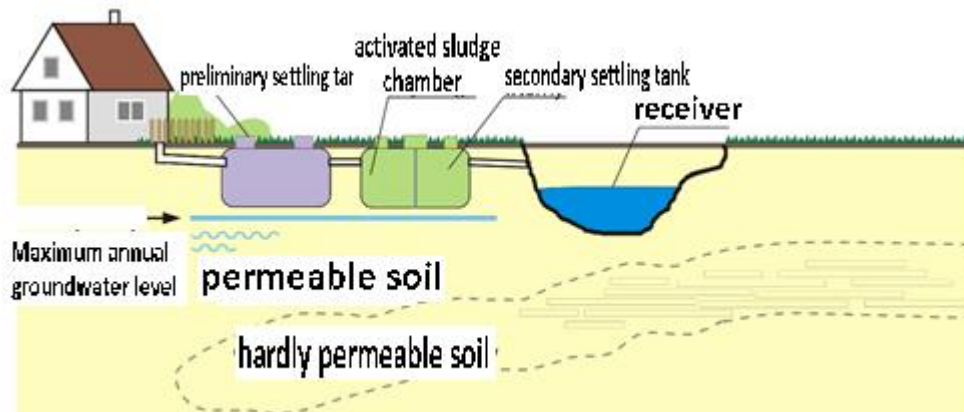
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Activated sludge treatment plants

Activated sludge - these are clusters (flocs) of aerobic microorganisms that float in the wastewater, through which purification processes take place.

During the first start, the formation of microorganisms (flocs) is initiated through the use of special biopreparations.

Figure16. Sewage treatment plant with activated sludge



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The construction of this type of treatment plant is similar to that of a biological treatment plant. Unlike the previously described solutions, the microorganisms responsible for the distribution of pollutants contained in the wastewater, do not settle on any substrate, but float freely in a tank called the reaction chamber (activated sludge chamber).

In the tank in which the sediment has been inoculated, diffusers are mounted on the bottom, through which the aeration pump supplies oxygen. This solution, in addition to aeration of the sewage itself, causes the sludge to float constantly.

Then the wastewater flows into the second chamber - the secondary settler, in which the treated wastewater is separated from the multiplied flocs, and their excess is recycled to the primary settler with a recirculation pump, from which it is periodically removed.

Treated wastewater can be directly discharged into the soil through drainage or an absorbent well.

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The main advantages of the activated sludge treatment plant:

- high reduction of pollutants contained in sewage,
- a small area necessary for its assembly,

Main disadvantages of the activated sludge treatment plant:

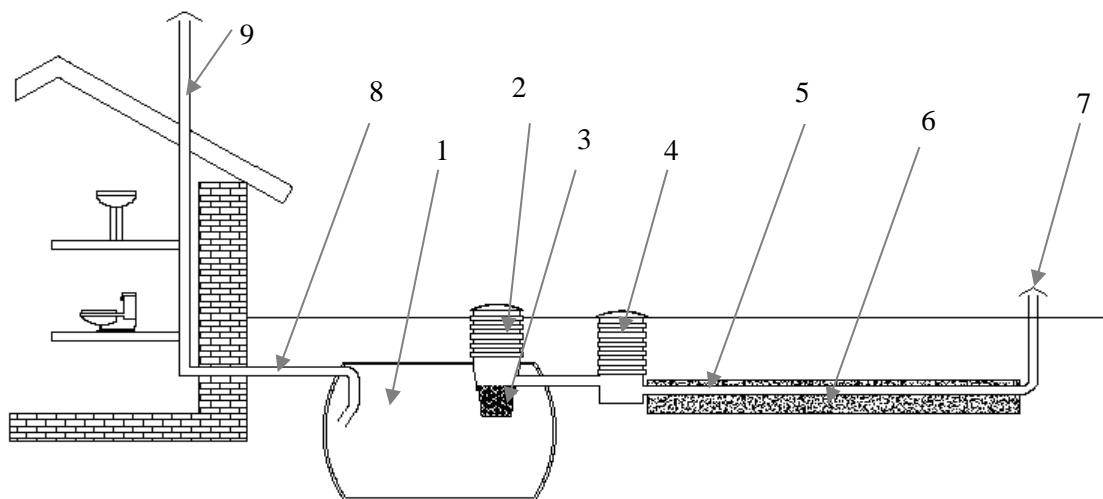
- higher operating costs, associated with the consumption of electricity, the purchase of preparations to support cleaning processes and the operation of the pump,
- high sensitivity to unevenness in the sewage inflow,
- the need to train a potential user as to how to operate the treatment plant properly,

- potentially higher failure rate of mechanical components.

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Use of technical documentation

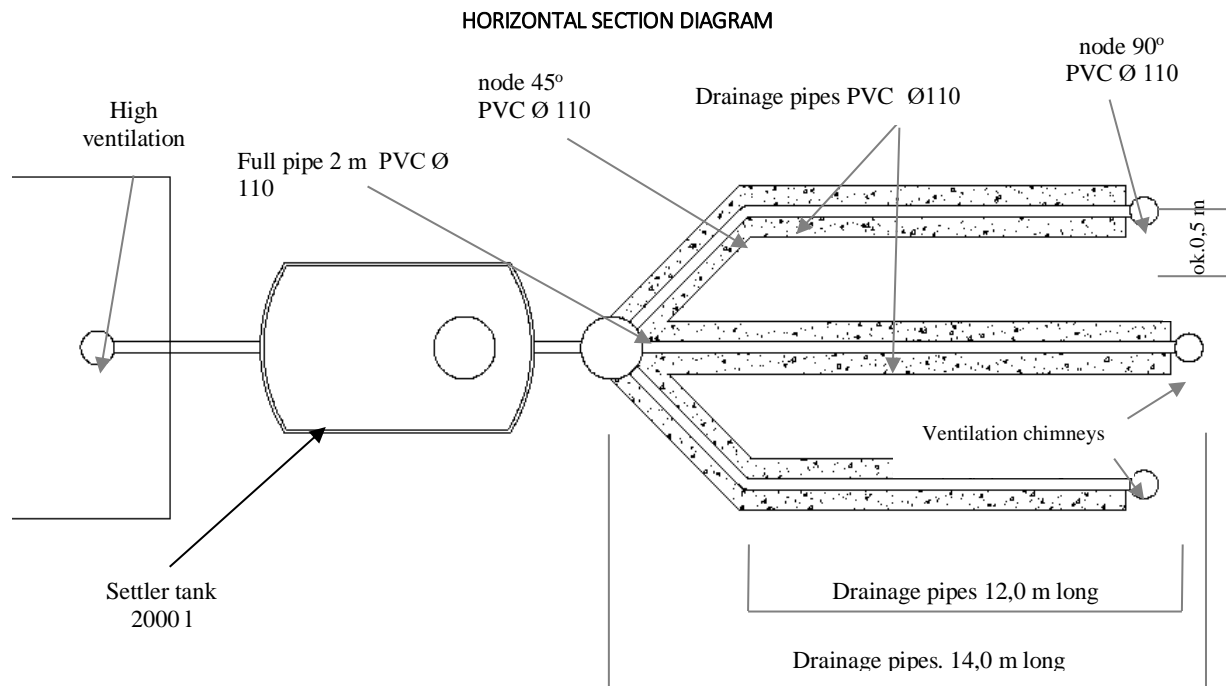
LONGITUDINAL SECTION DIAGRAM



Legend:

1. Septic tank
2. Settler extension
3. Filter basket with fittings
4. Distribution well
5. PVC fi 110 drainage pipe
6. Aggregate with 16 - 32 mm granulation
7. Ventilation chimney fi 110
8. Sewage pipe fi 110
9. High ventilation fi 110

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Estimating the amount of materials needed to complete the wastewater treatment plant

Method of calculating the amount of aggregate for the drainage treatment plant:

- number of users 4-5
- 3 drainage threads, each 20 m long, total length of drains - 60 m,
- excavations will be carried out mechanically, excavation width will be 50 cm,
- it was determined that the soil is moderately permeable (sandy-loam),
- the thickness (depth) of the filtration layer (i.e. the amount of aggregate under the drain 45 cm + 5 cm above the drain) - 50 cm.

We determine the total amount of aggregate that we must purchase:

$$V = 60 \text{ m} \times 0.5 \text{ m (width)} \times 0.5 \text{ m (depth)} = 15 \text{ m}^3$$

When converting m³ to tonnes, the converter is in the range 1 m³ = 1.7 - 2 t.

Depends on: aggregate granulation, admixtures of other (finer) fractions and humidity.

For calculations we take the factor - 1m³ = 2 t.

$$V = 15 \text{ m}^3 \times 2 = 30 \text{ t.}$$

We should buy 30 tons of aggregate.

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EVALUATION OF POSSIBILITIES OF LOCAL SEWAGE TREATMENT PLANTS

ANALYSIS OF TECHNICAL POSSIBILITIES

Before choosing the type of sewage treatment plant, it is necessary to analyze the technical possibilities of assembly and operation. The most important factors to consider before choosing the type of treatment plant are:

- current and future number of regular users,
- the nature of the object,
- groundwater level,
- surface area,
- source of drinking water supply,
- type of land,
- depth of drainage pipe out of the building,

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Number of regular users

In order to standardize the calculation of the amount of wastewater discharged, the concept of population equivalent number (RLM) was introduced.

The amount of wastewater pollution can also be represented by their quantity, which is why very often the RLM determines the amount of wastewater discharged by one resident who stays permanently in a given facility during one day. It is assumed to be 150 dm³ per day, corresponding to 1 RLM.

Taking into account the number of regular users, we determine both the required volume of the settler and the efficiency of other elements related to the sewage treatment plant.

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Settler selection

In most cases, the time required for pre-treatment of sewage in the settling tank is 2-3 days.

The duration of sewage being stored in the settler depends on its volume and the amount of sewage produced.

In order to independently select the proper capacity of the septic tank, the following formula can be used:

$$V = RLM \times L \times T$$

where:

V - minimum volume of the selected settling tank [dm³] or [m³];

L - amount of sewage discharged by 1 inhabitant [dm³] or [m³] - 130-150 dm³ / person / day is most often used;

T - assumed time for keeping sewage in the settling tank [day] - the most common value is 3.

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In order to increase the efficiency of treatment, it is recommended to use two (or three-chamber) settling tanks. Because the longer the path of sewage flows, the higher the degree of pollution reduction.

A similar effect can be obtained by connecting two or more settlers with smaller volumes in series.

In the case of small facilities, single-chamber settling tanks fulfill their role, provided they are correctly selected and equipped with a filter basket.

The used filter baskets, in short called filters - are filled with special polyethylene fittings, which are designed to protect subsequent elements of the sewage treatment plant against clogging by thicker fractions of pollutants floating in sewage.

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General rules for the selection and installation of settling tanks

Taking into account the aspects of the selection of settlers characterized in this lesson, the following practical recommendations can be made:

- when installing 2 settler tanks of different volumes, the larger tank should be installed first,
- settling tanks should be connected to each other only in series;
- settling tanks should be installed as close as possible to the house (5 - 10 m);
- especially in the case of settling tanks with small capacities (eg a settling tank with a volume of 2-3 m³), pay attention if the settling tank is equipped with a filter basket;

Example

We assume an analysis for the needs of a family of five, the amount of sewage generated is 130 dm³ (liters) per inhabitant per day, sewage storage time is 3 days, drainage length is 12m / person.

Settler capacity

$V = 5 \times 130 \times 3 = 1950$, the value is rounded, the result = 2300 l = 2.3 m³.

The length of the drains

$D = 5 \times 12\text{m} = 60\text{m}$.

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Groundwater level

The level of groundwater is important for the foundation of the installation due to the required 1.5 m distance from the bottom of drainage pipes to the level of the groundwater table. It is the distance that provides biological processes for wastewater treatment.

In the case of a high level of groundwater (for drainage treatment plants), it can be solved by using the construction of a sand, to raise the drainage. Then, it is necessary to use sewage pumping stations on the settler - drainage section.

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Land area

Plot area, due to restrictions resulting from legal provisions, can significantly affect the choice of the type and size of installations. There are legal restrictions on the location of various elements of the plant on the plot, resulting from the recommendations of the producers of the plant. So check:

- the required distance of drainage from trees,
- the required distance from the water intake (well) to the place where the drains are laid,
- the required distance from the septic tank to the water intake (well),
- required distance from gas and water pipelines,
- required distance from power cables,
- required distance from telecommunications cables.

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Drainage length

The length of drainage also depends on the amount of sewage generated per day. In the design guidelines and recommendations of sewage treatment plant manufacturers, the values quoted range from 8 - 16 m drains / person (RLM). These values largely depend on: the type of soil (its permeability). This means that for a large number of inhabitants, there is a need to either increase drainage threads or lengthen them.

An additional limitation is the minimum distance between individual drainage threads, which is 1.5 m. The maximum length of one drainage thread is 20-25 m. At larger distances to the final sections, the sewage will not flow. Recommended minimum length is 6 - 8 m.

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Type of soil

The type of soil is decisive in terms of whether the soil can be used as the second element of wastewater treatment - aerobic cleaning, which mainly takes place in drainage sewage treatment plants, or used as a receiver of cleaned sewage.

Only permeable soils (mainly sands and mixed soils dominated by sandy soils) are suitable for this purpose. Soils with such characteristics ensure a sufficiently long flow, necessary in the wastewater treatment process.

Identifying the type of soil is extremely important. This can be obtained in two ways:

- performing geological drilling,
- performing a percolation test.

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Application and selection of pumping stations

The selection of pumps takes into account several factors: capacity (amount of flowing sewage) and lifting height - the maximum height at which the pump can "lift" flowing sewage and the quality of sewage (raw sewage or dirty water pumps). Small pumps are powered by electricity (usually single-phase - 230 V).

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ANALYSIS OF LEGAL CONDITIONS

The analysis of the legal conditions of assembly and operation of domestic sewage treatment plants is related to the regulations set out by EU, national and local law, the size of the treatment plant (throughput), the minimum required distances of installation elements from buildings and other infrastructure facilities, the required level of wastewater treatment, aspects related to the disposal of treated wastewater to the soil and quality of planned technical solutions.

Local Law

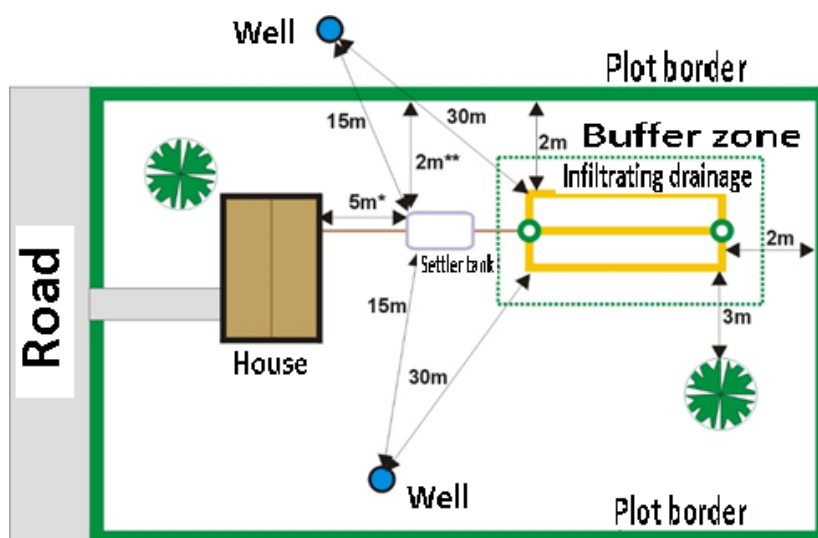
Before making a decision, make sure that the plot in question is not in an area where local law precludes construction of adjacent sewage treatment plants. The ban on construction of household sewage treatment plants can be related to two reasons: the location of the plot near or directly in areas of valuable nature or protection, and the concept of sewage system owned by the commune.

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Sewage treatment plant location

Installation of a domestic sewage treatment plant requires maintaining proper distances from other objects.

Figure 1. Minimum distances required by law from sewage treatment plant components to infrastructure buildings in single-family housing in Poland.



* in the event of venting via a sewage system, at least 0.6 m above the upper edge of windows and external doors, the settler tank can be located in the immediate vicinity of the buildings;

** it is also possible to position the settler next to the plot border, if it is adjacent to similar devices on the neighboring plot, provided that the remaining distances are maintained.

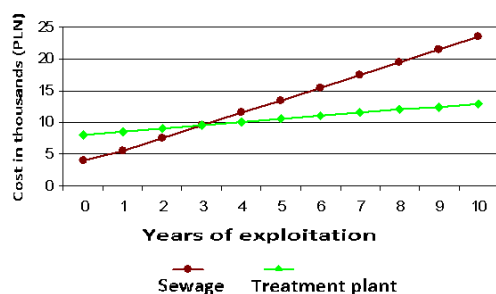
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ECONOMIC EFFICIENCY ANALYSIS

The analysis of investment profitability is always carried out as an alternative to another planned action. The most common alternatives when deciding to make a domestic sewage treatment plant are the purchase and maintenance of a drainage tank (septic tank).

The payback period for the construction of a domestic sewage treatment plant with a sand filter for a family of 5 is about 3 years, compared to the investment consisting of the purchase and maintenance of a drainage tank (septic tank). This applies to both investments financed from own funds and co-financed with credit

Figure 2. A schematic diagram of the profitability analysis of domestic sewage treatment plants



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SEWAGE TREATMENT PLANT INSTALLATION

DETERMINING THE PLACE OF VARIOUS COMPONENTS OF SEWAGE TREATMENT PLANT

1. Lay out the location of individual elements on the site

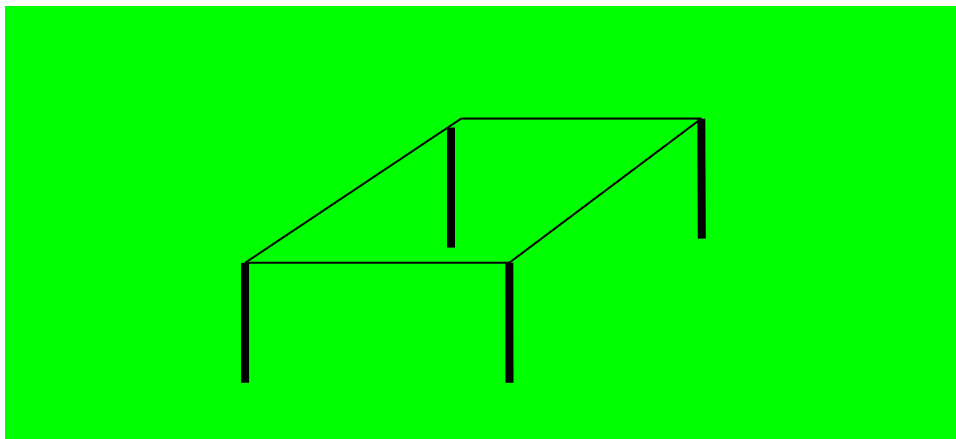
The place where the various elements of the sewage treatment plant are planned should be marked and any obstacles that may cause future problems with assembly should be removed. Also, the places of storage of materials necessary for the construction of a domestic sewage treatment plant and the route to the place of assembly should be taken into account.

2. Marking of foundation places

Marking the foundation places consists of measuring and marking the contour of the excavation for different devices using stakes.

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Figure 1. Diagram showing a rectangular staking of a device



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PREPARING THE PLACE FOR THE INSTALLER

Arranging the order of work performed

Depending on the plot's terrain conditions (unevenness of the plot, infrastructure of the plot), the most common order of work is as follows: planting the area (leveling the top layer of the ground to facilitate installation work), removing obstacles for the installer and excavator (dumps, branches, vegetation, etc.)), placing the excavator in a place suitable for installation works, excavations, foundation of key elements of a domestic sewage treatment plant, connecting elements of the sewage treatment plant.

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EXCAVATION WORKS

Excavations can be performed manually or mechanically (excavator, backhoe loader), depending on the type and purpose (e.g. for pipes, for the tank).

Remember to make excavations larger than the dimensions of the devices themselves. Especially in the case of settlers, it may be necessary for the installer to be present in the excavation.

Figure 1. Cavernous excavation



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Figure 2. Excavation for a sand filter



Figure 3. Manual excavation for pipes



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Figure 4. Mechanical excavation for drainage



Ręczne modelowanie wykopu

Modelowanie wykopu polega na skarpowaniu i poziomowaniu dna wykopu.

W przypadku wykopów realizowanych mechanicznie należy ręcznie wyrównać i wypoziomować dno wykopu. Często stosowanym rozwiązaniem w celu wypoziomowania dna wykopu jest zastosowanie obsypki piaskowej o grubości 20 cm.

Modelling of manual excavation

Excavation modeling consists of scarifying and leveling the excavation bottom.

In case of mechanically carried out excavations, the bottom of the excavation must be leveled manually. A frequently used solution to level the bottom of the trench is to use 20 cm thick sand backfill.

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Figure 5. Leveling the bottom of the excavation



Figure 6.

Profiling the bottom of the excavation



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PLACING THE KEY ELEMENTS OF VARIOUS TREATMENT PLANTS

Installation of key elements

Embedding devices in the excavation should be done manually or mechanically. The second method of embedding usually involves fixing the device with straps to an excavator bucket and adjusting the precise position manually (used for settling tanks). After mounting the device, the tank should be covered with native soil or a mixture of sand and cement. The above assembly principles apply to the embedding of tanks, distribution well, sewage pumping station, absorbent well, compact biological and mechanical treatment plant.

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Figure 1. Septic tank assembly



Figure 2. Pumping station in the excavation



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Figure 3. Installation of an absorbent well



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Creation of a sand filter at the sewage treatment plant

After the excavation, the bottom and slopes of the filter should be formed, and then the appropriate stages of the sand filter creation.

Work begins with making sand bedding for the film. This is to protect the film from breaking and isolating it from the native soil. This operation can be omitted if the native soil is devoid of elements that can damage the foil or if instead of foil we use a bentonite mat.

Figure 4. Making the first layer of the filter – sand for the film.



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The next stage is putting the geomembrane in the excavation (0.5 - 1 mm thick foil or bentonite mat).

Figure 5. Spreading the second layer of the filter - foil



Figure 6. Implementation of the second filter layer - bentonite mat.



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Kolejnym etapem jest wykonanie drenażu zbierającego. Wykonuje się go z rury drenarskiej. Drenaż zbierający ma za zadanie odprowadzenie oczyszczonych ścieków do odbiornika.

The next step is to make the collecting drainage. It is made of drainage pipe. Collecting drainage is intended to move treated wastewater to the receiver.

Figure 7. Collecting drainage



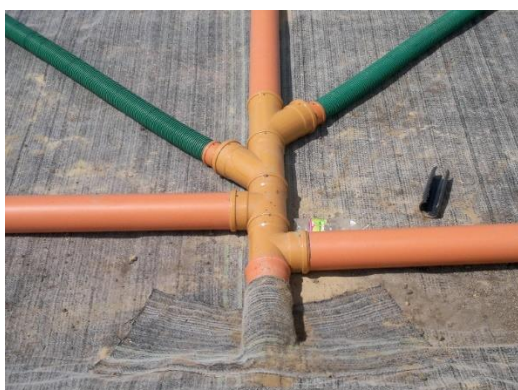
Drenaż zbierający wykonuje się przez połączenie końców rury drenażowej trójnikiem i podłączenie wentylacji. Wentylacja ma za zadanie natlenienie dolnej warstwy złoża. Składa się z rury kanalizacyjnej zakończonej wywiewką.

Collecting drainage is made by connecting the ends of the drainage pipe with a T-piece and connecting ventilation. Ventilation is designed to oxygenate the bottom layer of the bed. It consists of a sewage pipe ended with an exhaust.

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The next step is to make a tight passage of the pipe draining the treated sewage through the geomembrane.

Figure 8. Leading out a collecting drain through a bentonite mat



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The next stages are related to the heap of the middle layer of the filter and consist of:

- backfilling the collecting drain with aggregate of 8-16 mm or 8-32 mm (fig. 9), thickness of a layer approx. 20 cm,
- building a layer of approx. 50 cm with sand 0-2 mm (Fig. 10),

Heaping of subsequent filter layers can take place manually or mechanically or in a mixed system.

Subsequent layers should be leveled inside the filter manually due to the possibility of mechanical damage to the film by the construction machine.

The filter surface should be even. This will allow the bed to be evenly loaded by the sewage.

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Figure 9. Backfilling the collecting drain with aggregate



Figure 10. A sand layer



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To an even 50 cm layer of sand (0-2 mm thick) we add 5 cm of aggregate 8-16 mm or 8-32 mm of fraction,, and lay out infiltrating drainage. The method of installing drainage pipes is shown in Figure 11.

Infiltrating drainage is a system of pipes introducing mechanically treated wastewater onto a sand filter. Lay the infiltrating drainage pipes horizontally.

The infiltrating drainage is placed in aggregate backfill (20 cm thick) with the 8-16 mm or 8-32 mm fraction (Fig. 12) in which we then plant the swamp vegetation (Fig. 13) in a minimum of 4 pieces per 1 m².

Figure 11. Laying out infiltrating drainage



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Figure 12. Infiltrating drainage in the backfill



Figure 13. Planting plants



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Creation of the pond

A pond is one of the receivers of treated sewage, usually in the case of sand filter plants. It fulfills two tasks – it is a receiver of treated sewage and it is the last stage of their treatment. Denitrification, removal of phosphorus compounds, pathogenic bacteria and organic compounds happens in it.

The pond is made just behind the sand filter and the control well in the form of a hole in the ground 1-1.5 m deep. We connect the control well with the pond with a sewage pipe with a diameter of 110 mm.

Figure 14. Creating the pond



The pond can be planted with marsh plants (calamus, truncheon, gallows, etc.), they will support the purification processes.

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INSTALLATION OF CABLES AND ARMING THE INSTALLATIONS

Connection between the infiltrating drainage and the settling tank

If a pumping station is used between the settling tank and the drainage, a pipe connecting the drainage with the pumping station with a backflow (to the pump) should be laid in order to prevent the sewage in the pipe from stopping and possibly freezing. Flexible PE water pipes are used for the connection. Most often there is a decline of about 3% from the settler to the pumping station. The connection method is shown in Figures 1 and 2.

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Figure 1. Connection of the settler tank to the infiltrating drainage



Figure 2. Connection of the settler tank to the infiltrating drainage



In the absence of a pumping station, the connection of the infiltrating drainage with the tank is made via a sewage pipe with a drop from the tank to the drainage.

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LEAK TEST AND INSTALLATION START-UP

The leak test is carried out on an ongoing basis after the pipes are connected and before backfilling. It consists of releasing water into the internal sewage system and observing the connections of pipes connecting the internal sewage system with a settling tank or compact sewage treatment plant. The tightness test of connections coincides with backfilling the tank, because one of the requirements for the installation of a compact sewage treatment plant or settler is its filling when backfilling.

The bioactivator supports the oxygen processes, it is dosed into the aeration chambers of biological and mechanical sewage treatment plants with activated sludge. The amount of bioactivator depends on the size of the treatment plant, sewage composition, type of activator. The detailed way of using the preparation is described in the instructions for use, which should be attached to the bioactivator.

Lesson 5

Slide 1

MAINTENANCE AND REPAIRS

RULES OF MAINTAINING AND REPAIRING TREATMENT PLANTS

PERFORMANCE OF MAINTENANCE AND REPAIR WORKS

RULES FOR REPAIR AND MAINTENANCE OF THE TREATMENT PLANT

Causes of faults:

Errors in design; A common and very costly mistake is an incorrectly chosen type of treatment plant due to poorly recognized soil conditions. A typical example is the use of a drainage sewage treatment plant on impermeable soil or in wetlands. Making such a mistake usually always involves replacing devices with other types of solutions.

Errors during assembly; Most often these are caused by improper drops of pipes, leaking connections (rolled up gaskets or lack of them) or damage caused directly during installation. There isn't any sand and cement backfilling of the septic tank or else it might be of a poor quality.

Neglections during operation; The most common negligence is not emptying settlers in accordance with the manufacturer's instructions and guidelines (minimum once a year).

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Equipment maintenance; involves periodically checking the status of devices. Check the condition of devices visually, if you do not notice anything disturbing, you can stop there. As a cause for concern you can consider any deviation from the current way and effect of the device's work, in particular:

- no aeration in the aeration chamber,
- no sludge recirculation,
- an unpleasant smell from the drainage or aeration chamber,
- incorrect color and smell of treated wastewater,
- long-term stagnation of sewage on the surface of the sand filter,
- sewage retention in pipes,
- unusual pump operation in the pumping station (too long, noisy or frequent switching on of the device).

In the case of a sand filter plant, a characteristic maintenance operation is protection of the filter against freezing, taking care of planting (removal of dry plants in the spring).

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Repair of equipment; if you notice any of the abovementioned irregularities, investigate its causes and remove it immediately. When repairing and adjusting devices, follow the instructions provided with the device.

Checking the correct functioning; it often concerns checking the treatment effect, which is usually given by the manufacturer in the specification of a given type of treatment plant. Tests for the composition of sewage (in order to determine whether the discharged sewage water meets the standards) are carried out by specialized laboratories.

Compact devices, such as activated sludge treatment plants, become degraded over time. To avoid failures, check the correct adjustment settings and adjust if necessary. Carefully read the device's documentation provided by the manufacturer.