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INSTITUTE OF TECHNOLOGY AND LIFE SCIENCES IN FALENTY

DEPARTMENT OF TECHNICAL RURAL INFRASTRUCTURE SYSTEMS

MOUNTAIN RESEARCH CENTER IN TYLICZ

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- **Individual wastewater treatment systems in Polish rural areas with the consideration of specificity of mountain regions**

- **Economic and social determinants – Requirements and technologies used in practice Technological solutions of the Institute of Technology and Life Sciences in Tylicz**

ITP GCB TYLICZ

List of contents

1. BASIC FUNCTIONS OF MOUNTAIN AREAS AND A CONCISE CHARACTERISTIC OF WATER RESOURCES IN POLAND

Mountainous areas in Poland are the areas elevated above 350 m above sea level, with an area of about 25 000 km^2, which occupy little more than 8% of our country.

Hipsometric map of Poland's area

Source: Wikipedia. Physico-geographic regionalization in Poland

The Polish mountains consist of three basic physiographic units: the Carpathians (17 500 km^2), the Sudety Mountains (5 000 km^2) and the smallest: the Świętokrzyskie Mountains (2 500 km^2).

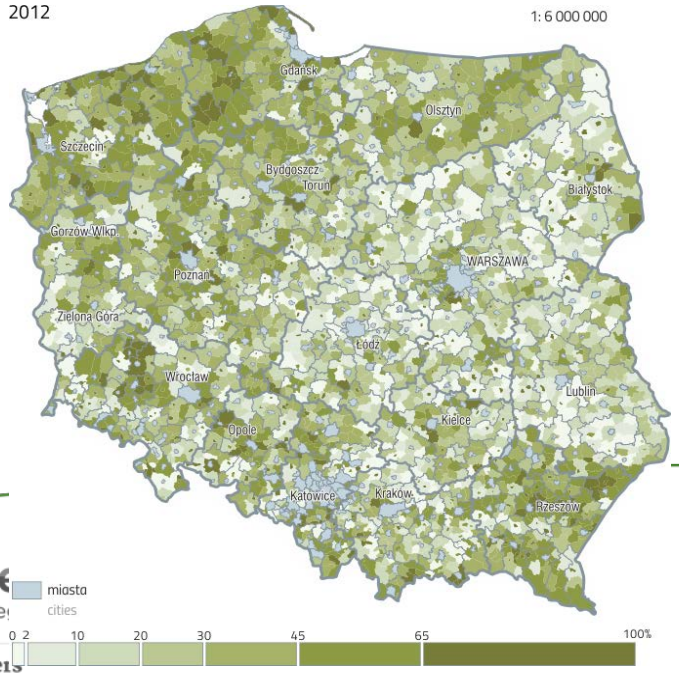
2. A CONCISE CHARACTERISTIC OF WASTEWATER MANAGEMENT IN RURAL AREAS – SOCIAL DETERMINANTS

Rural areas in Poland cover 290 759 km^2, which accounts for 92,88% of the total area of our country (in 2016).

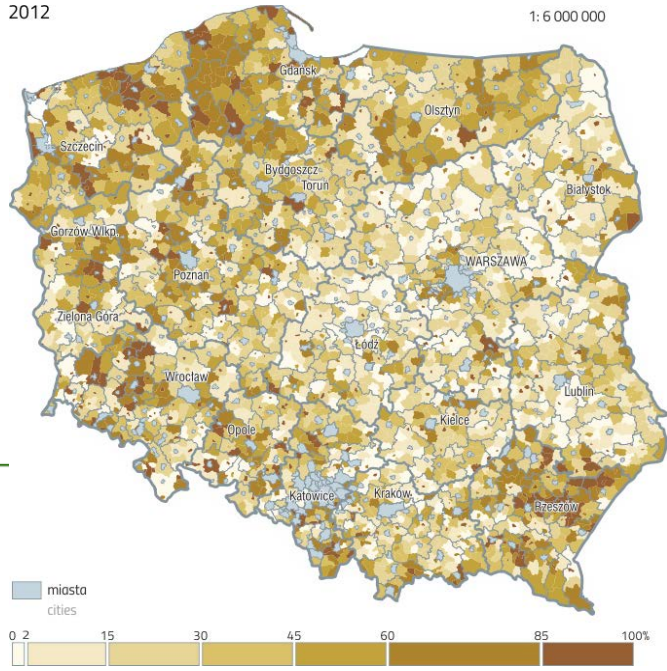
15,284 mln people live there: which stands for 39,76% of the country population.

They live in more than 95 500 rural localities including 43 068 villages, as well as other separate settlements, for example: parts in the villages (36 262), in colonies (2 203) or in houses concentrated near the villages (4 619).

Percentage of rural population using wastewater sewerage systems



Percentage of rural population using wastewater treatment plants



3. SPECIFICITY OF INDIVIDUAL WASTEWATER MANAGEMENT IN RURAL AREAS – INDIVIDUAL WASTEWATER TREATMENT SYSTEMS

In rural areas without a collective sewerage system, domestic sewage is usually collected in septic tanks (tanks without outflow) and their contents should be periodically empited "to the nearest wastewater treatment plant" by means of vehicles with special sucking tanks.

This is very expensive, and it is often impossible to carry out due to difficult terrain and climatic conditions, which often inspired the residents to dispose their sewage in illegal and very harmful ways causing a huge threat for the environment.

Wastewater quality from rural septic tanks and communal sewerage flowing to the central wastewater treatment plant in Krynica-Zdrój

Pollution indicators and components	Septic tanks Mean values	Septic tanks Maximum values	Average values in communal wastewater
BOD_5 [mg·dm^{-3}]	280 - 830	1250	197
COD [mg·dm^{-3}]	370 - 1300	2350	393
N-NH_4 [mg·dm^{-3}]	80 -136	250	25
Total nitrogen N_{tot} [mg·dm^{-3}]	100 – 180	270	36
P-PO_4 [mg·dm^{-3}]	12,3 - 17,6	26	6
Suspended solids [mg·dm^{-3}]	76 - 215	250	116

Source: own elaboration

It seems that the most accurate definition of an individual wastewater treatment plant is:

An individual household wastewater treatment plant is a device with wastewater flow capacity of up to 5 m^3 per day, used for a household or farm needs, according to the Polish Water Law.

It is often called an **Individual Wastewater Treatment System.**

This is an installation consisting of:

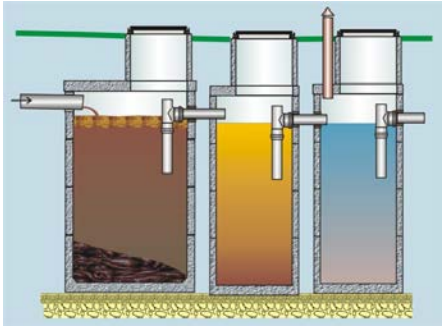
- a pipe connecting the home sewerage system with reactor,
- the reactor which guarantees similar level of treatment as communal wastewater treatment plants,
- a control well,
- infiltration system of treated wastewater in soil.

5. SHORT DESCRIPTION OF BASIC TECHNOLOGICAL EQUIPMENT USED IN HOUSEHOLD SEWAGE TREATMENT INSTALLATIONS

5.1. Septic tanks

Plastic tanks without baffles are being used more and more often. They are watertight and easy to install and have extended flow space. But for rural wastewater they often fail in terms of sedimentation efficiency and they prove to be a bad technological choice.

On the other hand, multi-chamber (three-chamber) septic tanks equipped with separators for stopping the floating parts of domestic waste, are more reliable, but are more troublesome to install.



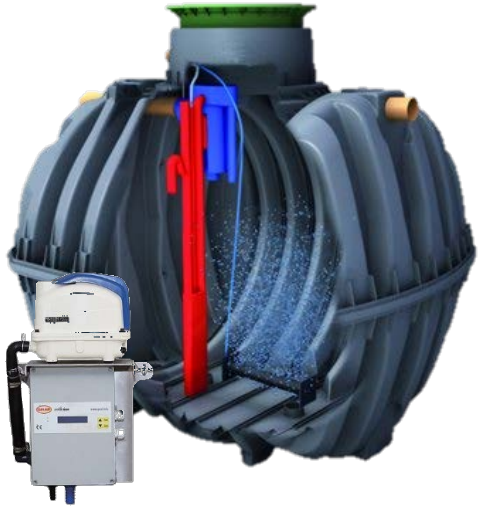
Septic tanks made of the concrete wells

Monolithic concrete tanks

Plastics tanks (PE, composites of fiberglass)

The market of prefabricated sewage treatment plants is dominated by installations:

- with activated sludge operating in the SBR system,
- with biological beds,
- a hybrid, a combination of biological beds and activated sludge as well as a combination of activated sludge together with separate immersed plastic elements covered with biofilm.



Example of household prefabricated SBR wastewater plant with activated sludge

Example of household prefabricated hybrid SBHR treatment plant with activated sludge and with elements of biological bed immersed in wastewater. During installation.

5.3. Filtration beds in the form of constructed wetlands with hydrophytes

Apart from prefabricated solutions there is also a variety of wastewater treatment installations with filtration beds, filled with soil and plants, which in practice use underground filtration processes. When properly constructed they are very effective, consume considerably less energy and are very easy to maintain and service.

The problem is that they require more area for instalation and are more difficult to design. There is also the need to maintain a pleasant green area. That is the reason why, for now, they will not gain acceptation for more widespread implementation in rural areas.

An example of household wastewater treatment plant in the form of a cascade of filtration beds filled with gravel, sand, soil and hydrophilic plants, according to ITP ZSIT GCB Tylicz project.

Installation with biological bed with rainy distribution of wastewater and with a special bed on a slope filled with soil and hygrophilic plants on an agrotouristic farm, according to ITP ZSIT GCB Tylicz project.

5.4. Recipients of treated wastewater

In order to maintain a good quality of water in rivers and streams, wastewater after treatment in individual sanitation systems should be used on site, for domestic, but not for drinking purposes. Only the surplus which cannot be used in or around the homestead should be discharged to the environment but only to soil receivers instead of water.

These receivers can be as follow:

- shallow infiltration systems beneath a turf area and permeable trenches filled with gravel,
- tanks for micro-retention for household needs or naturalized ponds with water plants.

The soil receivers are commonly identified with the most controversial installations, so called "drainage systems", which are not authorized as adequate wastewater treatment plants.

First and foremost, there is no possibility of controlling and evaluating the final effects of their "purification".

Many, many years ago it was found that in underground drainage systems there are no natural conditions for effective wastewater treatment. Actually it is the discharge of untreated (raw) wastewater into the subsoil which has negative consequences.

6. BASIC CRITERIA FOR CHOOSING THE SYSTEM AND EQUIPMENT FOR INDIVIDUAL WASTEWATER TREATMENT

The selection of individual treatment systems should depend on:

- the quantity and quality of wastewater produced on the farm,
- the type of terrain, configuration and surface,
- the availability and characteristics of wastewater receiver including: hydrogeological conditions of the soil receives.

The choice of specific technological devices should take into account the following:

- Efficiency, quality and stability of wastewater treatment processes, with respect to existing regulations and local environmental requirements,
- the technical and functional level of the equipment, including the degree of difficulty of daily and periodic service and technical inspections,
- durability and reliability, including: access to professional service,
- construction and operating costs, including: energy consumption of devices used.

Additional guidelines for devices selection:

- The reluctance to change domestic wastewater (flow and load), typical in the countryside.
- Hermetical sealing, odorlessness, ease and safety of operation and maintenance.
- Additional sewage treatment options of biogenic residues, bacteria and metabolites of pharmaceuticals, in future.
- Possible chemical precipitation of phosphorus.
- The possibility of disinfection with UV rays should be provided because many types of dangerous bacteria and protozoa are resistant to traditional disinfection methods.

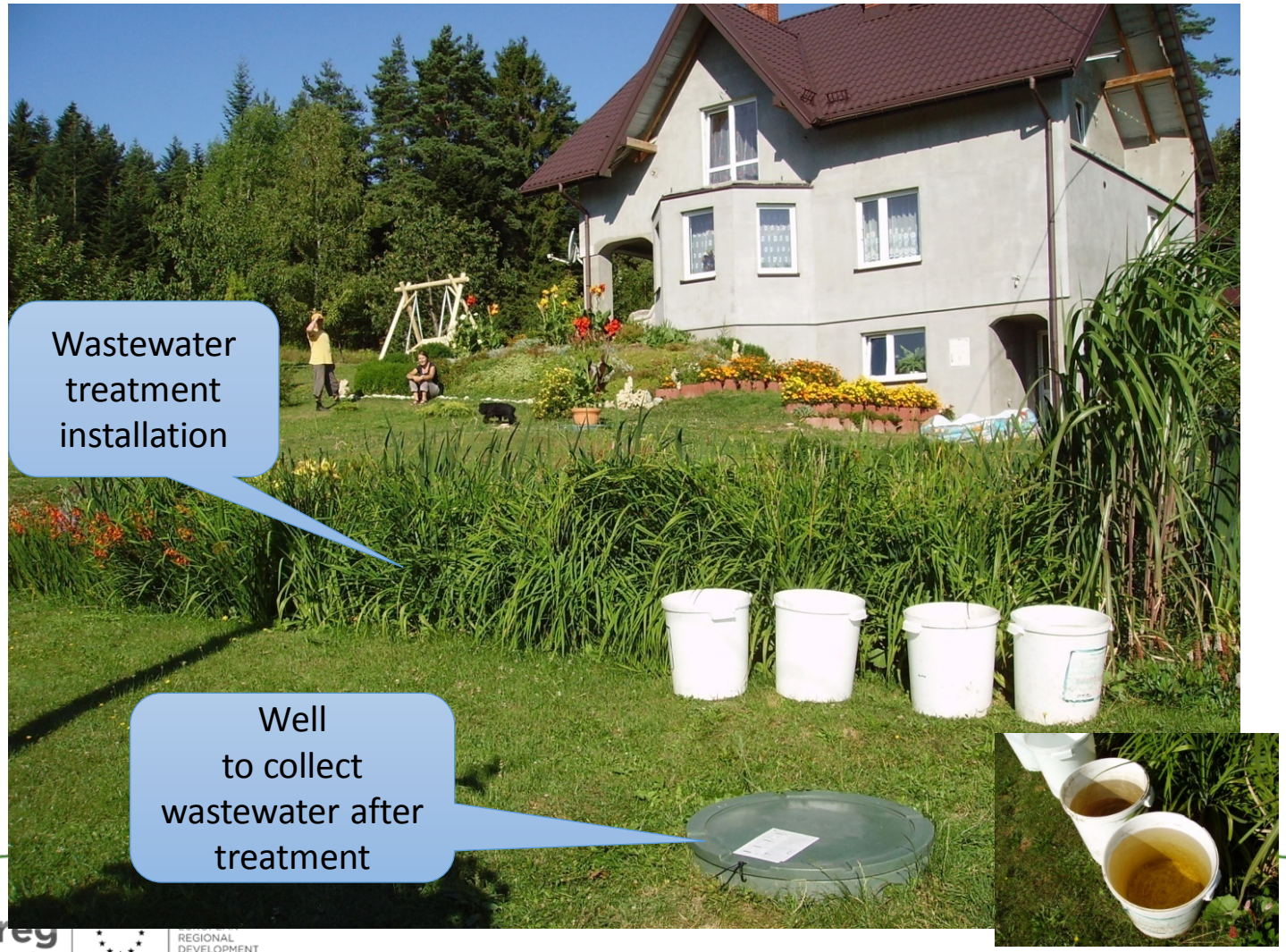
The need for final disinfection of treated wastewater before discharging into sensitive recipients.

Example of installation for final disinfection of wastewater in local treatment plant (SBR type) using UV radiation

Further recommendations:

- It is preferable to discharge the treated wastewater into a soil-plant environment receivers or to use it for non food purposes on the property. Direct discharge into rivers, ponds and lakes should be minimized.
- Wherever possible, wastewater treatment installations with filtration beds with soil and hydrophilic plants, constructed by the users themselves under the supervision, should have an equal place among the others.
- If it is not possible to use the sewerage services, the owner of the wastewater treatment plant should be responsible for the hygiene of sewage sludge on site, by composting it in a separated place in such a way that it is not burdensome for the surroundings and does not threaten the environment.

Utilization of treated wastewater for watering garden plants



7. RESEARCH POTENTIAL AND POSSIBILITIES OF ZSIT GCB IN TYLICZ

Individual wastewater treatment systems are built according to EU legislation, and each manufacturer is responsible for the safety of their operation.

A producer is ought to certify that his product meets the normative requirements in the group: PN-EN 12566.

Proof of conformity of the product to the above norms is the CE certificate which is issued by an Accredited Body upon receiving a test report from the notified laboratory.

Today ZSIT ITP-GCB in Tylicz is not a notified laboratory but it carries out complete testing of individual sewage treatment plants on a full technical scale which is installed directly in agricultural holdings or residential buildings in rural areas and tests them for normal house exploitation.

These tests verify the quality and reliability of these systems (claimed by their manufacturers) during multi-seasonal exploitation under particularly difficult conditions of rural wastewater management.

The results of these tests are a better basis for the safe selection the devices most suitable for the specific conditions of the future locations.

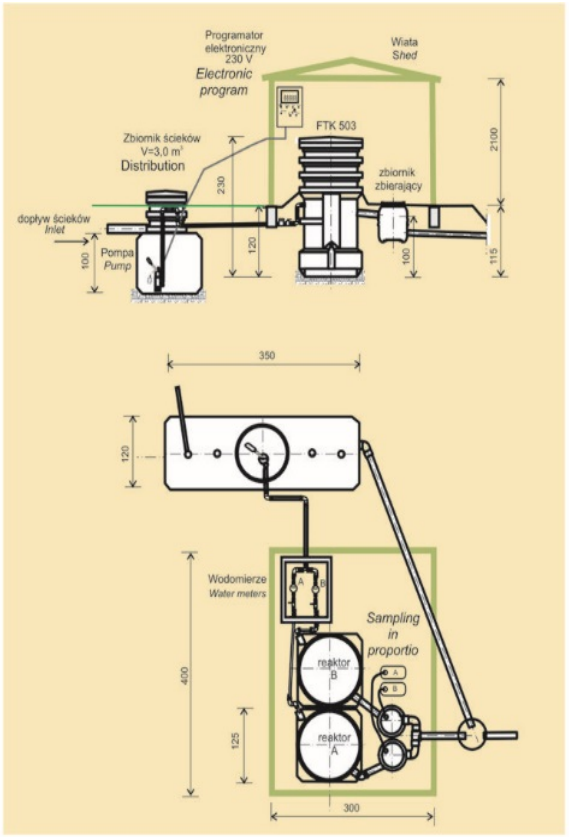
The ZSIT GCB in Tylicz is located in a unique, mountainous area, with a field laboratory enabling research on wastewater treatment processes in properly arranged technological lines:

- quasi technical objects with soil-plant and water-plant filtration beds,
- micro wastewater treatment plants,
- prefabricated devices for treatment of wastewater from septic tanks, and
- prefabricated devices for tertiary treatment of wastewater.

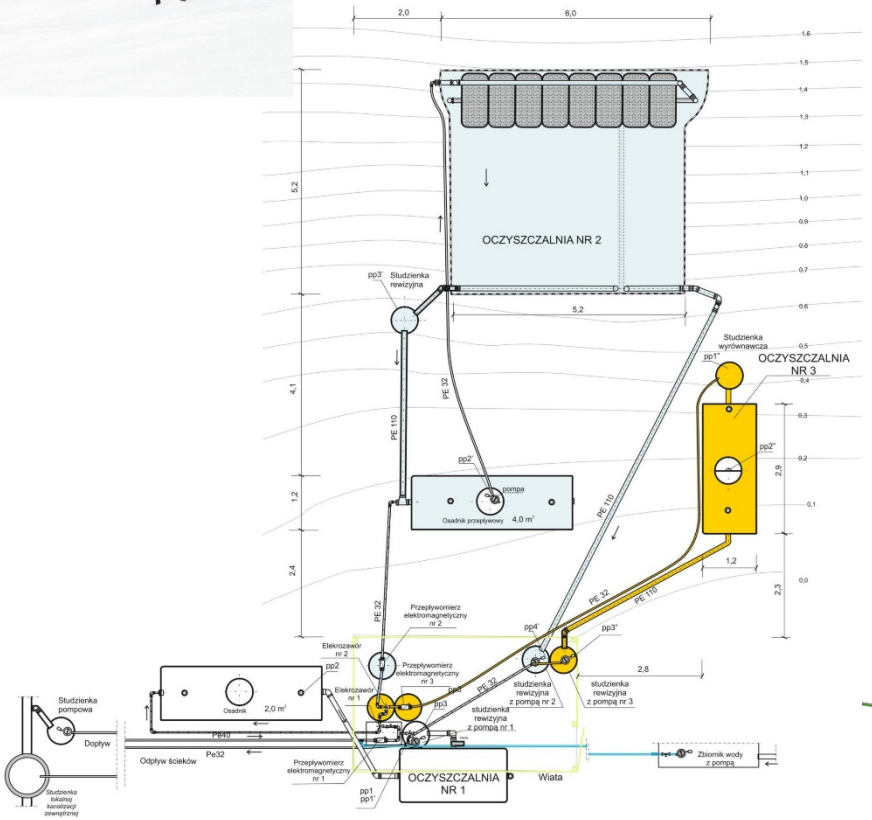
A field laboratory for testing of individual sewage treatment systems including the installations and facilities equipped with filtration beds (type of constructed wetlands)

Stand for testing the sorption capacity of mineral materials

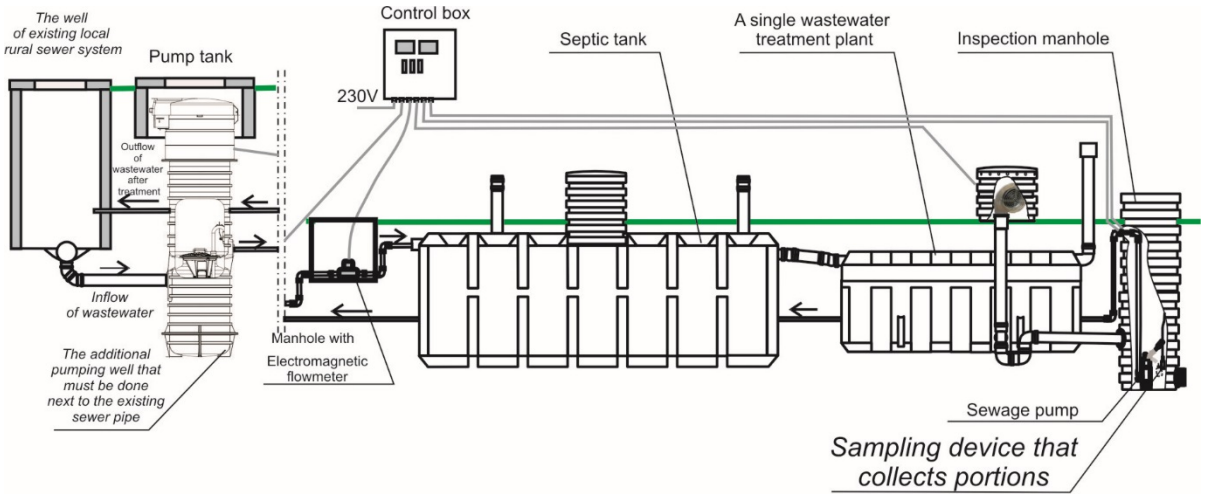
Stand for testing the equipment for tertiary treatment of wastewater



Stand for testing the treatment efficiency in small wastewater treatment plants, in accordance with EN 12566-3



Stand for testing small wastewater treatment plants for up to 50 PT according to EN 12566-3



8. WHAT THE ZSIT GCB IN TYLICZ DOES AND SOME TOPICS CARRIED OUT – POSSIBILITIES OF COOPERATION

ZSIT ITP-GCB in Tylicz is involved in the following types of research and development works.

1.The design of new solutions, systems and facilities for treatment and management of domestic waste water in situ (functional models, prototypes on a full technical-functional scale).

2.Research on the quality and reliability of devices used in individual sewage treatment systems, conducted on a laboratory scale as well as in a local conditions of wastewater management in rural areas.

3.Research on the impact of individual sewage treatment systems on the quality the local water resources, particularly water in rural wells.

4.Technical and functional laboratory tests on some components of the individual sewage treatment systems (reactors and equipment).

5.Research on the energy consumption in different variants of individual projects of sewage treatment systems.

6.Development of individual sanitation systems in specified areas and rural settlements with a choice of reliable equipment and wastewater treatment systems.

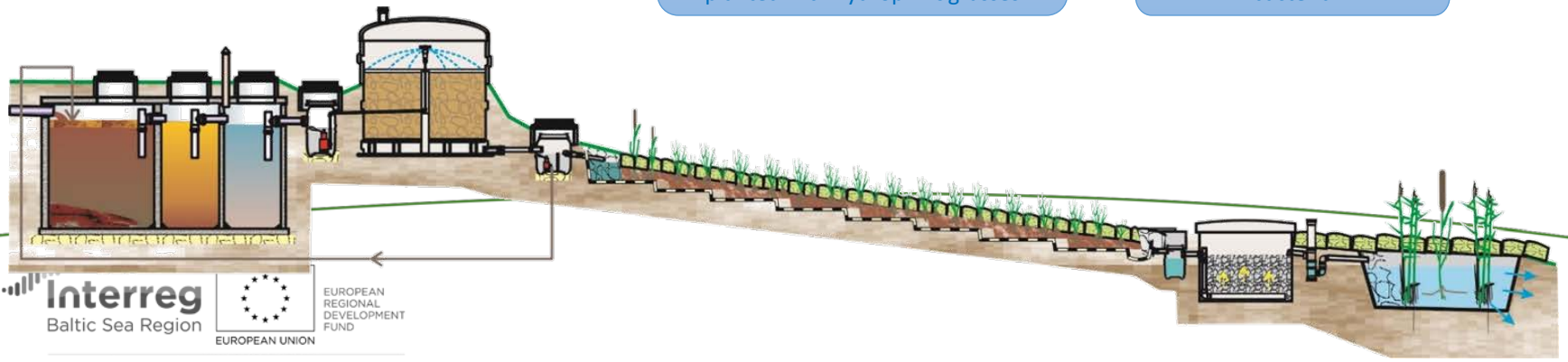
7.Installation of individual wastewater treatment plants requested by individual investors. Completing the documentation required during building procedure.

9. TECHNOLOGICAL SOLUTIONS OF THE INSTITUTE OF TECHNOLOGY AND LIFE SCIENCES IN TYLICZ

AN INDIVIUDAL WASTEWATER TREATMENT SYSTEM

DESIGNED BY ZSIT GCB TYLICZ

OPERATED ON AN AGROTOURISTIC FARM OOTSIDE KRYNICA-ZDRÓJ, POLAND



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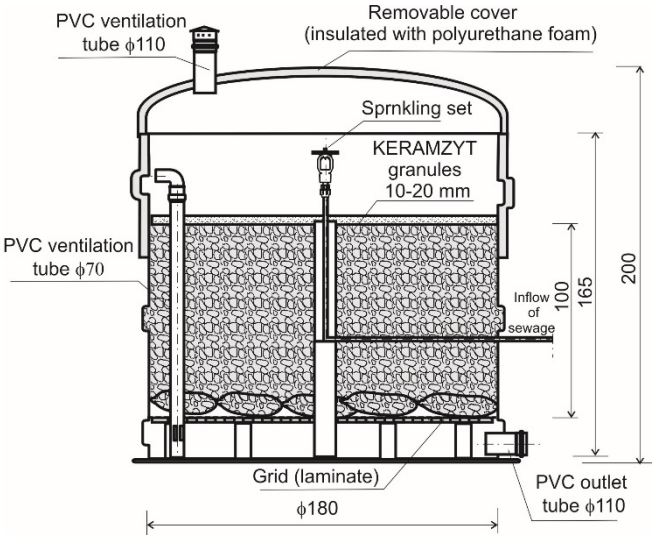
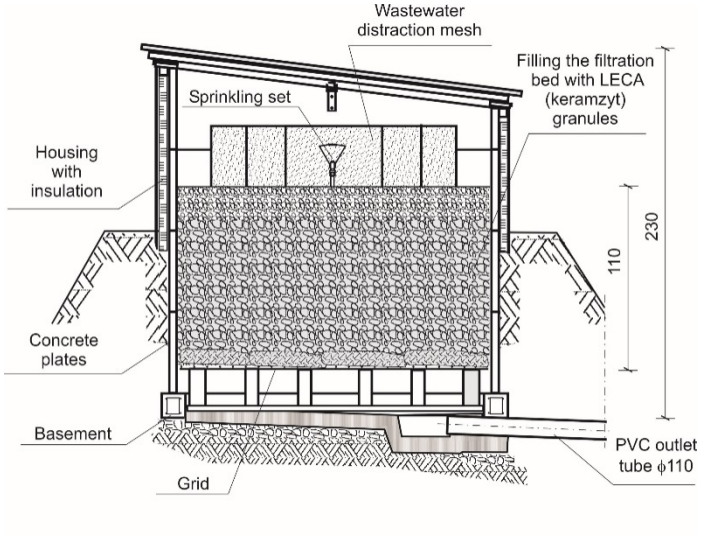
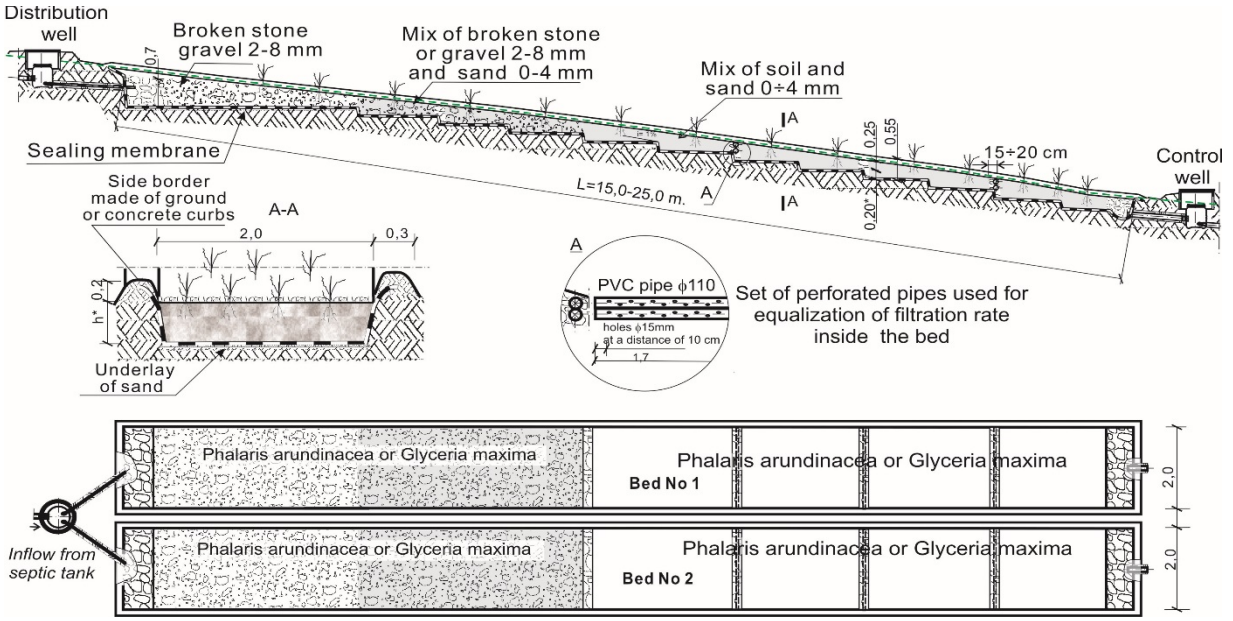
WASTEWATER TREATMENT EQUIPMENT WITH SPRINKLERS AND FILTRATION BEDS FILLED WITH PELLETS MADE OF CALCINATED CLAY MATERIAL DESIGNED FOR WASTEWATER MINERALIZATION AND NITRIFICATION



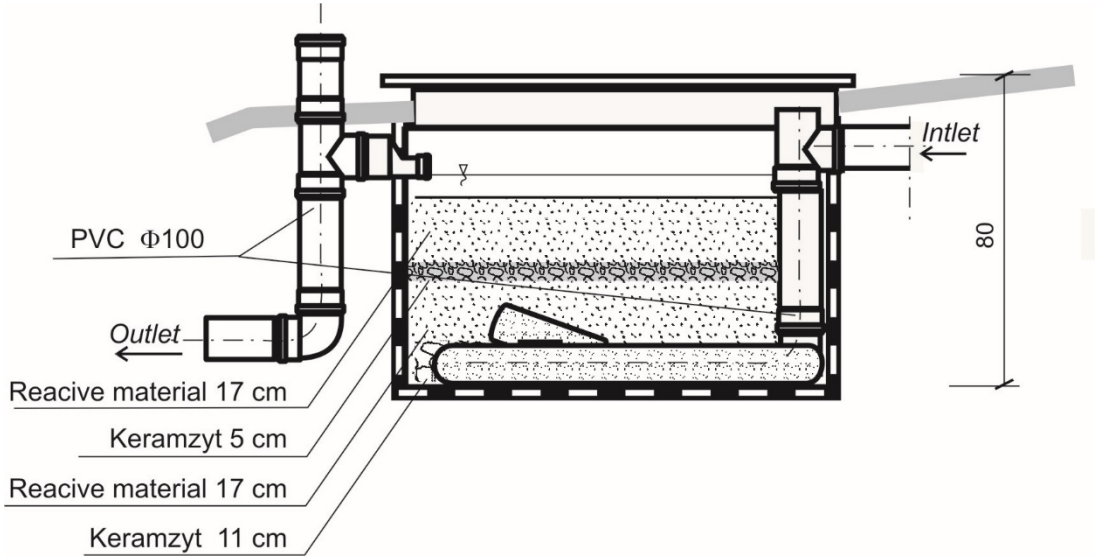


Another view of the biological beds with wastewater dosing by sprinkler
(according to innovative pattern PL 62839 Y1)

SPECIAL FILTRATION BEDS ON A SLOPE FILLED WITH A MIXTURE OF MINERAL SUBSTRATES WITH HYDROPHILOUS GRASSES



A FUNCTIONAL MODEL THE REACTOR FOR THE REMOVAL OF PHOSPHORUS AND FECAL BACTERIA WITH THE FILTER BED FILLED WITH GRANULAR ALKALINE MATERIALS



Some examples of water ditches and garden ponds

The ditch with duck weed (*Lemna*) and cattails (*Typha latifolia*) completes the final processes of wastewater treatment

The garden ponds with water plants – one way of micro-retention of treated effluents

Shallow ditch planted with *Typha latifolia* for final wastewater treatment

An example of garden ponds for reception and retention of treated wastewater on the farms

Another example of garden pond (micro-retention of treated effluents)

THANK YOU FOR YOUR ATTENTION

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