VillageWaters

Installation of technological systems for wastewater treatment

VillageWaters Project, Research about Wastewater Treatment Systems

Andrzej Eymontt*, Loreta Urtāne*, Virpi Vorne*, M. Gugała, C. Czarkowski, A. Jucherski, A. Walczowski, G. Skalniak, M. Peuraniemi, F. Silvenius, B. Lundström, K. Räsänen, V. Arvonen, A. Percovs, L. Cesoniene, M. Dapkiene, A. Radzevicius, D. Šileikienė, N. Dulova, K. Küngas

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FINDING THE BEST FITTING SOLUTIONS FOR WASTEWATER MANAGEMENT IN VILLAGES

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Institute of Technology and Life Sciences in Falenty (ITP), Poland, 2019

The following partner organizations have participated in data collection and editing of the report:

- Vytautas Magnus University Agricultural Academy, Lithuania
- Institute of Technology and Life Sciences in Falenty (ITP), Poland
- Sokoły Municipality, Poland
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- Environmental School of Finland (SYKLI), Finland
- Tallinn University of Technology (TTÜ), Estonia
- Kuusalu Soojus Ltd, Estonia
- University of Latvia (UL), Latvia

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Abstract

Part of the Village Waters project is building pilot wastewater treatment plants in participants countries using the experience gained during the testing of existing treatment plants. In each country are different rules of planning, design, building and exploitation wastewater treatment plants and varied needs of households and environmental conditions.

Pilot activity carried out in FINLAND in Länsi-Uusimaa region in Gennarby Raseborg were realized in one pilot village site consisting of 10 households and cottages closely surrounding the lake Gennarbyträsket. The inhabitants joined a project aiming to replace the old technology of on-site waste-water treatment in sedimentation tanks by joining the municipal sewer system. This solution was also applied at other small lake village with permanent residences nearby. The situation of the village at Lake Gennarbyträsket gave a possibility for getting information on the impact of the technology change on the water quality of the lake. Private inhabitants pay all the investments and equipment's by themselves.

The pilot village of LITHUANIA is Leitgiriai (175 inhabitants) in the district of Silute, near Leite River (tributary of the Nemunas). The present wastewater treatment plant of the village (build in 1991) does not provide adequate wastewater treatment. The wastewater treatment plant was not designed for nitrogen or phosphorus removal. Moreover, the plant stops working during the cold season because of the inability of the mechanical aerators to work in freezing circumstances. In order to ensure continuous and effective wastewater treatment in Letgiriai WWTP was modernized. The new technology is biological wastewater treatment (vertical flow labyrinth, VFL) with biological nitrogen and phosphorus removal. Benefits of this technology are high removal efficiency of nitrogen and phosphorus, low operation costs (low electric consumption), and low excess of sludge production.

The pilot areas in POLAND are Tylicz and Sokoły Municipality. Tylicz is located near Krynica Górska (southern Poland) and Sokoły in the Mazovian Voivoidship (northeast Poland). The pilot plant in Tylicz serves the educational path belonging to the polish project partner (ITP). The technology of the plant is a biological four-step treatment (1st sedimentation tank, 2nd – biological sand bed with aeration, 3rd – treatment of biogens with use of plants and denitrification ditch, 4-th – stabilization pond with water soluble plants and small animals).

The following pilot activities and objects are included in the pilot of Tylicz: 1) Educational and presentation trail of pilot system, all utilizing different innovative treatment technologies, such as various ways of using vegetation to remove biogens and stabilize the sewage, and 2) Small domestic wastewater treatment plant for agro touristic activity.

From primary schools in Bruszewo village, Sokoły Municipalty we designed pilot for a new wastewater treatment system for 50 pupils and 10 teachers, instead of the existing sedimentation tank with pumping to the slurry tanker and transportation to the central wastewater treatment station in Sokoły Village. The treatment plant in Sokoły consists of three stages: 1st step – treatment chamber, 2nd step –peat, soil, sand and calcined opoka layers that serves as filtration material and 3rd step – stabilization pond with plants and evapotranspiration balance. The soil layers and stabilization pond are separated from the soil by a plastic sheet. Building plant for school from one side decreases cost of sewage treatment, from the second improves aesthetic qualities and environmental conditions of surrounding area with ecological, economical and sanitary effects. Tendering process and supervision on the building process was run by Office of Sokoły Municipality. Output of treatment plant is less than 7.5 cu. m. per day.

The pilot village Ainaži of LATVIA is located in Northern part of Latvia on the Riga Gulf and close to the border with the Republic of Estonia. Area is located within neutral zone of North Vidzeme Biosphere Reserve. Old wastewater treatment solution was the individual collecting tanks which are emptied on regular bases and transported to the Ainaži WWTP. The new system connects all flats into one wastewater discharge system biological WWTP with activated sludge.

The Pilot Site Svētciems Village is located in Northern part of Latvia next to the Highway Riga–Tallinn. Approximately in 1 km distance from the Gulf of Riga. Area is located within North Vidzeme Biosphere Reserve. The old WWTP was designed for bigger capacity and concrete housing of WWTP was leaking, making secondary soil pollution. The new solution is biological WWTP with activated sludge. Since WWTP discharge is directed into Svētupe, which is salmonid water, additional phosphorous and total nitrogen treatment is advised.

Keywords: wastewater treatment, WWT technologies, village area, water pollution, investment, management, cooperation

This report titled as '*Installation of technological systems for wastewater treatment*' was published on 28th of February 2019 (the period 6 of the project) on project website. The report is part of the activity A3.2 called '*Building the technological system in the pilots'*. The aim of the A3.2 was to build up the pilots in the VillageWaters project and describe that on this report.

The main challenge of this VillageWaters -project ('Water emissions and their reduction in village communities – villages in Baltic Sea Region as pilots') is to find out the most sustainable technological wastewater treatment solutions to decrease wastewater emissions of sparsely populated areas locally but also into the Baltic Sea to the level set by the EU water legislation. The main objective is to support the needs of households to avoid unnecessary investments and operating costs when shifting to improved waste water treatment and thus encourage them to implement new treatment systems. The work is conducted in 13 activities under four work packages in this project by 13 partners from Estonia, Finland, Latvia, Lithuania and Poland. The project's schedule is 1st of March 2016 until 28th of February 2019, including 6 periods. The budget is about 3 million euros that is mainly funded by the Interreg Baltic Sea Region (BSR) Programme.

Interreg Baltic Sea Region
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND
VillageWaters

Abbreviations and Terms

BOD5 (or BOD7) –	mg O2 x dm-3 Biochemical oxygen demand at 5 or 7 days.
COD –	mg O2 x dm-3 Chemical oxygen demand.
End use –	condition in which a plant is normally installed.
KN	Kjeldahl Nitrogen – mg N x dm-3 Total nitrogen means the sum of total nitrogen measured by the Kjeldahl method (organic nitrogen N + NH #), nitrate nitrogen (NO #) and nitrite nitrogen (NO).
Laboratory –	body capable of testing a domestic wastewater treatment plant under controlled conditions.
LU	University of Latvia
MC	Municipal Council
MUC	Municipal Utility Company
NH4-N –	Ammonium nitrogen mg NH4 – N x dm-3.
Nominal designation –	expressed as an integer giving the maximum number of population equivalent appropriate to the plant.
P total –	Total phosphorus mg P x dm-3.
Packaged domestic wastewater treatment plant –	prefabricated factory-built wastewater treatment installation which accepts domestic wastewater and treats it to a declared quality.
Site assembled domestic wastewater treatment plant –	unit composed of prefabricated components assembled on one site by one manufacturer, which accepts domestic wastewater and treats it to a declared quality.
SS	Suspended solids – mg x dm-3 .
WWTP	Wastewater treatment plant
WWTS	Wastewater treatment system

A PILOT CASE OF BRUSZEWO VILLAGE IN SOKOŁY MUNICIPALITY

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1.1. Description of the project management

This part includes information of the process management groups, executing, project documentation, project monitoring and controlling:

Sokoły Municipality decided to change existing wastewater treatment system consisting of sedimentation tank and wheel transportation system of slurry to the collective wastewater treatment plant in Sokoły village as too expensive and troublesome. Basic school in Bruszewo Village contains about 50 pupils and 10 teachers and according to the law in Poland they can built pilot installation without special permission from regional technical offices. Municipality allocated proper amount of money; part from Village Waters project, part from their own investment money for building installation. In the Institute was prepared full project consulted with Municipality and volunteers from outside the project. Part of the documentation (background plans) prepared Municipality. Municipality organized tender process, supervision together with the Institute and control of the compliance of the building process with the documentation. Project implementation was successful despite of the initial objections from the regional, technical authorities regarding formal issues and compliance with national regulations. Small changes has been done in the materials chosen for project, what was been agreed with Institute.

1.2. Planning the investment

1.2.1. How contracting processes were organized and put to practice

Each of our programme countries has different contracting scheme for constructions or reconstruction of pilots depending on the local conditions and local law. We would like to collect the following data:

- *What contract do you need before running the investment and what is the legal basis for it?*

Project was prepared with accordance to polish standards PN-EN 12-566 1 to 7_2016 – 10 E, Water Law, Building Law and special environmental requirements when we can built and exploit small wastewater treatment stations for up to 5 cu.m. per day without special permission. Before starting design we checked, what the capacity of the treatment plant should be. According to the Water Law Act 2017 (Journal of Laws of 2017, item 1566, 2180, of 2018, item 650, 710.) the only limit of the procedure without a water permit is the so-called ordinary use of water up to 5 m3 / day, and an individual treatment plant can be used both by public utilities and small legal entities, agrotourism farms and owners, lessees and tenants of individual plots. Irrespective of the Water Law Act, in the Construction Law Act (Journal of Laws of 1994 No. 89 item 414 of the Act of 7 July 1994 Construction Law, Journal of Laws of 2017, item 1332, 1529, dated 2018 items 12, 317, 352, 650) in art. Article 29 (1) contains information that: Building permits do not require construction of: point 3) household sewage treatment plants with a capacity of up to 7.50 m3 per day (name: household sewage treatment plants is a colloquial name). After the municipality has determined the location of the planned treatment plants, the tender process should be started (if public funds are to be involved), in accordance with the public procurement procedure specified in the Act of 29 January 2004 on Public Procurement Law. Art.30.1. Sett. Public orders. The ordering party describes the subject of the order in one of the following ways, taking into account separate technical regulations:

- by specifying performance or functional requirements, including environmental requirements, provided that the parameters given are sufficiently precise to enable contractors to determine the subject of the contract and the contracting authority to award the contract;
- by reference in the order of preferences to:
  - a) Polish standards transferring European standards,
  - b) standards of other European Economic Area Member States transferring European standards.

- *As you know, 75% (Finland) or 85% (Estonia, Latvia, Lithuania, Poland) will be paid from project. Who is obliged to pay for the rest of the building activity?*

After tendering process and obtaining price for pilot building with accordance to the project, from Village Waters project was paid 75%, the rest Sokoły Municipality paid from their own budget. Tendering process was repeated three times because proposals exceeded the limit price sets in the tender process what was caused by fast growing of building materials and labor. Independently of the direct price for building we had to pay for external expert during process of clarifying formal issues related to the building permit with accordance to the existing law.

- *Parties of the contract. Who is responsible for what?*
- *What are the terms in the contracts?*

For the contract was responsible Sokoły Municipality. Institute was responsible for project and supervision. Tendering process was repeated three times. The tender for the treatment plant was won by Agricultural Cooperative in Sokoły with address 18-218 Sokoły, ul. Kolejowa 31 for the price of 34 931 PLN (7762 Euro). Time for realization by Agricultural Cooperative of investment was very short (from 25.10.2018 till 15.12.2018). They gave guaranty 24 months.

1.2.2. How the official processes were carried out.

- *How the official processes looks in your country (scheme of the legal path)?*

In Sokoły Municipality they need full documentation of pilot concerning plans, specifications and all necessary documents signed by authorized designer. Documentation was prepared by our Dpt. in institute. In case of building greater wastewater treatment plant than for 5 cu. m. per day project must be confirmed by local authorities involved in the approval of construction projects. In the case of Sokoły Municipality they need only present project to these authorities without confirmation according to the legal law in Poland. The application file must be complete, in accordance with the Act of 7 July 1994 Construction Law and the Act of April 26, 2001 on Environmental Protection Law.

- *What is your role in planning?*

The Village Water part of project in our Institute was concerning on choosing the technical solution in accordance with the existing law and standards in Poland and local conditions. We calculated total amount of sewage from school in Bruszewo and prepared full documentation of soil – plant installation for wastewater treatment what was recon ciliated with Sokoły Municipality. Important part of technology was separation sewage from sinking to the soil during all stages of the process and application of water soluble plants.

- *Who is responsible for designing total investment?*

In case of Bruszewo School Sokoły Municipality are responsible for the total investment excluding the design. Design was prepared by the Institute, dpt. of Sanitary Engineering and Rural Hygienization.

- *Do you need the tender procedure? If yes, please explain what kind of procedure.*

A tender procedure was used for choosing project contractor who prepared equipment (pumping stations and materials), machinery for installation and digging soil and for construction work. In Poland tender process must comply with Public Procurement Law. Tender process was repeated three times by Sokoły Municipality, what was caused by proposed prices planned by Municipality exceeding by participants of the bidding process. Each of tender processes lasted three weeks, which significantly delayed the implementation of the contract.

- *Is it necessary to obtain any assent for the building project from any institution?*

As described earlier, in case of building project of small wastewater treatment plants up to 5 cu. m. per day do not need special assent from any local authorities but institution preparing tender process must show project to ask if they have any objections.

- *Does your country require any tender or auction procedure for necessary construction materials?*

The “Act of Public Procurement” concerns the public procurements. Procedures depend on the quote of investment. In case of wastewater treatment plant for Bruszewo School tender process was prepared for complete investment. Sokoły Municipality did not need special auction for materials.

1.3. Execution of the project (building)

1.3.1. Technologies of the implemented systems

Description of the wastewater treatment plant in Bruszewo school, Sokoły Municipality

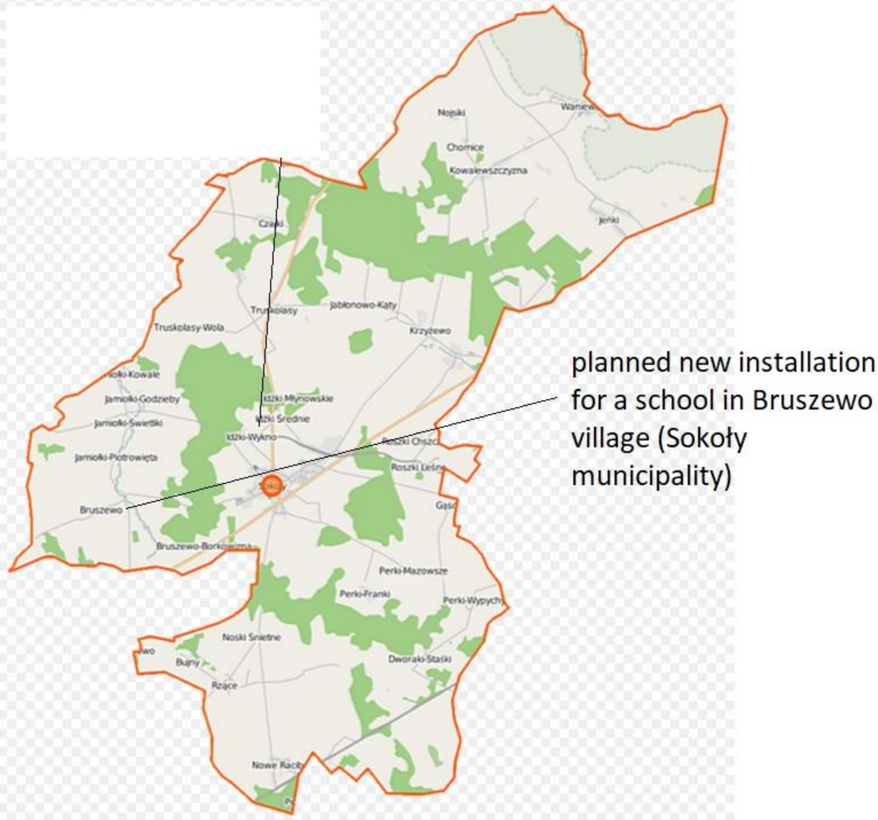


Figure 1. Location of the wastewater treatment plant in Bruszewo school, Sokoły Municipality

Basic design data:

- *Number of children – 46,*
- *Number of teachers – 10,*
- *Width of the place for building pilot plant – 20 m,*
- *Length of place from school to the road – 18,5 m,*
- *- daily standard of water consumption without a canteen for 1 child - 15 dm3 / d (table 3.2.2.4./3 - water supply and sewage - guidelines),*
- *- water consumption according to information received from the school - annual consumption - 120 m^3 / year, daily consumption - 330 dm^3 / d, which is about 6 dm^3 / d x person, which can be, among others, the result of the lack of part of students during lessons.*
- *For further calculations, the water consumption is assumed 10 dm^3 / d x person, hence the total consumption will be 560 dm^3 / d,*
- *Assuming a hydrophoic load with a vertical flow of 3 m^2 / 120 dm^3 / d, the total bed area should be about 5 m^2. With a bed width of 2 m, its length will be about 3 m. For safety reasons, a bed of 2 x 4 m is assumed.*

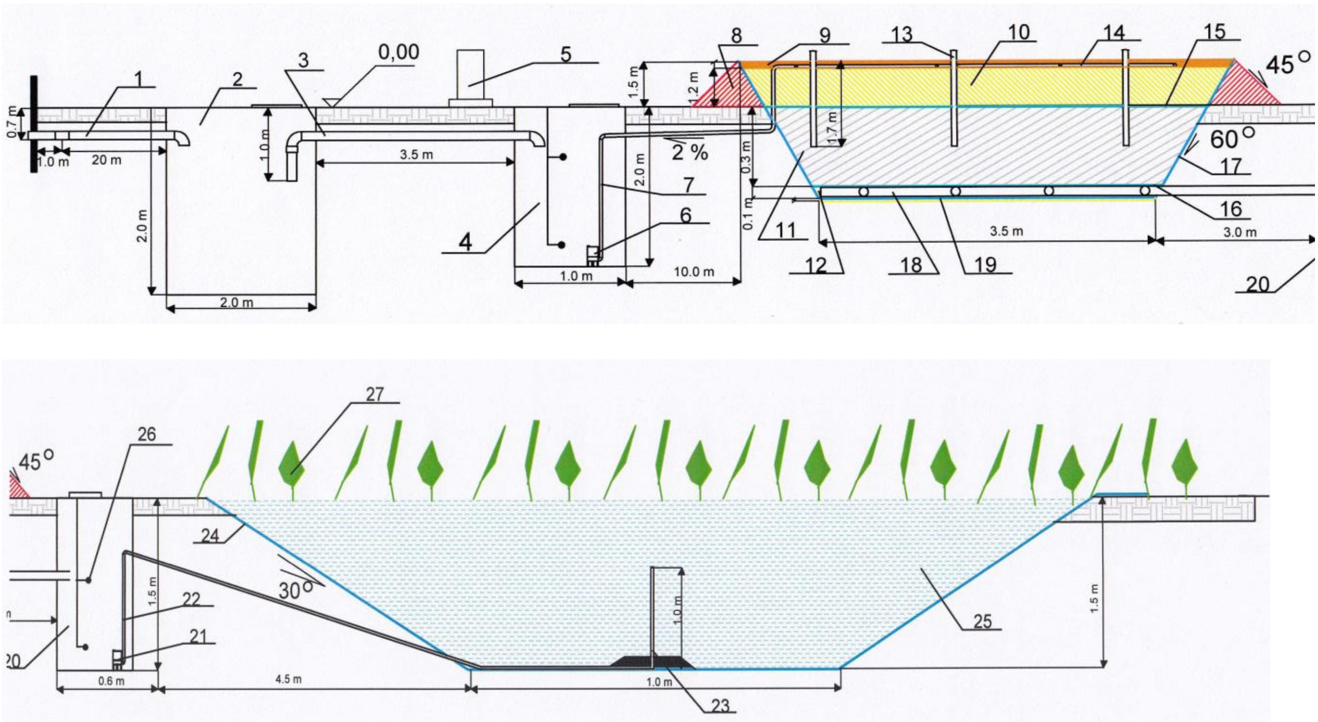


Figure 2. Scheme of the wastewater treatment plant for Bruszewo school in Sokoły Municipality.

Description of the pilot plant for the Bruszewo school.

Sewage disposal from school

Raw sewage flows from school by gravity pipe PVC ϕ 160 mm to the concrete sedimentation tank 2. From sedimentation tank 2 through PVC ϕ 160 mm pipe 3 pre-treated wastewater flows to the concrete tank 4. From tank 4 sewage are pumped by pump 6 equipped with disintegrator of solid parts by PEHD pipe ϕ 50 mm to the pipelines distributing sewage 14 laying on filter bed.

Construction of the filter bed

Bottom: rinsed sand with a thickness of 2 cm and grain size 0.5 - 2 mm (19), then a geomembrane (PEHD foil) with a thickness of 1 mm (17) laid on it, a layer of 100 cm thick gravel is poured onto the geomembrane (18), with a grain thickness of 4 - 16 mm. This gravel layer is covered with drainage pipelines (18) discharging filtered sewage to the final pumping station (20). On the layer of gravel there is a geotextile (16) separating the layer of gravel from the layer of calcareous rock (11) with the thickness of 30 cm and grain size 3 - 5 mm. The calcinated rock is pH = 12 and its task is to eliminate contaminants with pathogenic microorganisms and due to its chemical composition, the binding of physical and chemical impurities, such as nitrogen and phosphorus compounds. Above the layer of rock, separated by geotextile (15). there is a layer of sand and gravel sandbar with a thickness of 120 cm (10) and a grain diameter of 8 - 16 mm, which is designed to filter fine suspension and a partial physical-chemical impurity. The next, top layer is humus (9) with a thickness of 30 cm. Humus is made as a mixture of high peat (20%), mature compost (60%) and hardwood chips (20%). The upper layer is planted with macrophyte vegetation (manna mielec and rigid sedge). Plants growing on the humus layer and microorganisms contained in it constitute the first filtration layer. Under the layer of humus, a set of ϕ mm PVC pipelines (14) distributing sewage through the bed was placed. In the lower part of the geomembrane (17) a set of collecting drainage pipelines (18), Ø 75 mm connected to the drainage pipeline ϕ 75 mm HDPE with a slope to the final pump station (20).

Sewage disposal from filter bed

The sewage after passing through the filtration layer flows to the final pump station (20) from where it is pumped (21) and pipeline (22) to the stabilization tank (denitrification) (25) through the fountain nozzle (23). The stabilization tank is sealed with a foil (24), 1 mm thick, against leaks of treated sewage to the ground. In the winter period, during freezing temperatures there is a possibility of returning sewage to the final pumping station after manual overrunning of the three-way valve placed in this tank on the pipeline (22).

Power and control

Both pumps (6 and 21) are supplied from the school building via a control box next to the pumping station. The pumps are switched on and off in accordance with the liquid level set in the pump rooms by means of the floats placed in them (26). Regardless of the automatic pump control, there is a possibility of manual control.

Service and operation

The treatment plant works in an automatic cycle, after powering the pumps into electricity. However, it is necessary to periodically select sewage sludge from the first tank [settling tank (2)] every 6 months and take them to the collective sewage treatment plant for disposal. Supervision over the operation of the treatment plant can, after training, be performed by one person from the school service.

- *Who is the main investor?*

The main investor is the Sokoły Municipality using money from Village Waters project.

- *What is the tender procedure for project execution? Can you explain procedure in details with the choice criteria.*

Tender procedure organized Sokoły Muncipality. For starting they obtained from Institute (12) full documentation with necessary permissions. Documentation was available for inspection by the companies starting in tender. The main criteria were: the lowest price, experience in the implementation of similar facilities, the possession of appropriate equipment and qualified staff, as well as the due date. After opening proposals Municipality chose the most advantageous offer.

- *Give characteristic of the Company realizing the project after tender procedure.*

A small local company was in charge of the construction work dealing with the operation of existing treatment plants in the municipality region.

- *Beginning of the execution: signing agreement between investor and Company – explain all the terms of agreement from Investor and realizing Company sides, with scope of work.*

According to the agreement between Municipality and Company, the Company committed to transfer the complete facility.

- *What is the estimated costs distribution between earthworks, machinery and man-work in the building process?*

The estimated costs distribution between earthworks/man-work (installations) and machinery was 60/20/20.

- *What kind of materials, installations and devices will be used in the building process?*

The pilot plant includes gravity pipes, pressure pipes, pumps, valves, distribution pipes, collecting pipes, drainage pipes, electricity supply and control and filtration bed.. The electricity for the pumps is provided by the school.

- *Is there any investor supervision?*

The Sokoły Municipality employed the technical supervision service from a local expert. Also designer fulfilled the role of supervisor for compliance with the documentation.

- *If all changes in project by building company are agreed by designer of the investment? If yes, please explain changes in details (changes of materials, equipment, localization etc).*

There was no important need for changes in this project.

After completing the investment for technical and technological acceptance of the investment gathered the commission consisting of the representative of investor, supervisor, executor, designer and people from our project.

- *What criteria object should fulfill during start-up of objects?*

The first were minimum technological criteria according to the Maximum permissible values of pollution indicators or a minimal percentage of pollution reduction for domestic or municipal sewage introduced into waters or into the earth1) [Regulation of the Minister of the Environment of November 18, 2014] (for wastewater treatment plant up to 2000 persons:

  - *BOD5 in outlet sewage up to 40 mg $O_2/dm^{3,}$*
  - *COD in outlet sewage up to 150 mg O_2/dm^3,*
  - *SS (suspended solids) up to 50 mg/dm^3,*
  - *Total Ammonia up to 30 mg/dm^3,*
  - *Total Phosphorus up to 5 mg/dm^3.*

During the start-up of the treatment plant, the technological criteria can be lowered, for example: technological criteria for up to 50 %. All mechanical devices and electricity must work properly.

- *Explain how standards requirements are fulfilled?*

Strength and capacity criteria are tested in accordance with the standards PN-EN 12 566 (1 to 7). After completing pilot plant starts work for 24 hours and commission checks if all elements are function properly. Also, after the treatment plant has been refined independent, specialistic organization with certified laboratories takes probes of raw and treated sewage.

1.3.2. Problems encountered during the building and their solutions.

- *What changes and problems contains as-build project? Do changes inflow any problems on technology or constructions?*

Building process was carried out in accordance with the design plans and was completed in time. Planned by Sokoły Municipality cost was not exceeded.

Building cost calculated by the participants of the subsequent tenders in Sokoły Municipality exceeded amount allocated for building pilot plant in project, Bl 6. Each tender took the time, and in the third tender building cost has been accepted by Municipality in the late autumn. Building was completed in the end of December and we could not check parameters of the outflow sewage in low temperatures (denitrification pond was covered by ice).

- *From building process and mechanical parts please describe which elements are agreed with project design and which are not agreed.*

Each part was agreed upon from the beginning.

- *What was the most difficult problem?*

The unforeseen expenses as described earlier.

- *Who and how solved the problem?*

Sokoły Municipality decided to add necessary quote adequate to the proposed by the tender participant who offered lowest price.

1.4. Activities after the finalization of building process.

1.4.1. Overall conclusions on the building process.

- *What were the problems and other challenges in the project? What did you learn? What were done differently compared to the project plan?*

The greatest problem in the project was evidence in the local technical office, confirming all building projects that designed individual wastewater treatment plant for Bruszewo School does not need any confirmation, only submitting in office completed project. Technical details of project were discussed with employees from Sokoły Municipality during design process and as the end result building process was realized in accordance with the project.

- *What was properly or improperly designed and realized?*

The project management was successful, because of the organization all formal process by Municipality were handled properly. The construction work was finalized later than we expected because tender process was repeated three times. The project was completed, but exceeded planned budget and Municipality added necessary quote. The Pilot in Bruszewo school allowed for solving problem with transportation sewage by tanks to the central plant and is the good example for village citizens and their children how to build individual wastewater treatment stations with good technological results and nice view with water soluble plants.

- *Do these new structures meet habitants and your expectations? What was new comparing to the known technologies and constructions? Ownership of the installation?*

The new structures meet the inhabitants and the Village Waters Projects expectations. New technological and construction element was the layer of calcinated opoka in soil deposit protected against phosphorus and bacteria. Ownership of the installation is by the municipality.

1.4.2. Technological, economic, environmental, social and enviro-hygienic data acquired from the renovated wastewater treatment plants.

- *Current technological data acquired from the completed wastewater treatment plant.*

Description of the performance and functioning data of the constructed pilot wastewater treatment plant can't be completed at all because building process was finished in winter time and the treatment plant could not achieve the planned technological parameters. Results of purification efficiency were taken from similar plants in exploitation.

The BOD5, COD, total Ammonia and P reduction in pilot plant in Sokoły Municipality were as follow: reduction BOD_5 were 89,9%, COD – 65,5%, P total -27%, N total – 59%.

The electricity consumption was 0,346 kWh/m^3 with average annual amount of treated wastewater was 1820 m^3.

In the new built pilot improvement of the technological parameters are expected on the level of 30% comparing to the existing, measured parameters.

- *Current economic data acquired from the renovated wastewater treatment plant: What is the energy efficiency compared to the old system?*

In the new pilot we installed two pumps: one with power 1,5 kW, the second with the power 0,85 kW. Both pumps will consume 0,072 kWh/h and 630 kWh/year.

- *Current environmental data acquired from the renovated wastewater treatment plant: What are environmental benefits of the new system?*

Special calcinated opoka layer in soil filter allows for reduction phosphorus and pathogenic bacteria.

- *Current social data acquired from the renovated wastewater treatment plant: Are the expectations of the end-users met? What is their opinion? Did the inhabitants participate in the building process?*

Pilot plant has been built for school pupils. In building helped parents of their children in levelling soil layers, planting water soluble plants and laying stones on the rim of the denitrification pond.

According to the water sampling results have shown that during the treatment process the wastewater is treated efficiently and vary: biochemical oxygen consumption in 5 days (BOD5) 78 - 98%, total nitrogen (Nt) -1 - 93%, total phosphorus (Pt) -214 - 93 %. Soil pollution by all indicators is not high.

Acknowledgement

Thanks very warmly for all efforts of preparing and building new pilot plant for Bruszewo School for team from Sokoły Municipality. Special thanks are for Mr Cezary Czarkowski who was personally very strongly involved in preparing necessary documents, tendering process and supervision on building and in taking care of the water, sludge and soil sampling. Thank also very warmly for major of Sokoły Municipality dr Józef Zajkowski for taking care on the total process of preparation and realization of the Village Waters project and for cofinansing building process of the new pilot for Bruszewo School and their part of Village Waters project. The great thanks for inhabitants helping in the building process of the new pilot.

Appendices

Picture 1. School in Bruszewo with soil filter in building stage.

Picture 2. Soil filter with distribution and aeration pipelines before covering

Picture 3. Completed soil filter with vegetation

Picture 4. Pumping station

Picture 5. Denitrification pond

A PILOT CASE OF TYLICZ IN POLAND: THE POLIGONE CENTER FOR INDIVIDUAL SEWAGE TREATMENT CLEANING SYSTEMS

Authors: Andrzej Jucherski, Andrzej Walczowski, Grzegorz Skalniak

1.5. General information

Report from realization of object: Educational and presentation path of technological objects in individual wastewater treatment systems using filtration processes in quasi technical soil and plant installations.

The concept of the location of technological objects designed and made in the project is shown in the schematic diagram (Figure 3). Equipment and installations included in the technological path of the educational and presentation path were made according to detailed drawings, pictorial sketches as well as material specifications and lists of technical equipment elements of individual components of the devices. The basis for the program concept of the project was to create a closed (out-of-flow) system of quasi technical and technological facilities, made and operating in full technical and operational scale, configured in the process of the full range of wastewater treatment in individual systems operating in dispersed rural areas.

The constructed complex of devices and buildings is to fulfill three basic functions:

- *presentation, by indicating the basic principles and devices for wastewater treatment in devices used at home in rural areas,*
- *implementation, by showing ready solutions and the effects of their work and the possibility of their application in rural practice,*
- *training and instructional, through use in the form of ready props during the anticipated and indispensable educational activity related to village sanitation, addressed to a wide range of people from rural communities, where the level of general ecological awareness, as well as basic knowledge about environmental protection is still insufficient . Environmental education is the key to the success of any individual sanitation programs in the village.*

1.6. Planning the investment

1.6.1. How contracting processes were organized and put to practice

- *What contract do you need before running the investment and what is the legal basis for it?*

The team consisting of: Andrzej Jucherski, Andrzej Walczowski and Grzegorz Skalniak are the authors of the general concept of the project as well as detailed technological and technical solutions. The program was implemented using the procedures in force at the Institute regarding executive orders for people and purchases. For obvious functional and logistic reasons (costs), the local market and its cheapest representatives were taken into account when selecting participants of tenders and purchases.

1. The tender offer "Device of technological objects of the Field Presentation and Training Center at the Institute of Technology and Life Sciences in Tylicz" was carried out by the

selected local company "Transport services, Earthworks" by Bartłomiej Gierszewski from Powroźnik village

2. Demand for offers for construction and installation materials was carried out in the company "PPUH Witecki Jerzy and Kawula Marek spółka jawna" from Powroźnik village.
3. Wooden dresser for making wooden enclosures and fences was ordered at the local Forest Experimental Station.

- *As you know, 75% (Finland) or 85% (Estonia, Latvia, Lithuania, Poland) will be paid from project. Who is obliged to pay for the rest of the building activity?*

For the rest of activity (15% of the total quote) pays Ministry of Science and Higher Education.

- *Parties of the contract. Who is responsible for what? What are the terms in the contracts?*

Field Presentation and Training Center in Tylicz is the part of the Institute of Technology and Life Sciences in Falenty. Institute is responsible for the financing from Village Waters project (BL6) as nonprofit educational investment for habitants and municipalities from mountains region.

Educational path has been built in accordance with the design assumptions of the Village Waters project. All manual works were realized by employees from Tylicz Station, helping them neighbor's and other habitants from Tylicz Village. Works needed mechanical equipment, also delivery and shopping were realized with accordance to the Public Procurement Law and agreed assumptions of Village Waters project.

1.6.2. How the official processes were carried out.

In every country the official processes are carried out in different way. It depends on local conditions and local law, so:

- *How the official processes looks in your country (scheme of the legal path)?*

In Poland official tender process depends on the amount needed for realization, according to the Public Procurement Law. Tender processes in Tylicz Station were realized only for mechanical works and deliveries necessary for building educational path. For each work and delivery from outside the Institute were proceeded tender processes adequate to the amounts planned and included in individual contracts. For each contract was prepared inquiry with selection of the best offer. All the documents were properly prepared and signed.

- *What is your role in planning?*

Team from Tylicz Station before building prepared all necessary documentation with drawings, technological calculations, materials and equipment with necessary calculation of the amount included allocated in the Village Waters project (BL6) for construction. Educational path was constructed in accordance to the earlier prepared documentation.

- *Do you need the tender procedure? If yes, please explain what kind of procedure.*

Tender procedure was necessary for fulfilling requirements of Public Procurement Law. In the process of preparation of investment was necessary only simple tender procedure for small quotes. For each material, equipment, transportation and earthworks was prepared separate tender with inquiry and selection the best offer. After ending work or supply each contractor issued an invoice for Institute.

- *Is it necessary to obtain any assent for the building project from any institution?*

In case of building educational path Tylicz Station did not need any assent for project. Project was prepared as innovative and was realized on the own area of the Institute.

- *Does your country require any tender or auction procedure for necessary construction materials?*

The "Act of Public Procurement" concerns the public procurements. Procedures depend on the quote of investment. In case of educational path are only necessary simple tender procedures for small quotes for construction materials.

1.7. Execution of the project (building)

1.7.1. Technologies of the implemented systems

- *Description of the biological wastewater treatment installation in Tylicz Station*

1. Short description

Wastewater treatment installation in Tylicz Station was designed for mountain conditions and is localized on slope. Installation was intended for treatment sewage from individual houses, up to the 50 persons. Consists of the several treatment parts are visible on the pictures and photos. It is especially designed for mountains habitants living in separate houses without possibility connection to the piping system. Each part (station) of the installation is described on the special tables for better recognition by local population, which wants to build wastewater treatment stations for their own farm. Installation is designed with utilization water soluble plants.

2. Technology description

Installation consists of the 7 elements fulfilling different roles in the treatment system (Figure 3).

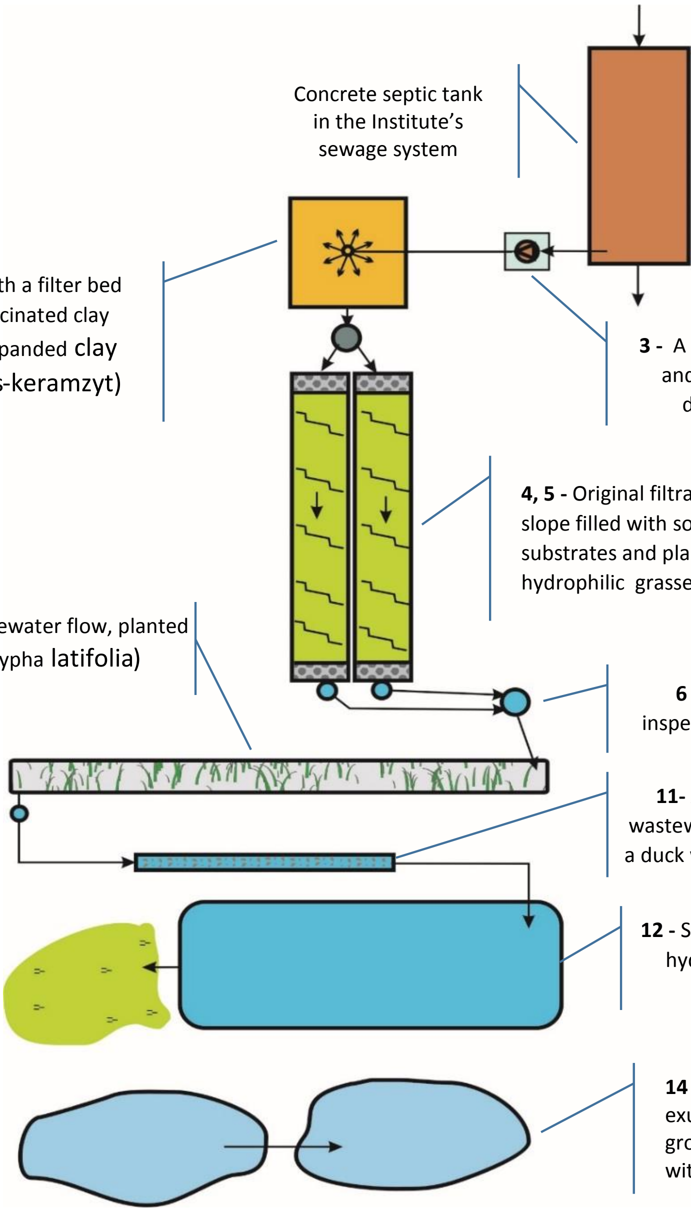


Figure 3. Layout of technological facilites in the ITP. ZSITW – GCB Tylicz project.

- *Who is the main investor?*

The main investor is Institute of Technology and Life Sciences investing money from Village Waters project (BL6).

- *What is the tender procedure for project execution? Can you explain procedure in details with the choice criteria.*

Investment were not realized in tender procedure. Only parts as soil excavation and levelling, materials and equipment delivering subjected to bidding or auctioning processes in small scale with the lowest price as choice criteria. As example were supply of wooden logs, pumps, tanks and other elements of the designed educational path.

- *Give characteristic of the Company realizing the project after tender procedure.*

There were not any one Company. Supplies and services were realized by small local companies and shops.

- *Beginning of the execution: signing agreement between investor and Company – explain all the terms of agreement from Investor and realizing Company sides, with scope of work.*

There were not any signing. Investment was realized directly by employees of the Tylicz Station.

- *What is the estimated costs distribution between earthworks, machinery and man-work in the building process?*

Estimated cost distribution I building process between earthworks, machinery and man-work was as 35/15/50.

- *What kind of materials, installations and devices will be used in the building process?*

Detailed description of the materials and devices is described in details in acknowledgement.

- *Is there any investor supervision?*

Educational path was physically realized by employees of the Tylicz Station, who designed all elements of path and they did not need any special supervision.

- *If all changes in project by building company are agreed by designer of the investment? If yes, please explain changes in details (changes of materials, equipment, localization etc).*

Answer for this questions is in the previous sentence.

- *What criteria object should fulfil during start-up of objects?*

Educational path has been built for education of habitants, municipalities and local organizations how to obtain proper technological and ecological results building individual wastewater treatment plants in mountain and other declined areas. This solution has a special reference to regions with requirements for higher technological parameters for treated slurries.

The first were minimum technological criteria according to the Maximum permissible values of pollution indicators or a minimal percentage of pollution reduction for domestic or municipal sewage introduced into waters or into the earth1) [Regulation of the Minister of the Environment of November 18, 2014] (for wastewater treatment plant up to 2000 persons:

- *BOD5 in outlet sewage up to 40 mg $O_2/dm^{3,}$*
- *COD in outlet sewage up to 150 mg O_2/dm^3,*
- *SS (suspended solids) up to 50 mg/dm^3,*
- *Total Ammonia up to 30 mg/dm^3,*
- *Total Phosphorus up to 5 mg/dm^3.*

During the start-up of the treatment plant, the technological criteria can be lowered, for example: technological criteria for up to 50 %.

Strength and capacity criteria are tested in accordance with the standards PN-EN 12 566 (1 to 7). All mechanical devices and electricity must work properly.

- *Explain how standards requirements are fulfilled?*

Strength and capacity criteria are tested in accordance with the standards PN-EN 12 566 (1 to 7).

1.7.2. Problems encountered during the building and their solutions.

- *What changes and problems contains as-build project? Do changes inflow any problems on technology or constructions?*

During construction educational path employees of Tylicz Station did not have any special technical and technological problems. One, important problem was formal with payment for materials, equipment and excavation because accounting department of our institute is in Falenty near Warsaw and all papers were sent from Tylicz to Falenty for signing and paying.

- *From building process and mechanical parts please describe which elements are agreed with project design and which are not agreed.*

Each part was agreed upon from the beginning.

- *What was the most difficult problem?*

The most difficult problem was how to complete investment on time, without exceeding assumed costs.

- *Who and how solved the problem?*

Problems with completing investment on time without exceeding costs the Tylicz team solved doing all manual works by themselves with help of neighbors. The base of all tenders and auction was the lowest price.

1.8. Activities after the finalization of building process

1.8.1. Overall conclusions on the building process

- *What were the problems and other challenges in the project? What did you learn? What were done differently compared to the project plan?*

Designers of the educational path expected, that part of the old path can be rebuilt, but they had to build construction with new elements. They spent on building more time as they expected working hard. As the result, new educational path have separate stations, each with short description for better understanding for viewers how to solve in the best way problems with wastewater treatment in individual households.

- *What was properly or improperly designed and realized?*

All construction was designed and realized properly and can be used as visit card how to build individual wastewater plants in the mountains regions.

- *Do these new structures meet habitants and your expectations? What was new comparing to the known technologies and constructions? Ownership of the installation?*

Technology and construction of educational path is based on sewage treatment with help of plants, grass and soil, and with sewage slowly leaking down the slope up to the stabilization pond. This type of construction takes more place as typical tank with aeration and denitrification zones, but is more effective and can be part of gardening with water soluble plants. However, construction as educational path needs more care by habitants than aerated, underground tank. Summing up, this is construction proper for agro touristic households teaching guests how to treat wastewater in a people- friendly way. Ownership of the installation is by the municipality.

1.8.2. Technological, economic, environmental, social and enviro-hygienic data acquired from the renovated wastewater treatment plants.

As already mentioned, the essence of the project was the planned specialized implementation activities, carried out by competent group of the Institute's employees for the benefit of the entire rural community, but without its participation.

This is not an example of one specific sewage treatment plant, but a systematized set of appropriate functional models of devices that can be used in different ways by individual investors, according to their needs, capabilities and local requirements of environmental protection.

The intention of the project was to present the technological possibilities of domestic wastewater treatment by quasi technical solutions designed especially to use on rural low populated areas but working with the treatment efficiency that is compared to the possibilities of the wastewater treatment facilities applied in agglomerations.

Current technological data acquired from the completed wastewater treatment plant.

Description of the performance and functioning data of the constructed pilot wastewater treatment plant can’t be completed at all because building process was finished in winter time and the treatment plant could not achieve the planned technological parameters. Results of purification efficiency were taken from similar plants in exploitation.

Average, many-year quantities of pollutants assessed in in treated wastewater: - BOD_5 -2,5 mg O_2 / dm^3; COD - 25.0 mg O_2 / dm^3; N_{total} - 19.5 mg / dm^3; P-PO_4 - 1.5 mg / dm^3 and a total suspension of 6.5 mg / dm^3 were lower than required by Polish regulations.

Technological reliability of the installation, evaluated in the same components of the Weibull impurities: BOD_5 and COD - 100%; N_{total} - 76.8%; P-PO_4 - 98.2%; total suspension - 99.5%, was very high, compared to other household sewage treatment devices, which makes the rated solution unique to the effective protection of local water resources.

- *Current economic data acquired from the renovated wastewater treatment plant: What is the energy efficiency compared to the old system?*

Renovated wastewater treatment system is based on the gravitational downslope flow of sewage, and in 50% of solutions doesn't need any pump or special aeration. We can assume, that in this system energy consumption is zero. In case of the rest of these systems we need small pump for pumping from septic tank to the filter bed with sprinkling system. In this case energy consumption is 0,275 kWh/m^3 and 41,25 kWh/Year

- *Current environmental data acquired from the renovated wastewater treatment plant: What are environmental benefits of the new system?*

The main environmental benefit from building wastewater treatment plant in accordance to the technological and construction solution of Educational path is very high level of effectiveness with the nice view of the system.

- *Current social data acquired from the renovated wastewater treatment plant: Are the expectations of the end-users met? What is their opinion? Did the inhabitants participate in the building process?*

In the mountains region many households who run agritourist farms or rent rooms directly in summer and winter. For them is very important, that wastewater treatment system can accept a variable amount of sewage supply of wastewater. In addition, proposed pilot system looks nice with hydrophilic plants, small stabilization pond, trench and pond with possible fishes.

- *Current enviro-hygienic data acquired from the renovated wastewater treatment plant: Comparing and discussing the differences between the analysis results of the old and new system (table).*

The installation is supplied with wastewater coming from the Institute's buildings (sewage inflow: Q = 4.0 m^3 / day) through the existing sewage system. The sewer system is equipped with a settling tank of volume V = ca. 80 m^3 with a 20-day wastewater retention time. In addition, this wastewater is periodically diluted by the water from the Institute's buildings drainage system.

The physico-chemical characteristics of wastewater according to average long-term (18-year) data is as follows:

- *pH: from 7.28 to 7.33,*
- *Redox: from -192 to -228 mV,*
- *Temperature: from 5.2 to 11.8 centigrade,*
- *Dissolved oxygen content: from 0.7 to 1.5 mg / l,*
- *BOD_5: from 95 to 150 mgO2 / l,*
- *COD: from 145 to 196 mgO2 / l,*
- *$N\text{-}NH_4$: od 43 do 45 mg/l,*
- *N_{tot}: od 48 do 59 mg/l,*
- *$P\text{-}PO_4$: od 5,6 do 6,0 mg/l,*
- *Total suspended solids: od 36 do 51 mg/l.*

According to the water sampler results the wastewater is treated efficiently and vary during the treatment process: suspended materials 83–100%, biochemical oxygen consumption in 5 days (BOD_5) 95 -100%, total nitrogen (N_t) 37 - 98%, total phosphorus (P_t) 48- 84 %. Contamination of groundwater is higher in Krynica-Zdrój wastewater treatment plant than Sokoły wastewater treatment plant regarding Fecal enterococcus and Coliformic bacteria but lower re-garding E. coli-bacteria. The groundwater in this place is also not suitable for human consumption due to microbiological contamination. Soil pollution by all indicators is not high.

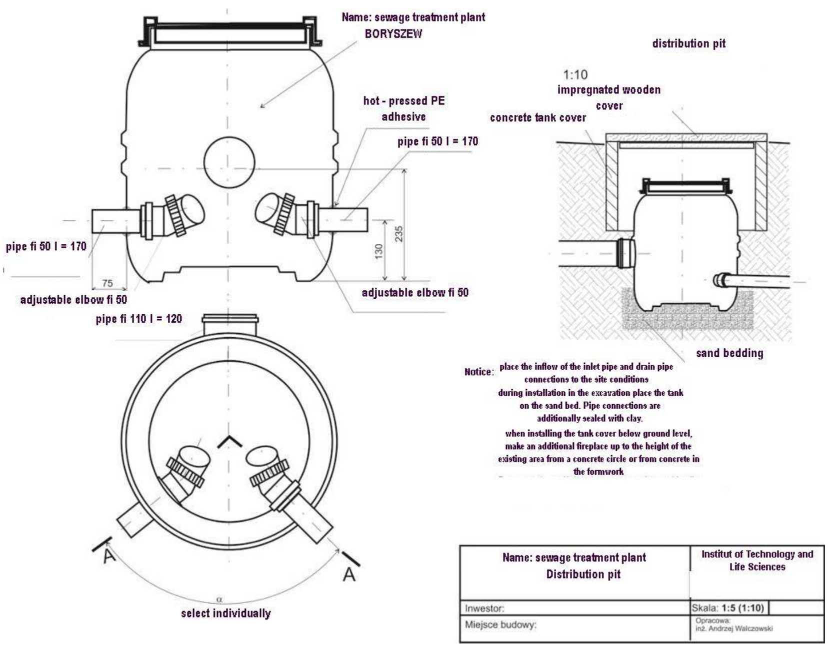
Acknowledgement

Thanks very warmly for all efforts of preparing and rebuilding educational path for team from Tylicz Station. Special thanks are for prof. Andrzej Jucherski, Andrzej Walczowski, Grzegorz Skalniak and the rest of participants who was personally very strongly involved in preparing necessary documents, tendering processes, building and in taking care of the water, sludge and soil sampling. Thank also very warmly for the team in Falenty for taking financial care on the total process of preparation and realization of the rebuilding process of educational path in Village Waters project. The great thanks for inhabitants helping in the building process of the new pilot.

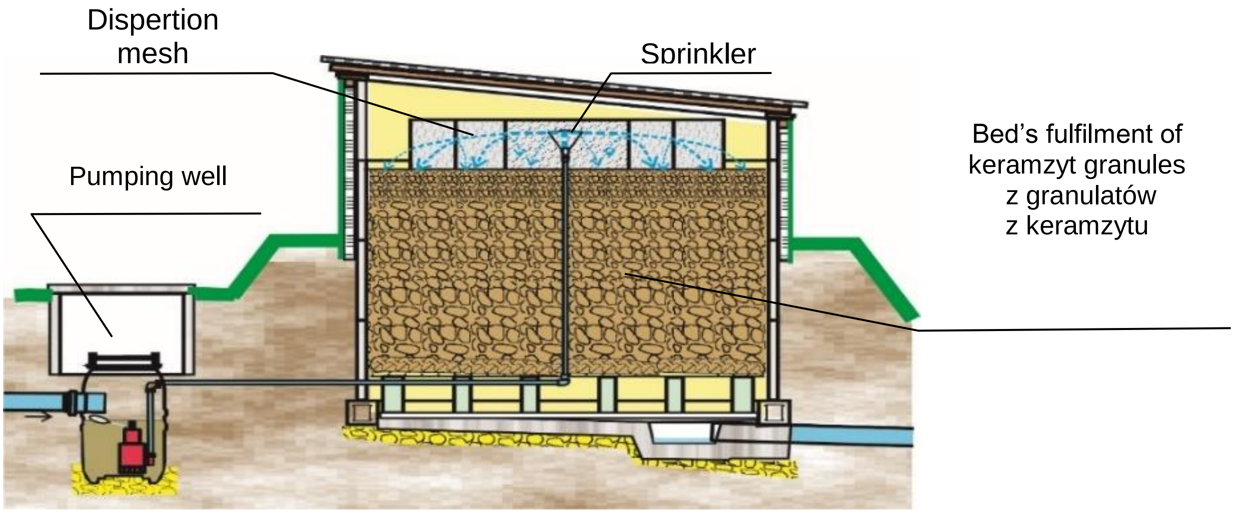
Appendices

List of works carried out in the project and elements of educational path

Picture 6. Container with a distribution well and a pumping system for supply of all objects with wastewater. a. making roofing cover of sheet, b. making of facing on outside walls with use of impregnated wood, c. replacement of inside insulation (by use of keramzyt).



Picture 7. A control and distribution well.

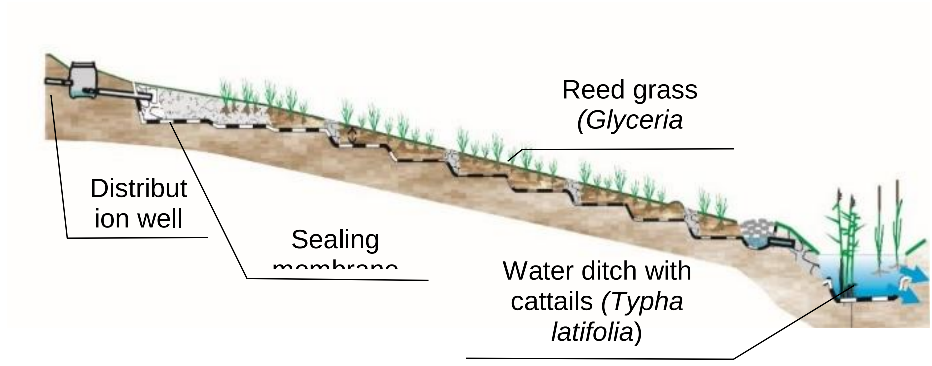


Picture 8. Quasi technical reactor with a sprinkled filter bed.

a. design and construction of a new roofing cover in form of a removable frame with a polycarbonate transparent sheets,
b. replacement of the upper filtration layer of granules from expanded clay (30 cm),
c. modernization of the sprinkler for increasing the coverage of bed surface with sewage
d. equipping the lateral inner walls of the bed housing with a layer of synthetic grass in order to weak the wastewater stream and increase their area of interception and time of retention.

A well for control and wastewater distribution to appropriate places.
a. making and replacement of wooden frame by use of impregnated wood logs and stones.

Original filtration beds formed on a slope in form of filtration strips filled with selected compositions of a sand and fine gravel creating filtration media, covered with hydrophilic grasses (Fig. 3).



Picture 9. Filtration bed on a slope:

Reconstruction of one of two filtration beds on a slope
a. manual earthworks, removing an old soil and plant layer,
b. profiling the shape of the bed bottom,
c. purchase and delivery of 15 m^3 of gravel with a grain size of 4-12 mm and sand with a grain size of 1-2 mm,

d. purchase, delivery and arrangement on the bed bottom of two sealing layers of building foil, ca.1 mm thick.
e. purchase, delivery and arrangement of fabricated curb elements of the 50 meter long in order to bordering the sides of the filtration bed.
f. purchase and making of 2-meter sections of PVC pipes ø160 (8 pieces) and their perforation to create openwork baffles arranged perpendicular to the direction of filtration in designated places along the length of the bed, to equalize of sewage flow inside the bed (alternatively: purchase of a stone and ready-made mesh elements and the making of gabions that meet these requirements).
g. purchase and deliver of concrete elements, manual earthworks related to reinforcing and stabilization of escarpments with use of ready-made "jumbo -type" perforated concrete plates,
h. mechanical and manual works related to backfilling the filter mixture of the bed ,
i. preparation of water manna seedlings and planting in the spacing of 20 x 20 cm ,
j. making of two roofing covers with use of wood and steel sheet elements to cover the concrete housings on the inlet of wastewater into the filtration strips

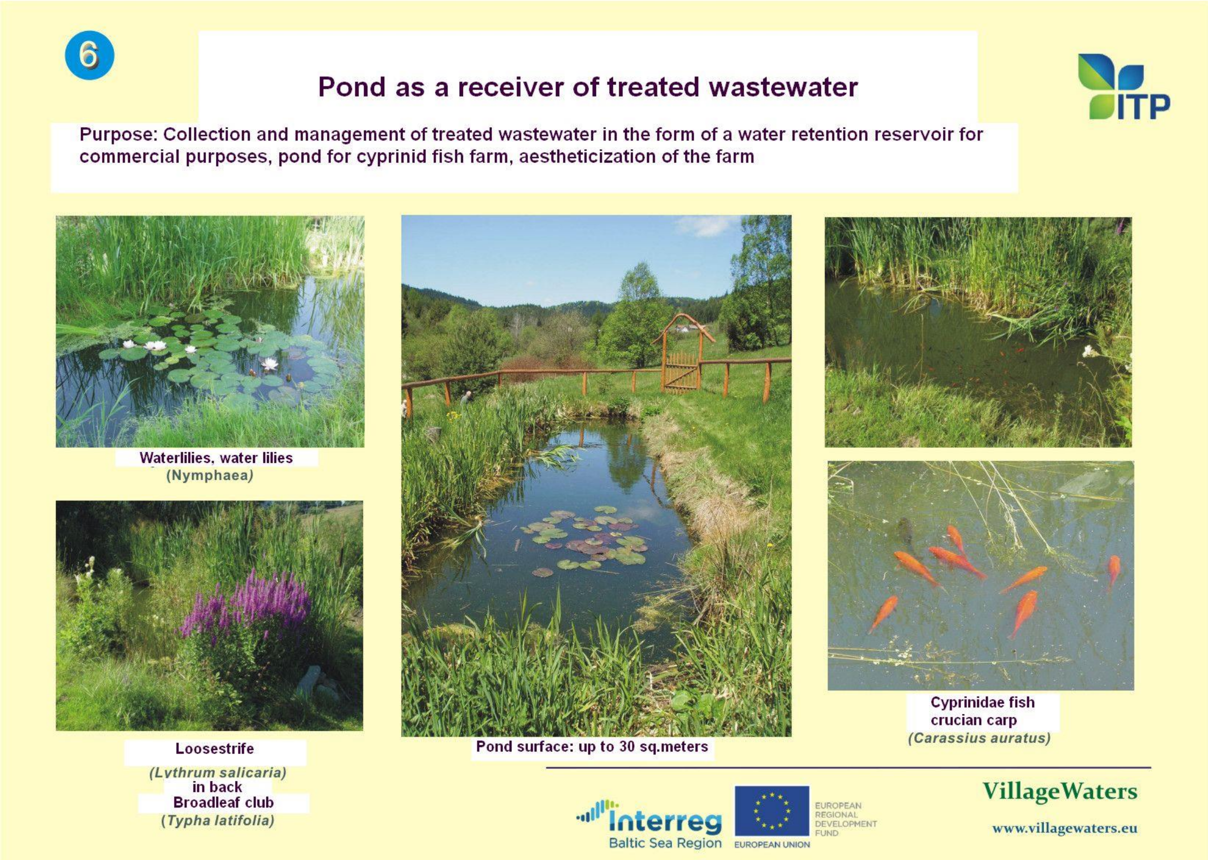
Wells for inspection and sampling.
a. purchase of 4 ready-made PVC containers and pipes and fittings (made of PVC) and their workshop adaptation and installation in the bed on a slope.

Ditch with wastewater flow
a. purchase of pipe sections (50 mm, 80 mm and 100 mm diameter) with fittings and 2 PVC containers. Making of connections and installation of control well in the ditch.
b. renovation of a pipe installation with a well for outflow of sewage from a ditch.

An open ditch with a duck weed
a. esthetic and functional renovation of the ditch and making a duct of PVC pipes supplying the sewage to the pond.

Picture 10. Denitrification ditch.

Stabilization pond
a. manual earthworks. Preparation of the surface of the pond for its sealing with the membrane,
b. purchase of a sealing membrane and it delivery to the workplace.
c. lining the pond with the membrane and fixing it at the edges of the pond,
d. manual earthworks: housing and protection of the shore zone of the pond (slabs, stones, turf),
e. purchase of pipes and fittings made of PVC with a diameter of 100 mm, making of overflow the sewage from the pond to the infiltration area through a distribution ditch filled with stones, made at the front part of the area .
f. purchase of wooden logs (ca. 100 m) at a local forest plant, cutting and debarking, purchase of impregnate means and wood impregnation,
g. purchase of ready-made steel elements for embedding of wooden fence posts in the ground, purchase of protective paints and making of anti-corrosion protection,
h. construction of 60 m long pond fencing - specialist works with the use of hand tools and a mechanical saw.



Picture 11. Pond as receiver of treated wastewater.

Ponds with an exudation of a shallow ground water
a. purchase of poles in the local forest inspectorate (ca. 100 m in total), debarking and cutting, purchase of impregnation and protection of wood logs,
b. purchase of ready steel elements for embedding wooden posts in the ground,
c. purchase of anti-corrosion paints and painting of steel elements,
d. pond fencing works with hand tools and a mechanical saw,
e. earth and planting works, pond's care works.

Making the information boards.
Making the wooden supports for setting the information boards.

Picture 12. Information board. Mountain-based hydrological use with typical flora and fauna.

A PILOT CASE OF GENNARBY IN FINLAND: THE PROCESS OF BUILDING A PRESSURIZED SEWER SYSTEM BY A COOPERATIVE

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The Association for Water and Environment of Western Uusimaa
Natural Resources Institute Finland (Luke)

1.9. Description of the project management

The co-operative of Nytorp Vatten andelslaget was in charge of the whole building project management. The co-operative stood for all the investments made. The board of the cooperative did the practical leading during the whole project. The board was in charge of the allocation of resources and documentation of the building work.

As the board of the co-operative work voluntarily and is not professionals in building infrastructure, some help from different experts was needed. This is where Village Waters stepped in. The project planner from LUVY (one of the partners in Village Waters) Bernhard Lundström, was the key person to search for the right people and instances in different situations. He helped the co-operative to find experts and contacts (from the municipalities, from the project Village Waters etc.) and helped the board in communication towards the members of the co-operative. He helped the board to make a schedule for the building work and was active in the dialogue towards the authorities (the municipal water utility). He participated in the monitoring and controlling of the proceeding of the project together with the technical supervisor that the municipal water utility required to ensure the quality of the work.

The project management was successful, because of the connections to the local people were handled properly. All the citizens participated eagerly and the construction work was finalized in time.

1.10. Planning the investment

1.10.1. How contracting processes were organized and put to practice

- *What contract do you need before running the investment and what is the legal basis for it?*

As the project Village Waters has no investments in the construction of the Gennarby pilot in Finland, it is up to the citizens to make the investment in improving the wastewater treatment system. In Gennarby the citizens have established a water co-operative (a company) for execution of the project. The legal basis for a co-operative is “The Co-operative Act” (Osuuskuntalaki). Every co-operative has rules of its own. The aim of a co-operative is to provide services that members need. When making an investment the co-operative can execute a tendering-process if the members consider it necessary.

- *Parties of the contract. Who is responsible for what?*

The constructor gives an offer that the board of the co-operative considers. When the offer is accepted, the parties (co-operative and constructor) agree on the execution of the project. A contract of the construction is agreed upon.

- *What are the terms in the contracts?*

The land-owners give their permission of land-use according to the rules of the co-operative. An agreement of land-use is made with the land-owners that are not members of the co-operative. When the co-operative is connected to the municipal water supply and sewer network, an agreement with the municipality is needed.

- *As you know, 75 % (Finland) or 85 % (Estonia, Latvia, Lithuania, Poland) will be paid from project. Who is obliged to pay for the rest of the building activity?*

No money was invested to the pilot by the VillageWaters-project. As the citizens pay 100 % of the investment, they're engaged to building a water supply and pressurized sewer which cover the northern part of the lake. In the same ditch there are power supply cable and optical fibre for communication connection. VillageWaters-project used money for the experts in the building process and also data collection.

1.10.2. How the official processes were carried out.

- *How the official processes looks in your country (scheme of the legal path)?*

In Gennarby the legal path is restricted to agreements between the members, land-owners and municipality, because there is no wastewater treatment and outlet, only transferring the wastewater to another network.

- *What is your role in planning?*

The Village Waters Project participated in the planning process of the water supply and sewage network by giving consultation to the co-operative. The co-operative was responsible for the overall planning and costs. The co-operative has a local project manager whose work was financed by Village Waters project.

- *Who is responsible for designing total investment?*

In Gennarby, the co-operative is responsible for the total investment including the design.

- *Do you need the tender procedure? If yes, please explain what kind of procedure.*

A tender procedure was used for equipment (pumping stations and materials) and for construction work.

- *Is it necessary to obtain any assent for the building project from any institution?*

As described earlier, agreement from the land-owners and from municipal water utility was needed.

- *Does your country require any tender or auction procedure for necessary construction materials?*

The "Act of public procurement" (hankintalaki) concerns the public procurements, sometimes even co-operatives if they're big enough or if it can be considered a monopoly.

1.11. Execution of the project (building)

1.11.1. Technologies of the implemented systems

- *Description of the technology*
- *Amount (l/m^3) of wastewater inflow*
- *Inflow and outflow of BOD, N, P*
- *Use of chemicals and electricity*
- *The description of the process: basic information and description of the treatment process with the technological schemes, what is realizing in each step of technology*
- *Sludge formation amounts and how many times sludge has to be collected*
- *Description of regular maintenance needed*
- *Amount of households connected to the technological system*

The description of the technology includes pumping stations, pressurized sewer pipes, trunkline and finally Tammisaari Wastewater treatment plant. The amount of households was nine and the amount of wastewater can be assumed to be 0.4 m^3/d, but is surely dependent on the number of inhabitants and usage season of the households.

The length of the sewage pipes were assumed to be 800 meters together and the material polyethylene, which gives for the weight approximately 512 kg. The weights of the pumps are 29 kg iron and the pumping tanks 120 kg polyethylene, each. The BOD inflow was assumed to be 200 g/d/household, nitrogen 56 g/d/household and phosphorus 8.8 g/household.

Tammisaari Central Wastewater Treatment Plant has BOD-reduction 99 %, N-reduction 68 % and phosphorus 99 %, so the reductions are much more effective than the previous situation with only the septic tanks as wastewater treatment alternative. Used chemicals are ferro sulphate, lime and aluminum-based chemicals.

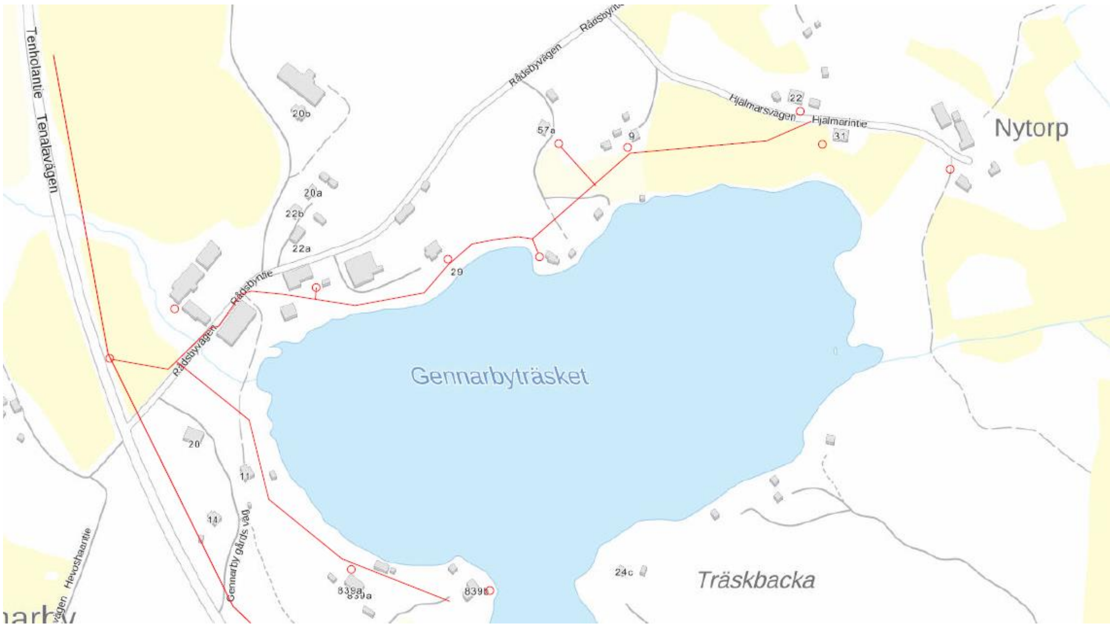

Figure 4. An overall map of the pressurized sewer system in Gennarby. The wastewater is pumped through the pressurized sewer to the trunkline of the municipal of Raseborg. The wastewater is treated at the municipal wastewater treatment plant.

- *Who is the main investor?*

The main investor is the co-operative with its members.

- *What is the tender procedure for project execution? Can you explain procedure in details with the choice criteria.*

The citizens in Gennarby desired reliable wastewater system with a long life span. A water supply, power supply cable and optical fibre were needed to be included. Due to the nearby municipal trunkline for water services, there was no need for a treatment plant. The citizens doubted the longevity of small scale wastewater treatment plants. The municipal wastewater treatment plant is modern and of a high quality and guarantees a sufficient level of treatment. This is why building a pressurized wastewater pipeline was chosen.

- *Give characteristic of the Company realizing the project after tender procedure.*

A small local company was in charge of the construction work, owned by one of the members of the co-operative.

- *Beginning of the execution: signing agreement between investor and Company – explain all the terms of agreement from Investor and realizing Company sides, with scope of work.*

As the owner of the company is a member of the co-operative.

- *What is the estimated costs distribution between earthworks, machinery and man-work in the building process?*

The estimated costs distribution between earthworks/man-work (installations) was 40/60.

- *What kind of materials, installations and devices will be used in the building process?*

The sewer system includes pressure pipe, pumping stations and valves. The electricity for the pumps is provided by the connected households.

- *Is there any investor supervision?*

The co-operative bought the technical supervision service from a local expert.

- *If all changes in project by building company are agreed by designer of the investment? If yes, please explain changes in details (changes of materials, equipment, localization etc).*

There was no need for changes in this project.

1.11.2. Problems encountered during the building and their solutions

- *What changes and problems contains as-build project? Do changes inflow any problems on technology or constructions?*

The final cost for connection fee was published to the members before the information of the final cost of the project was available. This reduced the flexibility of the construction budget.

Due to misunderstanding, some of the pipes needed to be replaced by different size (before the building process), which caused some changes in the costs.

The municipal water utility required a technical supervisor for construction, which was not budgeted.

- *From building process and mechanical parts please describe which elements are agreed with project design and which are not agreed.*

Every part was agreed upon from the beginning.

- *What was the most difficult problem?*

The unforeseen expenses are described earlier.

- *Who and how solved the problem?*

The local project manager managed all the challenges together with the board of the co-operative with the assistance of Village Waters-project.

1.12. Activities after the finalization of building process

1.12.1. Overall conclusions on the building process

- *What were the problems and other challenges in the project? What did you learn? What were done differently compared to the project plan?*
- *What was properly or improperly designed and realized?*

The project management was successful because of the connections to the local people were handled properly. All the citizens participated eagerly and the construction work was finalized in time. The project was completed according to the budget. The Gennarby Pilot has inspired citizens in nearby villages to enhance their wastewater treatment by building sewer networks connected to the municipal network.

- *Do these new structures meet habitants and your expectations? What was new comparing to the known technologies and constructions? Ownership of the installation?*

The new structures meet the inhabitants and the Village Waters Projects expectations to the fullest. Pilot is in first owned by wastewater cooperative and later ownership will be moved to Raasepori municipality.

1.12.2. Technological, economic, environmental, social and enviro-hygienic data acquired from the renovated wastewater treatment plants

- *Current technological data acquired from the renovated wastewater treatment plant.*

The BOD and P reduction of Raasepori Central Wastewater Treatent plants were 99 % and N-reduction 68 %. The electricity needs are 0.83 kWh/m^3. The annual amount of treated wastewater is 1 200 000 m^3. For the function of the technology, the new solutions prevent remarkably BOD-, N- and P- loads to water systems.

- *Current environmental data acquired from the renovated wastewater treatment plant: What are environmental benefits of the new system?*

Analysing the water samples have shown that the renovation of Gennarby WWTP had a positive impact into Gennarbyträsket Lake water status, wastewater is treated efficiently. Due to the short study period, no positive change in soil quality has been identified. Long-term research is needed.

- *Current social data acquired from the renovated wastewater treatment plant: Are the expectations of the end-users met? What is their opinion? Did the inhabitants participate in the building process?*

In Gennarby, inhabitants told that so far there haven't been any problems in the new system. One of the interviewed inhabitants mentioned that it feels now safer when there are more properties sharing the costs and potential problems of the wastewater system. Via the pilots the information about the new wastewater systems has spread to neighbouring areas and technologies used in pilots have been copied in other private houses or villages. The water co-operative in Gennarby has got new members from the surrounding area and they are building new water pipes.

- *Current economic data acquired from the renovated wastewater treatment plant: What is the energy efficiency compared to the old system?*

In Gennarby, before the changes, the wastewater costs consisted of emptying the old septic tanks maximum once per year. After joining the municipal network, the costs increased significantly, due to wastewater charge paid for the municipality (3€/ m^3+ fixed charge). In Gennarby, before the changes owners considered that it the cost not very much; some considered it was rather much. Inhabitants knew that the prices will increase after the changes and they were prepared for more expensive costs.

Acknowledgement

We warmly want to thank all Gennarby inhabitants whose home was connected to the wastewater treatment system built up in the VillageWaters-project. Thank you also for them for giving valuable information concerning their households. We want to thank VillageWaters-partner Vesa Arvonen from SYKLI for attending to the planning and building process of the pilot. Off course thank you a lot for the project that gave a finalized support for co-operation and additional information for the inhabitants of the current environmental, economic and social situations that where related to their surrounding environment. Special thanks to following parties: Bernhard Lundström for taking care of all practical issues concerning pilot area. Vesa Arvonen from SYKLI for attending to the planning and building process of the pilot. All Gennarby- pilot inhabitants for giving valuable information concerning their households. Staff in Luvy and Luke for taking care of the water, sludge and soil sampling and analyzes.

Appendices

Picture 13. Taking water samples in Gennarby pilot.

Picture 14. VillageWaters -project partners are evaluating the new pumping stations in Gennarby pilot.

A PILOT CASE OF NURMIJÄRVI IN FINLAND: THE EFFECTS OF RENEWAL OF THE PRIVATE HOUSEHOLD SOIL FILTRATION TO THE ENVIRONMENT

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The pilot plant is located in southern Finland, Nurmijärvi. In the pilot a renewal of the private household soil filtration for a new one was conducted in a private household because an old one was not function anymore. The changes were done in August 2017. No project investment money was used in the pilot because household owners paid everything by themselves. Project money was used for data collection and analyses of the project.

1.13. Description of the project management

- *Who was in charge of which parts for the project management?*

The work was done by the owner of the system, who was then also in charge of the project management.

- *How the management group has been divided into following steps of project management?*

There was no management group, because the owner of the system di most of the work on his own.

- *Who took care of management of different kind of sub-tasks as well as schedules and budgets so that they follow product plan as well as possible?*

Sub-tasks concerning how the project plan is followed in relation to the schedules and the budget were managed by the owner.

- *Who took care of the relations of the authorities and the dialogue during the project?*

The owner of the house

- *How the allocation of resources was done and who was responsible for that?*

This project is small and all resource allocation was made by the owner of the house

- *Who was responsible for documentation?*

Documentation was made by owner of the system.

- *How the responsibilities were divided in the project group? How the documentation was organized between different parts (schedule of the project, costs, quality, effectiveness, dissemination)?*

There is no project group in this pilot project

- *Who is responsible for monitoring and controlling?*

The owner of the house

- *Which were functions that were monitored (can be costs, quality, schedule etc.)?*

The most important were costs and schedule (timing of the construction machines)

- *How feedback between product phases has been arranged?*

The owner of the house built up this system by himself.

- *How the management was succeeded?*

Management went well, because schedule was observed.

1.14. Planning the investment

1.14.1. How contracting processes were organized and put to practice

- *What contract do you need before running the investment and what is the legal basis for it? Parties of the contract. Who is responsible for what? What are the terms in the contracts?*

As the project Village Waters has no investments in the reconstruction of the Nurmijärvi pilot in Finland, it is up to the owner of the house to make the investment in improving the waste water treatment system.

The so-called household wastewater regulation requires sufficient purification efficiency for the treatment of wastewater from the houses. As a result, thousands of wastewater treatment systems have been refurbished in Finland. In this case one of the reasons for the renewing of this system was this wastewater regulation.

- *As you know, 75% (Finland) or 85% (Estonia, Latvia, Lithuania, Poland) will be paid from project. Who is obliged to pay for the rest of the building activity?*

The whole pilot was paid by the household owner by himself.

1.14.2. How the official processes were carried out.

- *How the official processes looks in your country (scheme of the legal path)?*

According to the Finnish Land Use and Building Act, a permit is required for the construction of a waste water system. This authorization is done by the municipal building supervision.

Household owner applied a permission for its technological changes via local authorities as filling a form of the planning permission for minor construction (http://www.nurmijarvi.fi/filebank/4813-Rakennuslupahakemus.pdf) and its appendix (http://www.nurmijarvi.fi/filebank/5183-3861-Suunnitelma_jatevedet_uusilomake_UUSIN_241011.pdf).

- *What is your role in planning?*

The Village Waters Project participated in the planning process of the wastewater treatment plant by giving consultation to the house owner. The owner of the house was responsible for the overall planning and costs. In addition, data collection and analytics were conducted by the project.

- *Who is responsible for designing total investment?*

The owner of the house

- *Do you need the tender procedure? If yes, please explain what kind of procedure.*

No

- *Is it necessary to obtain any assent for the building project from any institution?*

The neighbors must be informed. In theory, neighbors must accept plans, but in practice their approval does not matter if the plan meets the requirements of law

- *Does your country require any tender or auction procedure for necessary construction materials?*

No

1.15. Execution of the project (building).

1.15.1. Technologies of the implemented systems.

- *Description of the technology*

The old technology consisted on four septic tanks, small pump (0.4 kW) and Uponor ground filtration pipe packet. The filtration material was sand, and in addition, crushed stone was used.

In the new technology the septic tanks were the same and sand, crushed stone and pipes were changed and one same kind of pump was added before the outflow of the system. The amount of sand was 100.75 tons, crushed sand 20.85 tons, mass of pipes 150 kg, mass of pumps 4 + 4 kg and mass of filtration textile 4 kg. The number of septic tanks was four and they were 600-1200 mm by the diameter and height 2140-2200 mm.

- *Amount (l/m3) of wastewater inflow*

Amount on wastewater inflow is assumed to be 575l/d which is quite near a general assumption of four persons with 144 l/day/person as an average.

- *Inflow and outflow of BOD, N, P*

The inflow of BOD was assumed to be 200 g/d, nitrogen 56 g/d and phosphorus 8.8 g/d. There reduction before changes is for BOD 38%, nitrogen 78% and phosphorus 97%. After changes the reductions are for BOD ?, nitrogen 78 % and phosphorus 97.5 %

- *Use of chemicals and electricity*

Electricity consumption is rather small, because it consists only on one or two pumps: 18.5 kWh/year for the old system and 37 kWh/year for the new system.

- *The description of the process: basic information and description of the treatment process with the technological schemes, what is realizing in each step of technology*

The wastewater goes first to the precipitation tank and then it is pumped to soil filtration.

- *Sludge formation amounts and how many times sludge has to be collected. Description of regular maintenance needed.*

Sludge was collected once or twice a year.

- *Amount of households connected to the technological system*

  Only one household with four inhabitants, occasionally more.

- *Who is the main investor?*

The owner of the house

- *What is the tender procedure for project execution? Can you explain procedure in details with the choice criteria.*

The building had already a similar wastewater treatment system, but it had been blocked. This is why the wastewater treatment system was renewed. Since the building already had precipitation tank and a pump, only soil filtration was renewed

- *Give characteristic of the Company realizing the project after tender procedure.*

The owner of the house

- *Beginning of the execution: signing agreement between investor and Company – explain all the terms of agreement from Investor and realizing Company sides, with scope of work.*

The owner of the house made the assembly work

- *What is the estimated costs distribution between earthworks, machinery and man-work in the building process?*

The estimated costs distribution between earthworks/man-work (installations) was 70/30.

- *What kind of materials, installations and devices will be used in the building process?*

PE-pipes, gravel, sand

- *Is there any investor supervision?*

No

- *If all changes in project by building company are agreed by designer of the investment? If yes, please explain changes in details (changes of materials, equipment, localization etc).*

There was no need for changes in this project.

1.16. Problems encountered during the building and their solutions.

- *What changes and problems contains as-build project? Do changes inflow any problems on technology or constructions?*

Implementation was made mainly according to plan. There were some challenges in part delivery like missing parts and wrong pipes. A second pump had to be installed after the soil filter so that the water could be discharged to the ditch. The soil filter was slightly higher than planned and in that case the excavator was a little too small for that work. The soil was too immersible and the working area of the excavator had to be built with a supporting work platform (gravel and geo textile).

- *From building process and mechanical parts please describe which elements are agreed with project design and which are not agreed.*

Every part was agreed upon from the beginning.

- *What was the most difficult problem? Who and how solved the problem?*

The all problems were solved by the owner of the house

1.17. Activities after the finalization of building process.

1.17.1. Overall conclusions on the building process.

- *What were the problems and other challenges in the project? What did you learn? What were done differently compared to the project plan? What was properly or improperly designed and realized?*

This project was so simple and well-designed that nothing big went wrong. This was made easier by the fact that the owner of the house designed and implemented the project himself.

- *Do these new structures meet habitants and your expectations? What was new comparing to the known technologies and constructions? Ownership of the installation?*

So far yes. The used technology is traditional and similar than old system. The pilot is owned by house owner.

1.17.2. Technological, economic, environmental, social and enviro-hygienic data acquired from the renovated wastewater treatment plants.

- *Current technological data acquired from the renovated wastewater treatment plant.*

The main point in changing the system was that the old system was not functioning any more. The new system is very much like the old one, additional was only one pump more. The owner of the house was satisfied with the old system, but because it was not working any more, the change had to be done.

- *Current economic data acquired from the renovated wastewater treatment plant: What is the energy efficiency compared to the old system?*

Almost same, only one extra pump: 18.5 kWh/year for the old system and 37 kWh/year for the new system

- *Current environmental data acquired from the renovated wastewater treatment plant: What are environmental benefits of the new system?*

The new sand filtration layer removes phosphorus more efficiently than the old one

The soil analysis have shown that the renovation of Nurmijärvi WWTP had a positive change in soil to total and soluble phosphorus, soluble nitrogen, ammonia and nitrates nitrogen concentrations in all point; Long-term research is needed.

- *Current social data acquired from the renovated wastewater treatment plant: Are the expectations of the end-users met? What is their opinion? Did the inhabitants participate in the building process?*

In Nurmijärvi inhabitants were satisfied with the technology of soil infiltration due to low costs and easiness of the system. This was reason to build a similar one. They haven't perceived any changes in their life after building the new system. The costs to build an infiltration field are rather much, but use and maintenance costs of the system are affordable, and according to owners' calculations this was most affordable solution for their own use. Owners did the physical work in building process by themselves.

- *Current enviro-hygienic data acquired from the renovated wastewater treatment plant: Comparing and discussing the differences between the analysis results of the old and new system (table).*

The new soil filtration system was set up in the summer 2017. Every side of the absorption field (1-4 point, 25 cm and 100 cm depths) soil results have shown that, from October 2017 until September 2018 total and soluble phosphorus, soluble nitrogen, ammonia and nitrates nitrogen concentrations in all point were lower compared to the concentrations in 2017. But from October 2017 until September 2018, nitrites nitrogen concentration in all points was higher compared to the values in 2017. From October 2017 until September 2018, Coliformic bacteria , Escerichia coli bacterial, Fecal colifomic bacteria and fecal streptococci values were the same compared to the values in 2017.

Acknowledgement

We warmly want to thank Nurmijärvi inhabitant, the owner of the house, who came part of our VillageWaters-project pilots. We want to tank VillageWaters-partner Vesa Arvonen and Jari Heiskanen from SYKLI for connecting this Nurmijärvi pilot case for our project. Thank you also for giving valuable information concerning the household. Special thanks for Vesa Arvonen from SYKLI and Luke experts, Frans Silvenius, Vesa Joutsjoki and Yrjö Virtanen, for collecting information for the project. Thank you also for a staff in Luvy and Luke for taking care of the water, sludge and soil sampling and analyzes. Off course thank you a lot for the project that gave a finalized support for co-operation and additional information for the inhabitants of the current environmental, economic and social situations that where related to their surrounding environment.

Appendices

Picture 15. Taking water samples in Nurmijärvi pilot site.

Picture 16. Construction of the Nurmijärvi pilot soil filtration system.

A PILOT CASE OF SILUTE IN LITHUANIA: BUILDING THE TECHNOLOGICAL SYSTEM IN THE PILOTS

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1.18. Description of the project management

The project "Water emissions and their reduction in village communities – villages in Baltic Sea Region as pilots (Village Waters)" is being implemented in Leitgiriai village, Šilutė district municipality, Lithuania. The purpose of this project is to analyze the best technological wastewater treatment solutions reducing the wastewater contamination in sparsely neighboured rural places in the Baltic Sea Region and to install the effective wastewater treatment systems in Leitgiriai village.

The project is implemented by the administration of Šilutė district municipality in cooperation with Aleksandras Stulginskis University. Šilutė district municipality is the implementing authority in charge of purchase and realization of wastewater treatment equipment. Aleksandras Stulginskis University is carrying out various scientific researches that help to analyze the best technological solutions for wastewater treatment plants. The work groups have been formed in these two institutions, and the persons responsible for certain activities of the project and handling of their documentation have been appointed, i.e. each person performs the assigned work and handles the documents related to that particular work.

The administration of Šilutė district municipality has formed a work group of four employees of the administration of Šilutė district municipality and one employee of the municipal company of Šilutė district UAB "Šilutės vandenys" (Šilutė Waters Ltd.). This work group consists of the following: a project's manager is responsible for supervision of the project's team, ensuring of achievement of the set goals, successful implementation of the project's activities, upkeep and submission of reports; a project's coordinator, who is observing the course of the project under implementation and status of activities, participates in the control process of the project's works, controls compliance with specification of the project's documentation, and supervises implementation of the project's financial contract; a specialist is responsible for organization and implementation of public procurements, following of their course, preparation of documentation for public procurements, coordination with the project's partners, members of the project's group, and organization of making the contracts with the selected supplier; a specialist responsible for preparation of technical documentation, assessment of the suppliers' suitability, installation of wastewater treatment technology, supervision and coordination of construction works; a project's financier is responsible for the project's accounting, preparation of financial part of the financial documents, reports and payment applications, payment of wages to the project's employees, and control of the project's finances.

The work team of Aleksandras Stulginskis University formed for the project consists of five employees of the University, who are responsible for implementation of different activities of the project: a project's manager is responsible for activities of the Lithuanian partners, successful implementation of the project's activities, supervision and submission of reports, communication and cooperation with the project's partners; a specialist who is responsible for technical and economical assessment of wastewater treatment plants installed in the Lithuanian village and for the selection of wastewater treatment technology for the pilot project of Leitgiriai village in Šilutė district; a specialist is responsible for assessment of technological, economical and social wastewater treatment solutions in Lithuania, for spread and publication of the project's results and for cooperation with the community of Leitgiriai village; a specialist is responsible for the project's administration and implementation of the project's activities; a specialist is responsible for the project's accounting, preparation of financial part of the financial documents, reports and payment applications, payment of wages to the project's employees, and control of the project's finances.

The work groups formed in the institutions were working effectively, every member of the work group was performing own duties in the project excellently, thus the project's implementation was successful and in accordance with the implementation schedule of the project.

1.19. Planning the investment

1.19.1. How contracting processes were organized and put to practice

Before the project's implementation is started, the institution's managers decide whether the institution may take part in the project, whether the project is useful for it, and whether the project's implementation will contribute to the improvement of life quality of society. If it is decided to take part in the project, the institution's managers sign the documents that the institution agrees to take part in the project and assigns the persons responsible for the implementation of the project's activities. All the documents of the project shall be signed by the institution's managers or persons authorized by them. When the project's implementation is started in municipalities, the approval of the municipal council (the municipal council consists of the members of municipal council – community's representatives elected by permanent residents of the municipalities) (council's decision) is also needed for the project's implementation. It provides not only the consent but also the undertaking to contribute to the project's financing using the funds of the municipal budget, e.g. at least 15 percent of all the qualified expenses, and to guarantee covering of funds unqualified for funding but necessary for the project's implementation, as well as the part of qualified expenses not covered by the support granted to the project.

The funds intended for the project's implementation are provided in the budget of each institution, in the strategic and other funds- related documents of the institution. The implementation of this project is carried out in the mode of funds' reimbursement, thus first of all, the project's expenses are covered by own funds of the institutions and part of them (85 percent of all the qualified funds) are refunded from the structural funds of the European Union upon their declaration.

1.19.2. How the official processes were carried out.

The procurement methods used by private companies, State, municipal organizations and other public institutions differ. Public institutions have to carry out competition of public procurement, with regard to which different procedures apply, depending on the purchased goods and services. Public procurements are distributed into goods, services and works according to the type. The procurement method is selected according to the procurement amount. There are no separate legal acts in Lithuania on procurement of wastewater treatment plants. The purchase method is selected with regard to the type of procurement (goods, services or works) and the set requirements are applied. While implementing this project ("Water emissions and their reduction in village communities – villages in Baltic Sea Region as pilots (Village Waters)", the procurement method of wastewater treatment plant was attributed to the contracted works, because designing of wastewater treatment plants and reconstruction were purchased. Additional services were acquired separately for reconstruction of wastewater treatment plants: general expertise of the project and technical supervision of the building's construction (General expertise of the project is an assessment of the building's project as an integral document by checking how the solutions of the building and its parts and systems (building's engineering systems, engineering networks and communications satisfying needs of the building and the construction lot) and the land lot meet the requirements of the Lithuanian legal acts. Technical supervision of the building's construction is supervision of the building's construction organized by the customer, the purpose of which is to control whether the building is being constructed in accordance with the building's project, requirements of the contract for contracted construction works, laws, other legal acts, normative construction technical documents, and normative documents of building's safety and purpose).

The purpose of the public procurements in Lithuania is to ensure that all the companies and natural persons would have the same possibilities to sell their goods, services or works to the State.

The requirements are applied to the participants in public procurement competitions (suppliers and production or services they supply) in order to use the budgetary resources intended to purchase the necessary goods or services properly, to guarantee their quality and to make the purchase contracts with reliable suppliers of goods and services. These requirements are presented in the documents for each procurement.

When the contracting authority is planning and implementing procurements, executing procurement contracts and establishing procurement controls, it follows the Law on Public Procurement of the Republic of Lithuania, the legal acts implemented on its ground, other laws and legal acts adopted by the contracting authority.

The manager of the contracting authority is responsible for compliance with the Law on Public Procurement and other legal acts regulating public procurements. The manager appoints persons, commissions and its members responsible for planning, organization, implementation of public procurements, etc. The need of goods, services or works for the contracting authority is formed by the procurement initiators assigned by the contracting authority's manager. Every procurement initiator has to submit a list of procurements for the next budgetary year to the person responsible for procurement planning in the end of each budgetary year.

Upon receipt of the lists of procurements, data, results of market research and purchase justification from the procurement initiators, the person responsible for procurement planning shall check them and start preparing the procurement plan of the contracting authority, as well as information about the planned internal transactions.

The authority's manager shall assign to the persons responsible for public procurement to carry out the procurement procedures and to select the procurement method. With regard to the planned procurement (purchased amounts of goods, services or contracted works), different procedures are applied to procurements. Any undertaking may provide services or goods to public organization. The essential difference is in the value of procurements. It usually determines the requirements for the supplier (the supplier has to satisfy the set requirements).

In case of low-value public procurements, the organizations may carry out surveys about prices and choose the tender of the lowest price. The high-value public procurements are usually more complex and the procedures are longer. Certain qualification requirements are applied on the supplier (e.g., minimal turnover, certificates, etc.); such procurements are called e-public procurements because the tenders are submitted through the electronic system of public procurements (CVP IS). The technical specifications are announced before the procurement. The suppliers may submit remarks and suggestions regarding them.

The Lithuanian Law on Public Procurements was amended on 01 July 2017. The assessment of low-value and high-value procurements was changed. Before 01 July 2017 the amount of low-value purchase of goods and services was up to EUR 70 180, and that of contracted works – up to EUR 175 450; whereas after 01 July, all the procurements up to EUR 12 100 may be conducted by survey, inviting the selected number of suppliers, and the procurements for the amount exceeding EUR 12 100 have to be public (open competition, where all entities in compliance with the set requirements may take part).

In implementation of this project, the procurement of reconstruction works of domestic wastewater treatment plants was done before 01 July 2017. The procurement was carried out through the electronic system of public procurements (CVP IS) by written survey of suppliers. The commission was formed to assess the suppliers' tenders (tender for construction's project, in accordance to which the reconstruction works were to be implemented), according to the laws, building technical regulations, other legal acts, instructions and requirements of the contracting authority. They had to be in compliance with the objectives of the project under implementation (Village Waters). The most advanced and effective wastewater treatment technologies that would guarantee the best treatment of wastewater had to be presented in the tenders for wastewater plants.

All the submitted tenders were assessed and the project of construction of wastewater treatment plants and reconstruction works were purchased. When the contractors prepared the construction project, the services of general expertise of the building's project were also acquired (the construction project was assessed by independent expert). Moreover, the services of technical supervision and supervision of execution of the building's project were implemented in the course of reconstruction works of wastewater treatment plants.

1.20. Execution of the project (building)

1.20.1. Technologies of the implemented systems

- *Description of the technology*

1. Treatment steps:

1. Mechanical pre-treatment:

- *Hand skimmed screen;*
- *Sand/grit separator, sand box for gravitational dewatering.*

2.Wastewater distribution/abnormal inflow management:

- *Local pumping station;*
- *Equalisation tank;*

3.Biological treatment step:

- *Biological reactor with anaerobic, anoxic, aeration, clarification chambers in one compact tank;*
- *Airblowers (1 operational + 1 on standby);*
- *Excess sludge tank.*

2. Design parameters

	163	PE
Average daily in inflow	26,08	m^3/d
Maximal daily in inflow	37,0	m^3/d
Maximal hourly inflow (dry)	4,67	m^3/h
Maximal hourly inflow (wet)	6,63	m^3/h
Concentrations/contamination loads:		
BOD_7	437,5	mgO_2/l
N_{tot}	76,7	mg/l
P_{tot}	16,9	mg/l
BOD_7	11,41	mgO_2/l
N_{tot}	2,0	kg/d
P_{tot}	0,44	kg/d

3. Design treatment efficiency

BOD_7	23	mgO_2/l
N_{tot}	30	mg/l
P_{tot}	4	mg/l

4. Use of chemicals and electricity

- *The implemented technology is without chemical use.*
- *Electricity consumption:*

Device	Number of working units	Work time, h/d	Installed power, kW	Power consumption	
				kWh/d	kWh/year
Blovers	1	12	1,90	22,80	8322,00
Pumps	1	2,50	1,50	3,75	1368,75

The description of the process: basic information and description of the treatment process

5. Basic information

The existing pre-treatment step was morally and technologically outdated and physically damaged from the long years of use. Old installations were dismantled and new hand skimmed screen for screenings and a sand/grit separator were installed. Also a pumping station was designed for distributing wastewater flow during the wet periods when the inflow increases drastically. In these specific circumstances part of the wastewater is directed into the old reactor which is reconstructed into an equalization tank. After the excessive inflow is over the accumulated wastewater is returned to the treatment process.

In place of the old biological step reservoir a completely new bioreactor was installed with its air blowers and excess sludge tank.

Specific configuration of the technological chambers, equipment and circulation system enable specific retention time which results in relatively small amounts of excess sludge. The sludge from the biological reactor is removed using airlifts to the thickening tank where it is further aerobically stabilized and thickened.

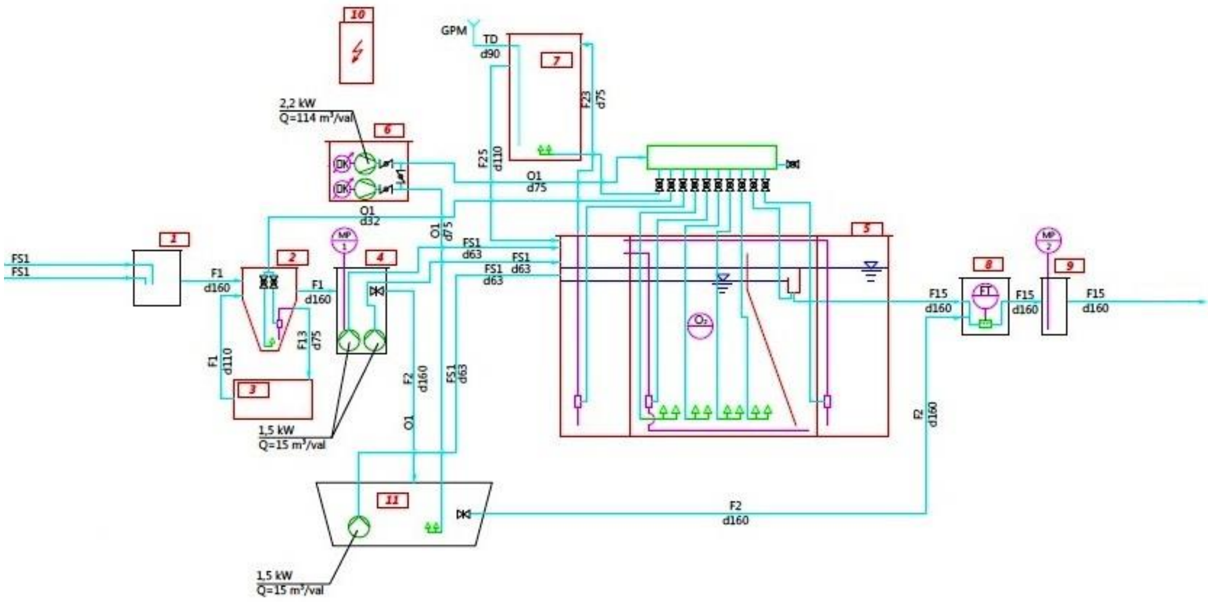


Figure 5. Overview of the WWTS. 1.Hand skimmed screen; 2- Sand/grit separator; 3- Sand grit removal tank; 4- Pumping station; 5- Biological reactor; 6- Air blower tank; 7- Excess sludge tank; 8- Flow meter; 9- Sampling well; 10- Control panel; 11- Equalization tank.

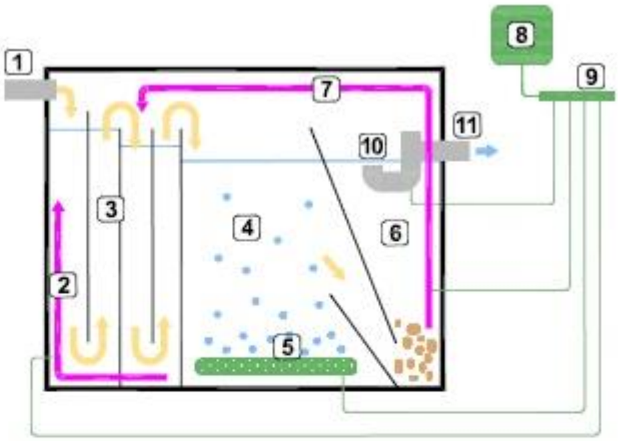
6. Description of the treatment process:

Biological reactor

First the wastewater flows into the anaerobic/anoxic zone. The anaerobic and anoxic chambers are divided by a series of overflowed and under flowed baffles into compartments. The inflow of wastewater and circulation of the active sludge as well as the particular arrangement of the baffles (patented Vertical Flow Labyrinth system) creates an upward and downward flow in the compartments, which ensures an effective mixing of the content in each compartment. In these chambers nitrogen and phosphorus removal takes place.

The activated sludge-wastewater mixture from the anoxic chamber flows to the aeration chamber. At the bottom of the aeration chamber air diffusers are installed. The diffusers provide fine-bubble aeration ensuring the content is in suspension and the amount of oxygen necessary for biological processes is dissolved, perforated elastic membrane is used in the air diffusers, which allow a long-term operation.

After the aeration chamber the activated sludge-wastewater mixture flows to the final clarification chamber. The operation is based on vertical settling process. The active sludge flows through an opening above the bottom of the tank and filters through a thickened sludge layer. That is when the particles of the active sludge are separated and the treated water flows through the collection system to the outlet.



1. Inflow
2. Airlift No. 1
3. Non-aerated chambers (anaerobic/anoxic)
4. Aerated chamber (oxic)
5. Aeration system
6. Final clarification chamber
7. Airlift No. 2
8. Air blower
9. Air distribution system
10. Flow Regulator
11. Outflow

Figure 6. Technological scheme of the biological reactor.

7. Excess sludge management

Excess sludge will be pumped out from the biological reactor to the aerobic sludge thickening tank, from it the sludge will be periodically pumped out and transported for further processing.

	Amount of thickened excess sludge, 2% SS		Number of deslugings per year
	m^3/d	$m^3/year$	
Excess sludge from the sludge tank	0,058	21,05	3

8. Operation and maintenance of the WWTP

All the innovative features of the AUGUST WWTP enable the system to run fully automatically using just the essential equipment with minimal demand for personnel intervention. Main purpose of the staff would be periodical inspection of the system (blowers, pumps, and excess sludge tank) and its maintenance, constant presence isn't necessary.

An automation system was implemented in the reconstructed WWTP it enables constant surveillance and real time adjustment of different technological processes.

- *Amount of households connected to the technological system*

40 households are connected to the technological system.

- *What is necessary for the project execution?*

Thorough analysis of the current situation. Condition of the existing WWTP and determination of design parameters reflecting actual situation with average and peak flows, contamination levels and connected households.

- *Who is the main investor?*

The main investors were the EU and Šilutė district municipality.

- *What is the tender procedure for project execution? Can you explain procedure in details with the choice criteria.*

The tender procedure was carried out through the electronic system of public procurements by written survey of suppliers. The suppliers had to fill a special form (tender) with all the prices for the reconstuction, and send it to the commission. The commission was formed to assess the suppliers' tenders, according to the laws, building technical regulations, other legal acts, instructions and requirements of the contracting authority. Tenders had to be in compliance with the objectives of the project under implementation (Village Waters). The most advanced and effective wastewater treatment technologies that would guarantee the best treatment of wastewater had to be presented in the tenders for wastewater plants. The choice criteria also is the cheapest price.

All the submitted tenders were assessed and the project of construction of wastewater treatment plants and reconstruction works were purchased.

- *Give characteristic of the Company realizing the project after tender procedure.*

The company that has won the tender is a local Lithuanian contractor UAB "Ecosolit", its main occupation is general construction works and networks (sewage, drinking water).

- *Beginning of the execution: signing agreement between investor and Company – explain all the terms of agreement from Investor and realizing Company sides, with scope of work.*

After all the submitted tenders were assessed it is time for 15 working days to sign a contract.

- *What is the estimated costs distribution between earthworks, machinery and man-work in the building process?*

Earthworks – 20 %. Machinery (equipment) – 60 %, man-work – 20 %.

- *What kind of materials, installations and devices will be used in the building process?*

The installation will require a variety of different mechanisms and materials because of the

Mechanisms and devices	Materials
• Trucks • Cranes • Excavators • Bulldozers • Compactors	• Sand • Gravel • Concrete • Piping

- *Is there any investor supervision?*

The main technical supervision is done by the specialist once per week in the construction of wastewater treatment plant.

- *If all changes in project by building company are agreed by designer of the investment? If yes, please explain changes in details (changes of materials, equipment, localization etc).*

All the construction works were done according to project.

- *What criteria object should fulfil during start-up of objects?*

When all the construction works and installation of technological equipment is fully complete, start-up of the system can be commenced. The main criterion that the system must meet is the treatment efficiency.

1.20.2. Problems encountered during the building and their solutions

- *What changes and problems contains as-build project?*
- *From building process and mechanical parts please describe which elements are agreed with project design and which are not agreed.*
- *What was the most difficult problem?*
- *Who and how solved the problem?*

The company that was selected for supplying their technology has long-term experience in designing WWTPs so all the preparation and analytic work before designing stage and the complete project amounted to a product that was implemented without significant interferences. The main problematic point in this project was peak inflows during heavy rainfall but it was solved by implementing an equalisation system.

1.21. Activities after the finalization of building process

1.21.1. Overall conclusions on the building process.

- *What were the problems and other challenges in the project? What did you learn? What were done differently compared to the project plan?*

The building process was very efficient due to thorough designing works.

- *What was properly or improperly designed and realized?*

There were no significant flows in the project design because the designing company closely cooperated and consulted with district municipality in every stage.

- *Do these new structures meet habitants and your expectations? Ownership of the installation?*

The implemented technology has met all the expectations and set tasks. Ownership of the installation is by the municipality.

- *Each country should write their own conclusions on the building process and then send them to us.*

Although the construction phase started and was ended during the cold season due to thorough design of the WWTP all the woks and installation of the technological equipment was done in a shortest possible period of time. Only the last part of the system – equalisation tank, was reconstructed last because it was needed to be operational for the whole construction period for maintaining a functioning treatment facility.

All the major works are already complete; the only task left is to saw the grass at the site.

1.21.2. Technological, economic, environmental, social and enviro-hygienic data acquired from the renovated wastewater treatment plants.

- *Current environmental data acquired from the renovated wastewater treatment plant: What are environmental benefits of the new system?*

Studies have shown that renovation of Leitgiriai WWTP has positive impact into Leite River water status, wastewater is treated efficiently.

- *Current economic data acquired from the renovated wastewater treatment plant: What is the energy efficiency compared to the old system?*

In the Leitgiriai area, the price of the sewage is based on the wastewater produced by the inhabitants (1,6€/m3). These prices did not change during the reconstruction of the WWTP. Before the changes, owners’ opinions about the price of wastewater treatment varied from rather much to not very much. After the changes owners think that the price of the wastewater treatment is an issue and they are afraid that the price will rise in a future.

- *Current social data acquired from the renovated wastewater treatment plant: Are the expectations of the end-users met? What is their opinion? Did the inhabitants participate in the building process?*

In Leitgiriai owners were not satisfied with the old WWTP since there was smell, it didn’t work properly on winter time and it affected on the water and fishery in Leite-river. After the new WWTP these issues have improved. In Leitgiriai the participation of the people in village has succeeded; the piloting project has increased communication and sense of community. According to inhabitants their daily life has changed into better direction mainly due to better drinking water after chancing the fresh water pipes. The building process increased community's communication, consolidation and problem solving ability significantly. During the project the inhabitants have received information about the conditions of environment and water issues, which they consider important.

- *Current enviro-hygienic data acquired from the renovated wastewater treatment plant: Comparing and discussing the differences between the analysis results of the old and new system (table).*

The results have shown that during the treatment process the wastewater is treated inefficiently and vary: suspended materials 29–99%, biochemical oxygen consumption in 7 days (BOD7) - 53 -98%, it means that the BDS7 value in the released wastewater is higher than that in the inflowing wastewater; total nitrogen (Nt) –4 - 95%, total phosphorus (Pt) 2- 92 %. During the assessment it was found that the treatment of total nitrogen and ammonium nitrogen has changed the most (%).The values tended to increase for all three indicators of wastewater cleaning efficiency (the function is positive, and the determination coefficients are $R2= 0.76$; $R2= 0.75$; $R2=0.56$ and $R2= 0.93$).

Acknowledgement

We thank all participants in this work. Special thanks to Silute District municipality, Šilutė district UAB "Šilutės vandenys" (Šilutė Waters Ltd.), AUGUST IR KO specialists and all the inhabitants of the Leitgiriai village for cooperation.

Appendices

Picture 17. The old wastewater treatment plant in Leitgiriai.

Picture 18. The new wastewater treatment plant during construction

Picture 19. Experience exchange between Lithuanian and Latvian pilots

Picture 20. The new installed system.

VillageWaters

Installation of technological systems for wastewater treatment

Activity 3.2: Building the technological system in the pilots of Latvia

Loreta Urtāne*, Aleksejs Percovs

FINDING THE BEST FITTING SOLUTIONS FOR WASTEWATER MANAGEMENT IN VILLAGES

VillageWaters Project
Research about Wastewater
Treatment Systems

A PILOT CASE OF SVĒTCIEMS IN LATVIA: THE PROCESS OF BUILDING THE TECHNOLOGICAL SYSTEMS

Loreta Urtāne*, Aleksejs Percovs

*Editor(s) are also authors

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University of Latvia, Riga, 2019

1.22. Description of the project management

The project "*Water emissions and their reduction in village communities – villages in Baltic Sea Region as pilots*" (Village Waters) in Latvia is being implemented in Svētciems and Ainaži village, Salacgrīva District Municipality. The aim of this Project Activity (A3.2) is to build the best-fitting wastewater treatment (WWT) systems in the in the pilot area of Salacgrīva District Municipality (Project Partner 8) and provide information from existing pilot plants to information tool (A2.6).

The project is coordinated by University of Latvia (PP6) and implemented by the administration of Salacgrīva District Municipality (PP8) in close co-operation with PP6. Salacgrīva District Municipality is the implementing authority in charge of construction of both WWT plants. PP6 is carrying out preparations – feasibility study, topographical survey, geological investigations – and development of technical documentation. The work groups have been formed both in PP6 and PP8 institutions, and the persons responsible for certain activities of the project and handling of their documentation have been appointed.

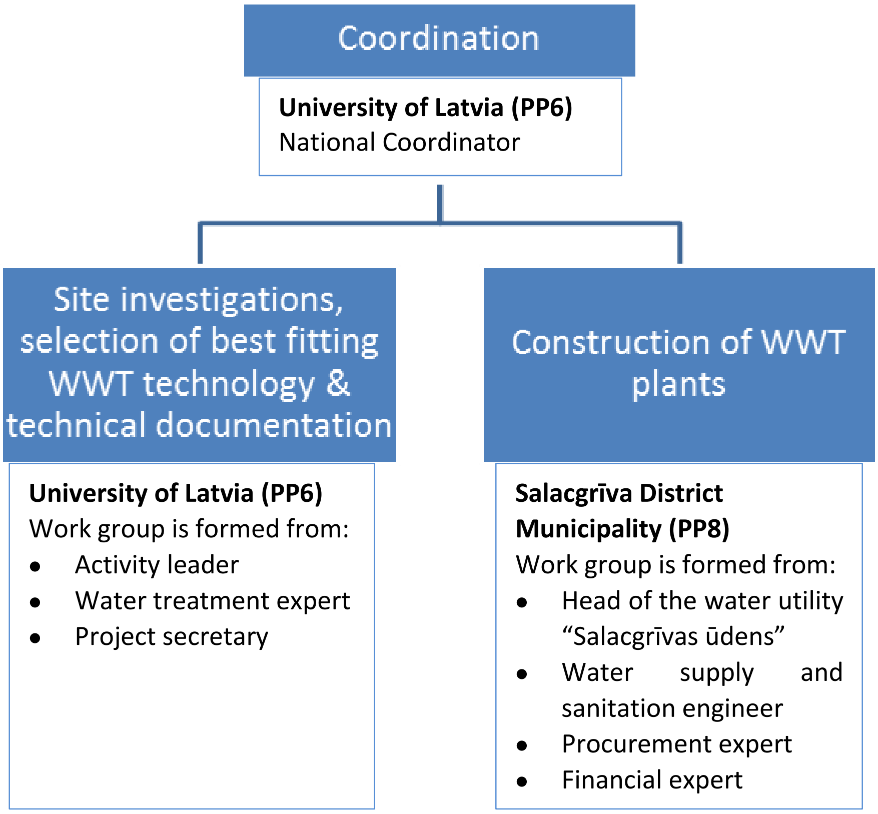


Figure 7. The organization scheme and dividing of responsibilities between project partners

1.23. Planning the investment

1.23.1. How contracting processes were organized and put to practice

All project related documentation, including pilot object construction or reconstruction, have to be signed by top management of partner organization. In case of University of Latvia it is Vice-rector for exact sciences, life and medical sciences, while in Salacgriva Municipality Council – Salacgriva Municipality Mayor.

University of Latvia (PP6)

The granted funding from the Programme for VillageWaters project is 85% and 15% is own contribution. If project partner is publicly funded educational institution, according to national legislation 15% of project expenses are financed from the State budget.

Project budget becomes part of whole budget of organization. Project expenses have to forecated and reported on regular bases.

The financing of VillageWaters project implementation is carried out according to following procedure – on the bases of signed project agreements (Subsidy contract and Partner Agreement) and financial plan of project expenses organization monthly receive 100% pre-financing from the Ministry of Education and 85% of them are paid back when are refunded from the structural funds of the European Union on the bases of Period's Reports.

Salacgriva Dictric Municipality (PP8)

The granted funding from the Programme for VillageWaters project is 85% and 15% is own contribution. If project partner is Municipality, according to national legislation 5% of project expenses can be refunded from the State budget.

Taking into account that co-financing of project activities is carried out from budget of Municipality, project budget have to be approved by Municipal Council, which consisting of representatives elected by residents of the municipality vote for council's decision. In practice it means that Project budget becomes part of whole budget of organization and 10% of all qualified project expenses (also unqualified expenses but necessary for the its implementation) are financed from Municipality budget.

The financing of VillageWaters project implementation is carried out as reimbursement according to following procedure – initially all project's expenses are covered by own funds of the organization (in case of this project it was loan to the Treasury) and 85% of them are refunded from the structural funds of the European Union upon their declaration.

1.23.2. How the official processes were carried out?

The international standards prepared by the International Federation of Consulting Engineers ("FIDIC") can be addressed to Village Waters project to explain project implementation steps and differences of implementation of A3.2 in different project partner countries. The procedure of Contract for Construction of Engineering Works Designed by the Employer (the "Red Book" contracts) was used if technical documentation, including design projects, was already developed in the beginning of project. Similarly, the procedure of Contracts for Construction of Engineering Works Designed by the by the Contractor (the "Yellow Book" contracts) was used if site investigations (topographical & geological survey) and preparation of technical documentation was done during the implementation of project. The implementation of A3.2 in Latvia was carried out according to procedure of "Yellow Book" and includes both construction and preparation of technical documentation. Therefore the implementation schedule was longer in cooperation with those partner countries (Finland, Estonia and Lithuania) were procedure of "Red Book" contracts were used. The procedure of A3.2 implementation and dividing of responsibilities between Latvian project partners PP6 and PP8 is resented in the Figure 8.

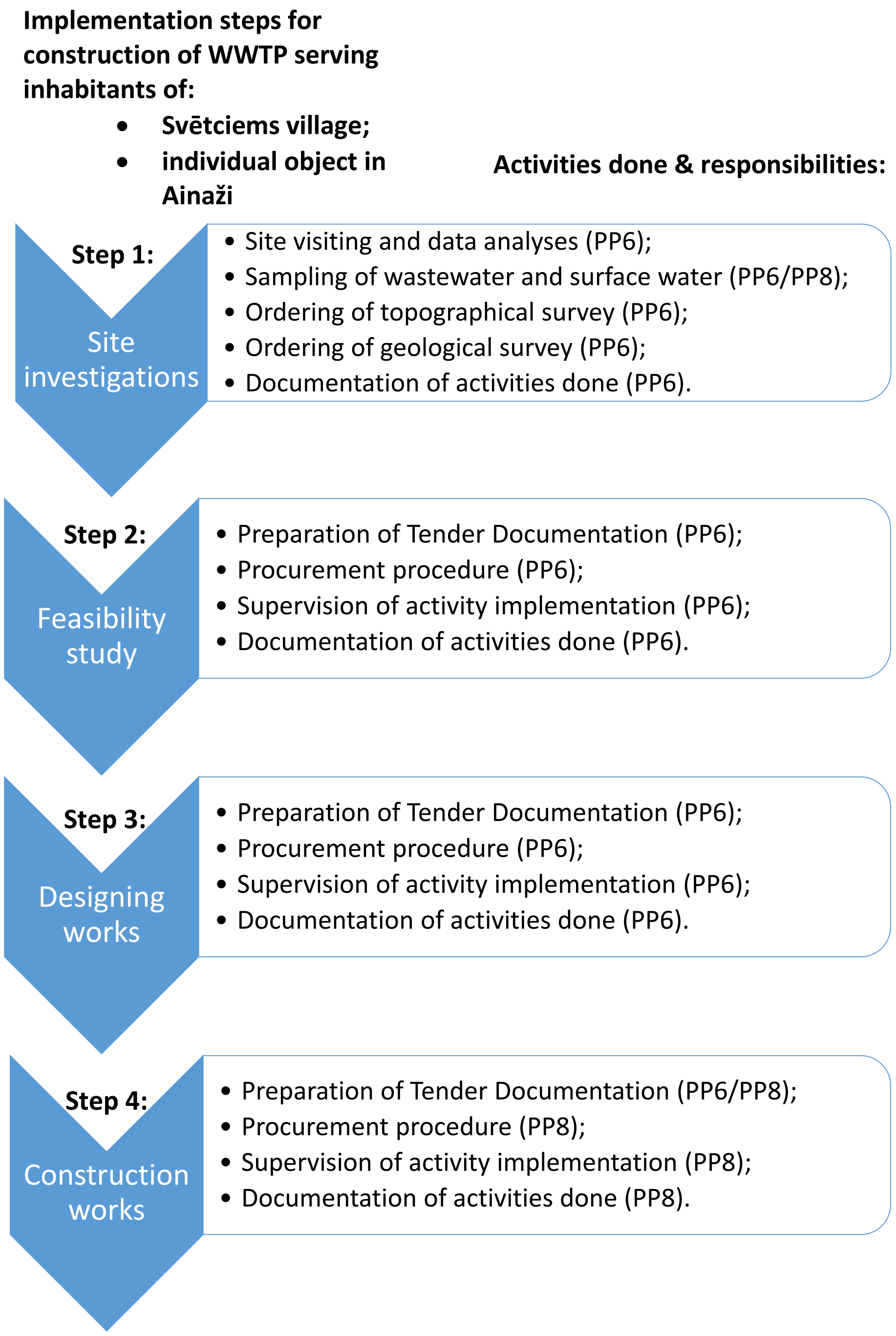


Figure 8. Implementation steps for construction of pilot objects in Latvia

- *Do you need the tender procedure? If yes, please explain what kind of procedure.*

University of Latvia (PP6)

According to project organization scheme (refer Figure 2) University of Latvia was responsible for (1) site investigations, including sampling of wastewater and surface water, ordering of topographical survey and ordering of geological survey; (2) feasibility study to select best technological solution and (3) designing works. All mentioned before activities were carried out as an external services. The ordering of external services is regulated both by national legislation (Public Procurement Law) and internal procedure set by University of Latvia. According to national legislation the tender procedure is not required if estimated contract price for external services is < 10 000 EUR, while according to the internal procedure of University of Latvia the provider of external services is selected on the bases of market research if estimated contract price for external services is < 1000 EUR. In practice it means that for all building preparatory activities – sampling of wastewater and surface water, topographical survey, geological survey, feasibility study and designing works – the technical documentation for service provider was prepared, at least 3 applicants were selected on the bases of market research, invitation letters were sent and the service provider selected on the bases of proposals received.

Salacgriva Dictric Municipality (PP8)

According to project organization scheme (refer Figure 2) Salacgrīva Municipality was responsible for construction works. The ordering of this external services is regulated by national legislation (Public Procurement Law). According to national legislation the procedure of price survey is required if estimated contract price for building services is > 20 000 and < 170 000 EUR, for which the minimum period for submission of application is 7 working days.

- *Is it necessary to obtain any assent for the building project from any institution?*

The procedure for assent of the building project depends from the amount of wastewater produced. The building board of Municipality determines the list of organizations, which are issued the technical regulations for the design project. For the small wastewater producers (< 5 m3/day) the technical regulations are issued by the Building Board of Municipality itself, electricity providers, gas providers and providers of telecommunications. Additionally to organizations mentioned before the technical requirements are required also from Environmental authority (Regional Environmental Board) if amount of wastewater produced exceeding 5 m^3/day.

- *Does your country require any tender or auction procedure for necessary construction materials?*

The construction materials are specified by design project. The specific tender for construction materials is not required.

1.24. Execution of the project (building)

1.24.1. Technologies of the implemented systems

- *Characteristics of Pilot site*

Location: The Pilot site is located in Northern part of Latvia next to the Highway Riga–Tallinn.
Sensitivity of area: Svētciems is located in the protected area – North Vidzeme Biosphere Reserve and is approximately in 1 km distance from the Gulf of Riga. Settlement is located on the banks of salmonid river Svētupe. Therefore the more strict requirements for treatment of sewerage water are defined by environmental authority.
Population and its density: The population of Svētciems is 379 inhabitants. Average density: 12,9 inhabitants 1 km^2 (average in Latvia: 36,6 inhabitants 1 km^2).

- *Description of the technology used before the execution of the project*

Collected wastewater are treated by using biological treatment technology and is characterized as follows:

Year of Construction	1986
WWT Technology	BIO – 100x2: Standard Project with 2 industrially produced aero-tanks
Projected capacity; m^3/day	Capacity of each aero-tank: 100 m^3 per day
Sewerage disposal	Treated wastewaters from aero-tank are discharged to surface water body through 4 biological ponds having function of surface flow constructed wetland. Thus additional nutrient purification is performed.
Requirements for recipient water body	Recipient water body: Svētupe, which is productive salmonid migration and spawning ground with status of salmonid waters. Additional treatment of wastewater is required.

- *What is necessary for the project execution?*

The problems to be solved with pilot object can be summarized as follows:

- The projected capacity of existing WWT facilities are too large for currently produced wastewater loads. Therefore only one aero-tank is operated;
- Since WWT plant was designed for bigger capacity and partial load was not expected for a long time, air blower power consumption is much more, then necessary;
- Existing concrete housing of WWT plant is leaking, making secondary soil pollution;
- The wastewater treatment requirements, set by the Regional Environmental Authority, are reached not because of efficient treatment within aero-tank, but because of additional purification carried out in biological ponds. These ponds are not isolated from the soil and have function of surface flow constructed wetland.

- <u>Amount of wastewater inflow:</u>
  - 48.7 m^3 per day;
  - 5.1 m^3 per hour.

- <u>Concentration of the pollutants in the inflow wastewater:</u>

Parameter	Value	Units of measure
BOD5	230	mg/l
COD	470	mg/l
Suspended solids	270	mg/l
Nitrogen total	94	mg/l
Phosphorous total	10.2	mg/l

- *Pollutants load per day:*

Parameter	Value	Units of measure
BOD5	11.2	kg
COD	22.9	kg
Suspended solids	13.1	kg
Nitrogen total	4.6	kg
Phosphorous total	0.5	kg

- *Concentration of the nutrients in the outflow wastewater after WWTP:*

Parameter	Value	Units of measure
BOD_5	3.6	mg/l
COD	41	mg/l
Suspended solids	1.5	mg/l
Nitrogen total	27.3	mg/l
Phosphorous total	3	mg/l

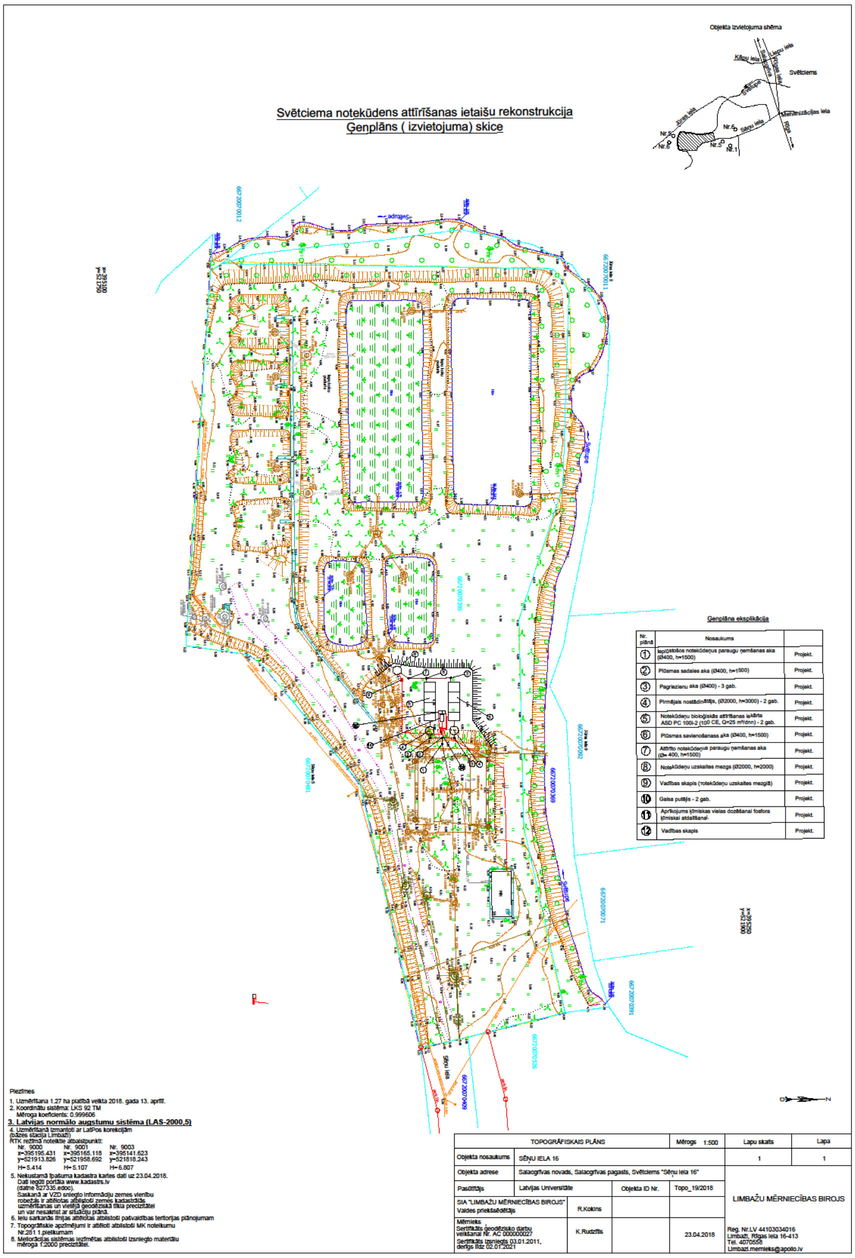
- *Pollutants load output from WWTP per day:*

Parameter	Value	Units of measure
BOD_5	0.175	kg
COD	2	kg
Suspended solids	0.073	kg
Nitrogen total	1.33	kg
Phosphorous total	0.146	kg

- Use of chemicals and electricity

No chemicals are used in the process, however the dosing pump is supplied and installed in case the quality of wastewater will become wore. Electrical energy daily consumption: 63 kW

- The description of the process: basic information and description of the treatment process with the technological schemes, what is realizing in each step of technology



- (1) Sampling of influent wastewater
- (2) flow distribution well
- (3) turning well
- (4) first settler
- (5) two factory-built Sequenced Batch Reactors
- (6) flow connection well
- (7) Sampling of effluent wastewater
- (8) wastewater metering unit
- (9) control unit
- (10) air blower
- (11) dosing of chemicals for nutrients removal

The equipment installation consists of two factory-built Sequenced Batch Reactors, which were delivered and installed into prepared construction pits. Each SBR performs independently from another, supplying more operation durability:

- SBR aeration zone volume is 49 m^3
- SBR clarification zone volume is 20 m^3

- Sludge formation amounts and how many times sludge has to be collected

Sludge formation amount is 40 m^3 per 6 months. Sludge collection is expected every 6 months.

- Description of regular maintenance needed

Regular maintenance needed:

  - Visual inspection every 1 month;
  - Sludge removal every 6 moths;
  - Blower air filter replacement every 12 months;
  - Electrical motors service every 5 years.

- *Amount of households connected to the technological system*

There are 45 family houses and five 3-floor apartment houses are connected to Svētciems WWTP.

- *Who is the main investor? Ownership of the installation?*

The main investors were the EU financial instrument – Baltic Sea Region Program – and Salacgrīva District Municipality. Ownership of the installation is by the municipality.

- *What is the tender procedure for project execution? Can you explain procedure in details with the choice criteria.*

The tender procedure was carried out only for construction of pilot objects. According to national legislation the procedure of price survey is required if estimated contract price for building services is > 20 000 and < 170 000 EUR, for which the minimum period for submission of application is 7 working days.

The tender procedure was carried out through the electronic system of public procurements. The announcement was published in the website of Salacgrīva District Municipality, where either Application forms and Technical Requirements, including design project, were available for downloading. The criteria for qualification to tender was previous experience for construction of WWT facilities of similar size and ability to guarantee advanced treatment of nutrients (N total ≤ 10 mg/l; P total ≤ 2 mg/l). The lower price criteria was used to select winner from the applicants who meet the qualification criteria.

- *Give characteristic of the Company realizing the project after tender procedure.*

The company selected during tender procedure is operated in Latvia since 2006 and since 2016 is the official partner of the German company KLARO GmbH in Latvia. Currently company have successfully installed more than 800 different wastewater treatment plants.

- *Beginning of the execution: signing agreement between investor and Company – explain all the terms of agreement from Investor and realizing Company sides, with scope of work.*

In order to finance the construction of pilot object the Salacgrīva District Municipality received a loan from the Treasury. Therefore the contract were signed for all construction costs. The constructor received 50% advance payment for the construction materials. Last payment were received after completing the works.

- *What is the estimated costs distribution between earthworks, machinery and man-work in the building process?*

Estimated costs distribution in the building process:

  - earthworks 40%
  - machinery 40 %
  - man-work 20 %

- *What kind of materials, installations and devices will be used in the building process?*

Materials, installations and devices used in the building process:

  - PE 100 pipes;
  - Sand;
  - SBR reactors, made of composite plastic;
  - Manholes, made of concrete, with cast iron closures;
  - Gate valves, made of ductile iron, epoxi coated;
  - Rotary air blowers, aluminium housing, electrical motor (cupper and ferromagnetics).

- *Is there any investor supervision?*

Investor supervision is performed by MUC "Salacgrīvas Ūdens" engineer.

- *If all changes in project by building company are agreed by designer of the investment? If yes, please explain changes in details (changes of materials, equipment, localization etc).*

No changes are made and accepted to the design project.

- *Completing the investment, technical and technological acceptance of the investment by the commission consisting of the representative of investor, supervisor, executor, designer and people from our project.*

According to Latvian legislation, the construction works, including technical and technological acceptance are performed by Parish Building Authority, Regional Environmental Authority and Construction Site Owner.

- *What criteria object should fulfil during start-up of objects?*

When all the construction works and installation of technological equipment is fully complete, start-up of the system can be commenced. The main criterion that the system must meet is the treatment efficiency and correspondence to design project.

- *Explain how standards requirements are fulfilled?*

According to Latvian legislation, the WWTP of such type should meet the following general requirements to effluent treated wastewater:

Parameter	Value	Units of measure
BOD_5	≤ 25	mg/l
COD	≤ 125	mg/l
Suspended solids	≤ 35	mg/l

The more strict requirements are set if recipient surface water body is classify as sensitive water. In case of Svētciems pilot object the responsible Environmental Authority did not set more strict requirements. The more strict requirements for nutrient's treatment (N total ≤ 10 mg/l; P total ≤ 2 mg/l) was set by VillageWaters Project to demonstrate with pilot object that additional treatment technologically is possible and also to get costs for more strict treatment.

1.24.2. Problems encountered during the building and their solutions

- *What changes and problems contains as-build project?*

In order to solve problems identified the design project includes both (1) reconstruction of biological WWTP with activated sludge, as cost effective and environmental more friendly solution the construction of new WWTP with appropriate capacity is designed on the land parcel of the old one and (2) cleaning of polishing pounds and its reconstruction to constructed wetland. Taking into account that the project budget was not sufficient for the whole project, it was decided to defined short-term and long-term activities and divide design project into several stages. After setting long-term activities the reconstruction of polishing pounds to constructed wetland was defined as 2nd stage for project implementation, which will be introduced out of frame of VillageWaters Project.

- *What was the most difficult problem?*

The Sequenced Batch Reactors technology is new technology for Latvia and until now has not been widely used in Latvia, the special efforts was needed to justify the benefits of this technology to responsible Environmental Authorities.

- *Who and how solved the problem?*

The communication with Regional Environmental Board to agree use of Sequenced Batch Reactors technology was arranged both as face-to-face meetings and sending of written documentation. Both project partners – PP6 (University of Latvia) and PP8 (Salacgrīva District Municipality) – and company selected during public tender procedure take part in this negotiations.

1.25. Activities after the finalization of building process

1.25.1. Overall conclusions on the building process

- *What were the problems and other challenges in the project? What did you learn? What were done differently compared to the project plan?*

The main challenge for the project was to introduce improved wastewater treatment, including nutrients removal. Reginal Environmental Board by issuing the technical requirements do not foreseen nutrients removal. Therefore improved wastewater treatment were introduce on the bases of procurement requirements, developed by Municipality (PP8).

The first level control has accepted only 75% of eligible costs, because according to procurement law the experience for using Sequenced Batch Reactors, which is best-available technology according to Information Tool, has no long enough experience in Latvia.

- *What was properly or improperly designed and realized?*

Everything was designed and realised properly.

- *Do these new structures meet habitants and your expectations?*

Yes. Treatment efficiency is good and operational costs low in comparison with previous.

1.25.2. Technological, economic, environmental, social and enviro-hygienic data acquired from the renovated wastewater treatment plants.

- *Current technological data acquired from the renovated wastewater treatment plant.*

The renovation of the outdated WWT facilities was initiated by Salacgrīva Municipality and evaluation of technical condition was done by University of Latvia, including sampling and analyses of influent and effluent wastewater and preparation of Feasibility Study. Project partners have been contacted to discuss best available technical solutions and Pilot sites in Lithuania and Poland was visited to select best technology for additional nutrients removal. Construction of new WWT facilities will be conducted in February-March 2018 and should be fully installed to start operate in April-May 2018.

- *Current economic data acquired from the renovated wastewater treatment plant: What is the energy efficiency compared to the old system?*

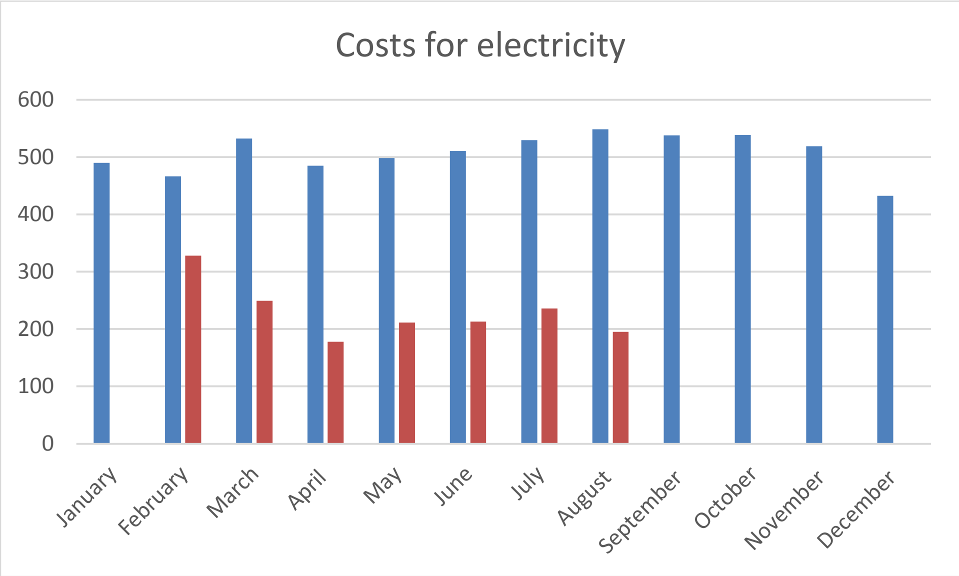


Figure 9. Costs for electricity before (blue) and after (red) reconstruction of WWT facility – pilot Svētciems

- *Current environmental data acquired from the renovated wastewater treatment plant: What are environmental benefits of the new system?*

  1. Smaller climate impact due to enlarged electry efficiency;
  2. Smaller eutrophication impact due to reduction of nutrient load;
  3. Improved wastewater treatment due to remote control of wastewater treatment.

- *Current social data acquired from the renovated wastewater treatment plant: Are the expectations of the end-users met? What is their opinion? Did the inhabitants participate in the building process?*

- *Current enviro-hygienic data acquired from the renovated wastewater treatment plant: Comparing and discussing the differences between the analysis results of the old and new system (table).*

The results have shown that during the treatment process the wastewater is treated efficiently and vary: suspended materials 93-100%, biochemical oxygen consumption in 5 days (BOD5) 92 -99%, total nitrogen (Nt) 53 - 100%, total phosphorus (Pt) 43%.

Acknowledgement

We thank all participants in this work. Special thanks to water utility "Salacgrīvas ūdens" for operative communication during construction period and all the inhabitants of the Svētciems village for experience sharing and providing information for social evaluations.

Appendices

Picture 21. The old WWTP in the Svētciems village.

Picture 22. The new WWTP during construction.

Picture 23. The inspection of WWTP construction carried out by responsible state environmental authority.

A PILOT CASE OF AINAŽI IN LATVIA: THE PROCESS OF BUILDING THE TECHNOLOGICAL SYSTEMS

1.26. Description of the project management

The project "*Water emissions and their reduction in village communities – villages in Baltic Sea Region as pilots*" (Village Waters) in Latvia is being implemented in Svētciems and Ainaži village, Salacgrīva District Municipality. The aim of this Project Activity (A3.2) is to build the best-fitting wastewater treatment (WWT) systems in the in the pilot area of Salacgrīva District Municipality (Project Partner 8) and provide information from existing pilot plants to information tool (A2.6).

The project is coordinated by University of Latvia (PP6) and implemented by the administration of Salacgrīva District Municipality (PP8) in close co-operation with PP6. Salacgrīva District Municipality is the implementing authority in charge of construction of both WWT plants. PP6 is carrying out preparations – feasibility study, topographical survey, geological investigations – and development of technical documentation. The work groups have been formed both in PP6 and PP8 institutions, and the persons responsible for certain activities of the project and handling of their documentation have been appointed.

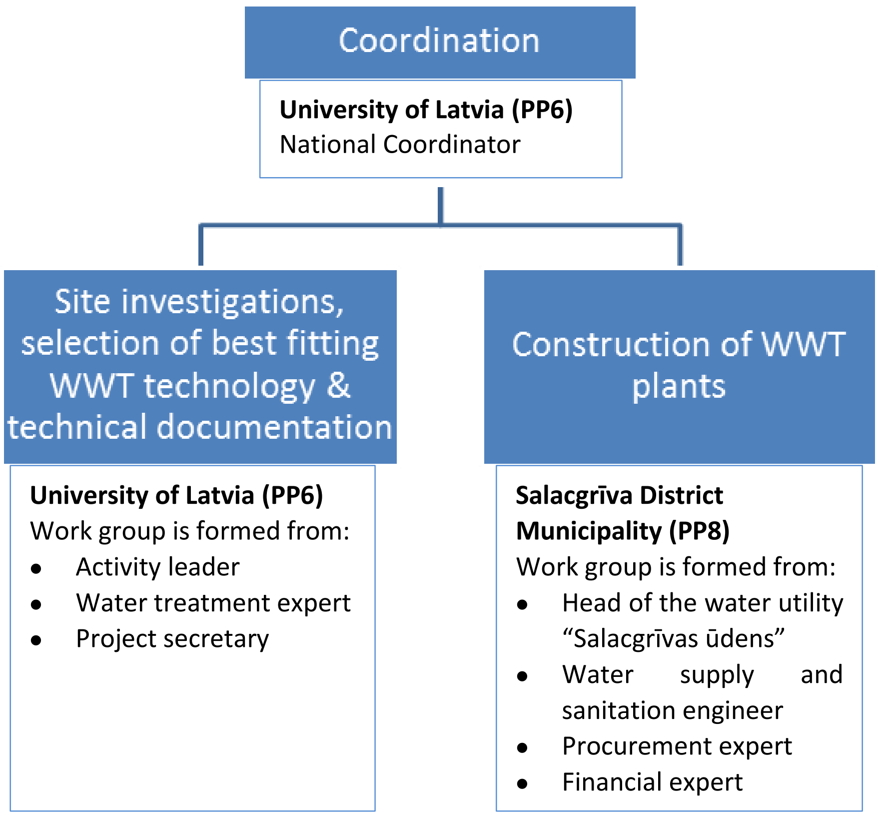


Figure 10. The organization scheme and dividing of responsibilities between project partners

1.27. Planning the investment

1.27.1. How contracting processes were organized and put to practice

All project related documentation, including pilot object construction or reconstruction, have to be signed by top management of partner organization. In case of University of Latvia it is Vice-rector for exact sciences, life and medical sciences, while in Salacgriva Municipality Council – Salacgriva Municipality Mayor.

University of Latvia (PP6)

The granted funding from the Programme for VillageWaters project is 85% and 15% is own contribution. If project partner is publicly funded educational institution, according to national legislation 15% of project expenses are financed from the State budget.

Project budget becomes part of whole budget of organization. Project expenses have to forecated and reported on regular bases.

The financing of VillageWaters project implementation is carried out according to following procedure – on the bases of signed project agreements (Subsidy contract and Partner Agreement) and financial plan of project expenses organization monthly receive 100% pre-financing from the Ministry of Education and 85% of them are paid back when are refunded from the structural funds of the European Union on the bases of Period's Reports.

Salacgriva Dictric Municipality (PP8)

The granted funding from the Programme for VillageWaters project is 85% and 15% is own contribution. If project partner is Municipality, according to national legislation 5% of project expenses can be refunded from the State budget.

Taking into account that co-financing of project activities is carried out from budget of Municipality, project budget have to be approved by Municipal Council, which consisting of representatives elected by residents of the municipality vote for council's decision. In practice it means that Project budget becomes part of whole budget of organization and 10% of all qualified project expenses (also unqualified expenses but necessary for the its implementation) are financed from Municipality budget.

The financing of VillageWaters project implementation is carried out as reimbursement according to following procedure – initially all project's expenses are covered by own funds of the organization (in case of this project it was loan to the Treasury) and 85% of them are refunded from the structural funds of the European Union upon their declaration.

1.27.2. How the official processes were carried out?

The international standards prepared by the International Federation of Consulting Engineers ("FIDIC") can be addressed to Village Waters project to explain project implementation steps and differences of implementation of A3.2 in different project partner countries. The procedure of Contract for Construction of Engineering Works Designed by the Employer (the "Red Book" contracts) was used if technical documentation, including design projects, was already developed in the beginning of project. Similarly, the procedure of Contracts for Construction of Engineering Works Designed by the by the Contractor (the "Yellow Book" contracts) was used if site investigations (topographical & geological survey) and preparation of technical documentation was done during the implementation of project. The implementation of A3.2 in Latvia was carried out according to procedure of "Yellow Book" and includes both construction and preparation of technical documentation. Therefore the implementation schedule was longer in cooperation with those partner countries (Finland, Estonia and Lithuania) were procedure of "Red Book" contracts were used. The procedure of A3.2 implementation and dividing of responsibilities between Latvian project partners PP6 and PP8 is resented in the Figure 11.

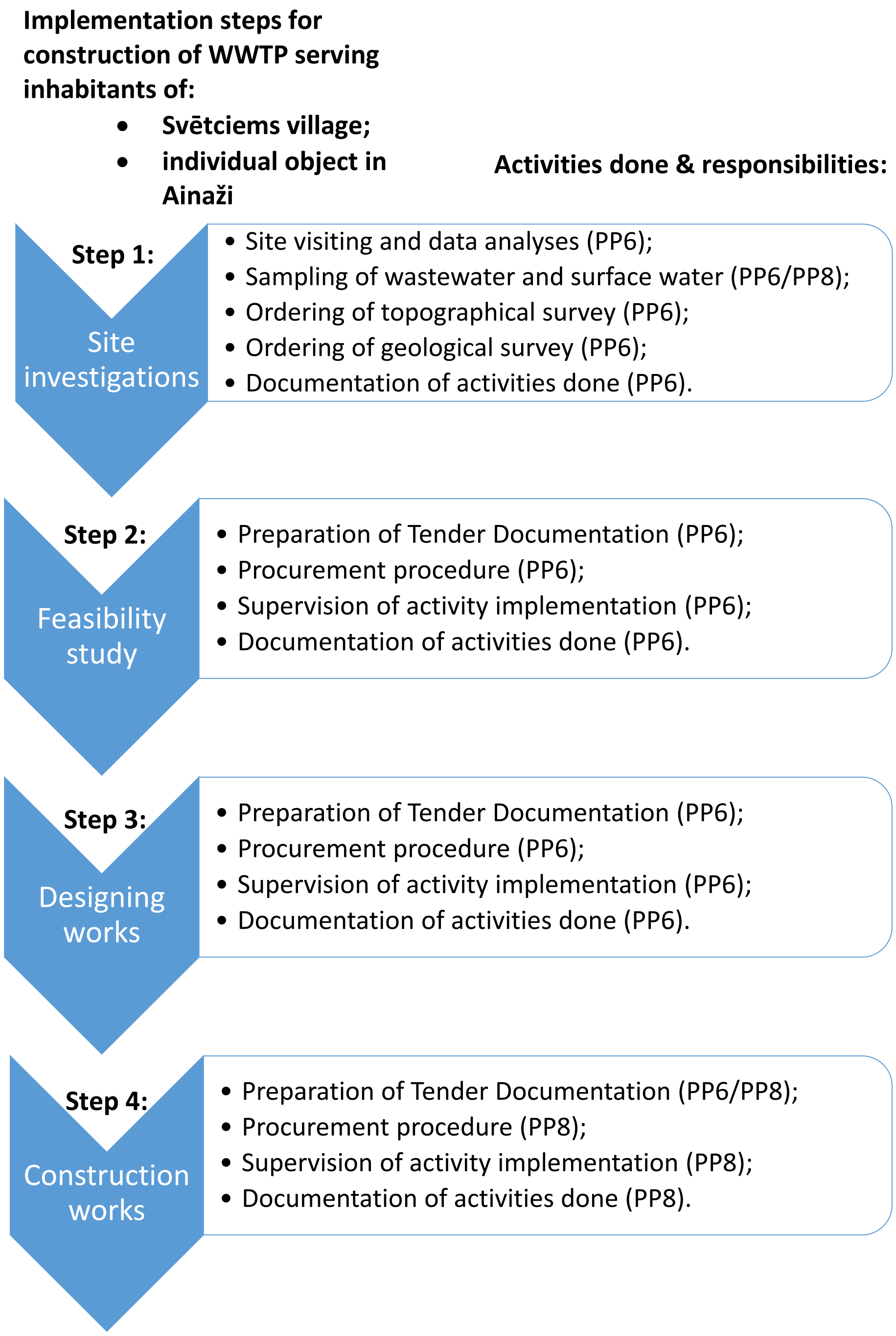


Figure 11. Implementation steps for construction of pilot objects in Latvia

University of Latvia (PP6)

According to project organization scheme (refer Figure 2) University of Latvia was responsible for (1) site investigations, including sampling of wastewater and surface water, ordering of topographical survey and ordering of geological survey; (2) feasibility study to select best technological solution and (3) designing works. All mentioned before activities were carried out as an external service. The ordering of external services is regulated both by national legislation (Public Procurement Law) and internal procedure set by University of Latvia. According to national legislation the tender procedure is not required if estimated contract price for external services is < 10 000 EUR, while according to the internal procedure of University of Latvia the provider of external services is selected on the bases of market research if estimated contract price for external services is < 1000 EUR. In practice it means that for all building preparatory activities – sampling of wastewater and surface water, topographical survey, geological survey, feasibility study and designing works – the technical documentation for service provider was prepared, at least 3 applicants were selected on the bases of market research, invitation letters were sent and the service provider selected on the bases of proposals received.

Salacgriva Dictric Municipality (PP8)

According to project organization scheme (refer Figure 2) Salacgrīva Municipality was responsible for construction works. The ordering of this external service is regulated by national legislation (Public Procurement Law). According to national legislation the procedure of price survey is required if estimated contract price for building services is > 20 000 and < 170 000 EUR, for which the minimum period for submission of application is 7 working days.

- *Is it necessary to obtain any assent for the building project from any institution?*

The procedure for assent of the building project depends from the amount of wastewater produced. The building board of Municipality determines the list of organizations, which are issued the technical regulations for the design project. For the small wastewater producers (< 5 m3/day) the technical regulations are issued by the Building Board of Municipality itself, electricity providers, gas providers and providers of telecommunications. Additionally to organizations mentioned before the technical requirements are required also from Environmental authority (Regional Environmental Board) if amount of wastewater produced exceeding 5 m^3/day.

- *Does your country require any tender or auction procedure for necessary construction materials?*

The construction materials are specified by design project. The specific tender for construction materials is not required.

1.28. Execution of the project (building)

1.28.1. Technologies of the implemented systems

Ainaži

- *Data about the technology*

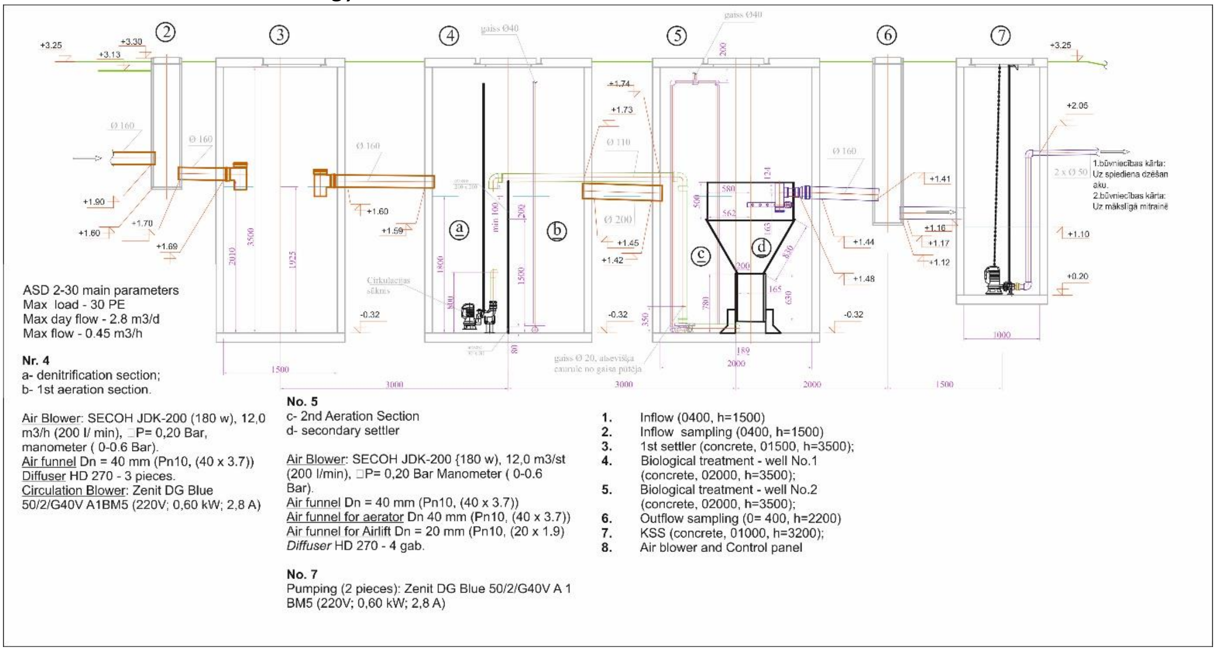


Figure 12. Scheme of the wastewater treatment plant for apartments building in Ainaži (Salacgrīva Municipality).

- *Amount of wastewater inflow:*

4.5 m^3 per day; 1.2 m^3 per hour.

- *Concentration of the pollutants in the inflow wastewater – calculated theoretically:*

Parameter	Value	Units of measure
BOD5	400	mg/l
COD	733	mg/l
Suspended solids	467	mg/l
Nitrogen total	67	mg/l
Phosphorous total	13	mg/l

- *Pollutants load per day:*

Parameter	Value	Units of measure
BOD5	1.8	kg
COD	3.3	kg

Suspended solids	2.1	kg
Nitrogen total	0.3	kg
Phosphorous total	0.06	kg

- *Concentration of the nutrients in the outflow wastewater after WWTP:*

Parameter	Value	Units of measure
BOD5	3.0	mg/l
COD	52	mg/l
Suspended solids	3.2	mg/l
Nitrogen total	21	mg/l
Phosphorous total	3.4	mg/l

- *Pollutants load output from WWTP per day:*

Parameter	Value	Units of measure
BOD5	0.014	kg
COD	0.234	kg
Suspended solids	0.014	kg
Nitrogen total	0.108	kg
Phosphorous total	0.015	kg

- *Use of chemicals and electricity*

No chemicals are used in the process, however the dosing pump is supplied and installed. It should be used to make total phosphorous output even lower. Electrical energy daily consumption: 3.6 kW.

- *The description of the process: basic information and description of the treatment process with the technological schemes, what is realizing in each step of technology*

The equipment installation consists of one line of concrete manholes, equipped with aeration system and two clarification systems, assembled on-site.

  - Prelimenary clarifier surface is 1.7 m²
  - BR denitrification zone volume is 2 m³
  - BR aerobal zone volume is 7.7 m³
  - Secondary clarifier surface is 1 m²

- *Sludge formation amounts and how many times sludge has to be collected*

Sludge formation amount is 1.8 m³ per 1 months. Sludge collection is expected every 1 month.

- *Description of regular maintenance needed*

Regular maintenance needed:

  - Visual inspection every 1 week;
  - Sludge removal every 1 moths;
  - Blower air filter replacement every 12 months;
  - Electrical motors service every 5 years.

- *Amount of households connected to the technological system*

There are 30 people in one two-floor apartment house are connected to Ainazi WWTP.

- ***Who is the main investor?***

The main investors were the EU financial instrument – Baltic Sea Region Program – and Salacgrīva District Municipality.

- ***What is the tender procedure for project execution? Can you explain procedure in details with the choice criteria.***

The tender procedure was carried out only for construction of pilot objects. According to national legislation the procedure of price survey is required if estimated contract price for building services is > 20 000 and < 170 000 EUR, for which the minimum period for submission of application is 7 working days.

The tender procedure was carried out through the electronic system of public procurements. The announcement was published in the website of Salacgrīva District Municipality, where either Application forms and Technical Requirements, including design project, were available for downloading. The criteria for qualification to tender was previous experience for construction of WWT facilities of similar size and ability to guarantee advanced treatment of nutrients (N total ≤ 10 mg/l; P total ≤ 2 mg/l). The lower price criteria was used to select winner from the applicants who meet the qualification criteria.

- ***Give characteristic of the Company realizing the project after tender procedure.***

The company selected during tender procedure is operated in Latvia since 2008 and specializes for small wastewater treatment plants construction.

- ***Beginning of the execution: signing agreement between investor and Company – explain all the terms of agreement from Investor and realizing Company sides, with scope of work.***

In order to finance the construction of pilot object the Salacgrīva District Municipality received a loan from the Treasury. Therefore the contract were signed for all construction costs. The constructor received 50% advance payment for the construction materials. Last payment were received after completing the works.

- *<u>What is the estimated costs distribution between earthworks, machinery and man-work in the building process?</u>*

Estimated costs distribution in the building process:

  - earthworks 40%;
  - machinery 25 %;
  - man-work 35 %.

- *<u>What kind of materials, installations and devices will be used in the building process?</u>*

Materials, installations and devices used in the building process:

  - PE 100 pipes;
  - Sand;
  - Manholes, made of concrete, with cast iron closures;
  - Gate valves, made of ductile iron, epoxi coated;
  - Pisto air blowers, PVDF housing, electrical motor (cupper and ferromagnetics).

- *<u>Is there any investor supervision? Ownership of the installation?</u>*

Investor supervision is performed by MUC "Salacgrīvas Ūdens" engineer. Ownership of the installation is by the municipality.

- *<u>If all changes in project by building company are agreed by designer of the investment? If yes, please explain changes in details (changes of materials, equipment, localization etc).</u>*

No changes are made and accepted to the design project.

- *<u>Completing the investment, technical and technological acceptance of the investment by the commission consisting of the representative of investor, supervisor, executor, designer and people from our project.</u>*

According to Latvian legislation, the construction works, including technical and technological acceptance are performed by Parish Building Authority, Regional Environmental Authority and Construction Site Owner.

- *<u>What criteria object should fulfil during start-up of objects?</u>*

When all the construction works and installation of technological equipment is fully complete, start-up of the system can be commenced. The main criterion that the system must meet is the treatment efficiency and correspondence to design project.

- *Explain how standards requirements are fulfilled?*

According to Latvian legislation, the WWTP of such type should meet the following requirements to effluent treated wastewater:

Parameter	Value	Units of measure
BOD_5	≤ 25	mg/l
COD	≤ 125	mg/l
Suspended solids	≤ 35	mg/l

The more strict requirement was set by VW to demonstrate with pilot object that additional treatment technologically is possible and also to get costs for more strict treatment.

1.28.2. Problems encountered during the building and their solutions.

- *What changes and problems contains as-build project?*

The investments preliminary identified in the Application after preparation of technical project was stated as being to low. In order to fit in budget line it was decided to separate project into short-term and long-term program. The long-term program includes construction on constructed wetland, where additional removal of nutrients is foreseen be conducted.

- *What was the most difficult problem?*

For the operation of wastewater treatment plant it was needed to provide with centralised water, supply, construct internal wastewater collecting system (pipes) and dig electricity cable. That form additional costs and time recourses.

- *Who and how solved the problem?*

Additional costs were covered from Municipality budget.

1.29. Activities after the finalization of building process.

1.29.1. Overall conclusions on the building process.

- *What were the problems and other challenges in the project? What did you learn? What were done differently compared to the project plan?*

The main challenge for the project was to introduce improved wastewater treatment, by using constructed wetlands for additional nutrients treatment. Technical project for constructed wetland was developed on the bases of experience obtained from Polish Partners.

Unfortunately building of constructed wetland was postponed to long-term program due to lack of finances and will be implemented after the VillageWaters project.

- *What was properly or improperly designed and realized?*

Building of constructed wetland was postponed to long-term program due to lack of finances and will be implemented after the VillageWaters project.

- *Do these new structures meet habitants and your expectations?*

Yes. The building of wastewater treatment plant, provide opportunity for inhabitants to receive also centralized water supply service.

1.29.2. Technological, economic, environmental, social and enviro-hygienic data acquired from the renovated wastewater treatment plants.

- *Current technological data acquired from the renovated wastewater treatment plant.*

The renovation of the outdated WWT facilities was initiated by Salacgrīva Municipality and preliminary evaluation of technical condition was done by University of Latvia, including sampling and analyses of influent and effluent wastewater and preparation of Feasibility Study. Project partners have been contacted to discuss best available technical solutions and Pilot sites in Lithuania and Poland was visited to select best technology for additional nutrients removal.

- *Current economic data acquired from the renovated wastewater treatment plant: What is the energy efficiency compared to the old system?*

Total costs are decreased due o fact that frequency of effluent removal is decreased dramatically.

- *Current environmental data acquired from the renovated wastewater treatment plant: What are environmental benefits of the new system?*
  1. Smaller climate impact due to enlarged electry efficiency;
  2. Smaller eutrophication impact due to reduction of nutrient load;
  3. Improved wastewater treatment due to remote control of wastewater treatment.

- *Current social data acquired from the renovated wastewater treatment plant: Are the expectations of the end-users met? What is their opinion? Did the inhabitants participate in the building process?*
  1. Yes. The building of wastewater treatment plant, provide opportunity for inhabitants to receive also centralized water supply service.
  2. No. construction was done by building company.

- *Current enviro-hygienic data acquired from the renovated wastewater treatment plant: Comparing and discussing the differences between the analysis results of the old and new system (table).*

No reference data because previously wastewater on site was only stored and removed for centralized treatment with municipal WWT plant.

Acknowledgement

We thank all participants in this work. Special thanks to water utility “Salacgrīvas ūdens” for operative communication during construction period and all the inhabitants of the Ainaži dwelling for experience sharing and providing information for social evaluations.

Appendices

Picture 24. The Ainaži pilot site before the construction of WWT plant.

Picture 25. The WWTP during construction.

A PILOT CASE OF KOLGAKÜLA AND VALKLA IN ESTONIA: THE RENOVATION/ INSTALLATION OF WASTEWATER TREATMENT PLANTS IN BOTH PILOTS AREAS

Niina Dulova, Kalle Küngas

1.30. Description of the project management

This part includes information of the process management groups, executing, project documentation, project monitoring and controlling:

*Hereinafter, the **project** is a project for the renovation/installation of wastewater treatment plants in both pilots areas (Kolgaküla village and Valkla village).*

- *Who was in charge of which parts for the project management?*

Responsible persons: Kalle Küngas (Kuusalu Soojus Ltd, Manager) and Külli Malm (Kuusalu Soojus OÜ Ltd, Finacial Manager)

- *Who took care of management of different kind of sub-tasks as well as schedules and budgets so that they follow product plan as well as possible?*

Responsible persons: Kalle Küngas (Kuusalu Soojus Ltd, Manager) and Külli Malm (Kuusalu Soojus OÜ Ltd, Finacial Manager)

- *Who took care of the relations of the authorities and the dialogue during the project?*

Responsible persons: Kalle Küngas (Kuusalu Soojus Ltd, Manager)

- *How the allocation of resources was done and who was responsible for that?*

Responsible parties: Design company (Vensen Ltd), Kuusalu Municipality where involved, all responsible for that was Kalle Küngas (Kuusalu Soojus Ltd, Manager).
Kuusalu Municipality initiated the renovation of outdated wastewater treatment facilities. Kuusalu Soojus Ltd realized the renovation of pipelines system and the construction/installation of the new WWTP.

- *Who was responsible for documentation?*

Responsible parties: Design compay (Vensen Ltd) and Kalle Küngas (Kuusalu Soojus Ltd, Manager)

- *How the responsibilities were divided in the project group? How the documentation was organized between different parts (schedule of the project, costs, quality, effectiveness, dissemination)?*
  - ✓ Responsible for schedule of the project - Kalle Küngas (Kuusalu Soojus Ltd, Manager)
  - ✓ Responsible for costs of the project – Külli Malm (Kuusalu Soojus Ltd, Financial Manager)
  - ✓ Responsible for quality of the project - Kalle Küngas (Kuusalu Soojus Ltd, Manager), Tanel Tõnsau (Kuusalu Soojus Ltd, Production Manager)
  - ✓ Responsible for effectiveness of the project - Kalle Küngas (Kuusalu Soojus Ltd, Manager), Tanel Tõnsau (Kuusalu Soojus Ltd, Production Manager), Külli Malm (Kuusalu Soojus Ltd, Financial Manager)
  - ✓ Responsible for dissemination of the project - Kalle Küngas (Kuusalu Soojus Ltd, Manager), Talel Tõnsau (Kuusalu Soojus Ltd, Production Manager), Külli Malm (Kuusalu Soojus Ltd, Financial Manager)

- *Who is responsible for monitoring and controlling?*

Responsible parties: Supervisor (Vetepere Ltd) and Kalle Küngas (Kuusalu Soojus Ltd, Manager)

- *Which were functions that were monitored (can be costs, quality, schedule etc.).*

The whole process (all steps/functions) was monitored.

- *How feedback between product phases has been arranged?*

Feedback was arranged after all product phases during the project meetings.

- *How the management was succeeded?*

The project management was trouble free.

1.31. Planning the investment

1.31.1. How contracting processes were organized and put to practice

- *What contract do you need before running the investment and what is the legal basis for it?*

No specific contract was needed before running the investment.

- *Parties of the contract. Who is responsible for what?*

Kuusalu Municipality initiated the renovation of outdated wastewater treatment facili-ties. Kuusalu Soojus Ltd realized the renovation of pipelines system and the construction/installation of the new WWTP. WWTP was produced by Keskkond & Partnerid Ltd (manufacturer of WWTP for both pilots areas). Supervisor (Vetepere Ltd). Design company (Vensen Ltd).

- *What are the terms in the contracts?*

The main terms in the contracts: 6 weeks for manufacture, 4 weeks for installation, 6 months for final analysis (final setting up of the treatment process, period of acclimatization of microorganisms, etc.)

- *As you know, 75% (Finland) or 85% (Estonia, Latvia, Lithuania, Poland) will be paid from project. Who is obliged to pay for the rest of the building activity?*

In the case of Estonian pilots there was **no financial support** for the VillageWaters project. The Municipality of Kuusalu and the local habitants funded the renovation of the pilots.

1.31.2. How the official processes were carried out.

- *How the official processes looks in your country (scheme of the legal path)? What is your role in planning?*

Kuusalu Soojus Ltd role was to coordinate all the planning process.

About company: Kuusalu Soojus Ltd is a utility company in Kuusalu Municipality. In 1991, the municipal company Sander was established by Kuusalu parish, which in turn was converted into a private limited company in 1998, Kuusalu Soojus Ltd.

The company owns boiler houses with district heating network in Kuusalu and Kolga small towns; sewerage facilities in Calvary, Kiius, Kuusalu, Valkla, Vihasol, Uuris and Kolgaküla and wastewater treatment plants in Kuusalu, Kolga, Valkla, Vihasoo, Uuri and Kolgaküla. Kuusalu Soojus Ltd is a water company in Salmistu, Viinistu, Pärispea, Kaberla, Leesi and Pudisoo villages. The company employs 11 people. The services provided by the company include the production and distribution of heat and drinking water, sewerage and cleaning of wastewater. In addition, residents and businesses are engaged in service activities related to their field. The main area of activity of the company is Kuusalu Municipality.

- *Who is responsible for designing separate pilots?*

Responsible parties: Kuusalu Soojus Ltd, design company (Vensen Ltd), manufacturer of unit (Keskkond & Partnerid Ltd)

- *Who is responsible for designing total investment?*

Responsible parties: Kuusalu Soojus Ltd

- *Do you have any specification of pre-requisite contract terms?*

No

- *Do you need the tender procedure? If yes, please explain what kind of procedure.*

No

- *Is it necessary to obtain any agreement for the building project from any institution?*

Yes

- *Does your country require any tender or auction procedure for necessary construction* materials?

In the case of this size of the project, there is no need to require a tender or auction for the necessary building materials.

Picture 26. Valkla village – installation of new WWTP.

Picture 27. Kolgaküla village – installation of new WWTP.

1.32. Execution of the project (building).

1.32.1. Technologies of the implemented systems.

- *Description of the technology (describe in relevant details, even though a description may be included in the 3.1 report), (=these designed parameters have been filled to the technology dataform A2.1. or/and A2.4)*

Kolgaküla village pilot:

- Amount (l/m^3) of wastewater inflow: 3…9 m^3/day
- Inflow and outflow of BOD, N, P:

2. Capacity	Waste water m3/day	BOD g/day	N g/day	P g/day	Acceptable duration days
Design inflow	6.6	3600	660	110	
Maximum inflow	9	4200	770	130	
Minimum inflow	3	1800	330	50	
Peak inflow	12	3600	660	110	1
Low occupation inflow	2	1200	220	40	7

- Use of chemicals and electricity: around 20 litres of ferrous sulfate

Valkla village pilot:

- Amount (l/m^3) of wastewater inflow: 100..150 m^3 /month
- Inflow and outflow of BOD, N, P

2. Capacity	Waste water m3/day	BOD g/day	N g/day	P g/day	Acceptable duration days
Design inflow	5.5	3000	550	90	
Maximum inflow	9	3600	660	110	
Minimum inflow	3	1800	330	50	
Peak inflow	12	3600	660	110	1
Low occupation inflow	2	1200	220	40	7

- Use of chemicals and electricity: around 20 litres of ferrous sulfate

- *The description of the process **for both pilots**: basic information and description of the treatment process*

  - **Purpose**

The wastewater treatment plant (WWTP) is designed to treat domestic wastewater. The plant is also capable to treat industrial wastewater with the similar waste concentrations as domestic wastewater.

  - **Technology**

The WWTP is based on activated sludge technology in sequencing batch reactor (SBR)

1. Basic information	
Manufacturer/Constructor	Keskkond & Partnerid OÜ
Country	Estonia
Make	Estonia
Model	Individual project, On-site made plant
Type of technology	Activated Sludge Plant, Sequence Batch Reactor (SBR)
Description of treatment process	Microbiological degradation, chemical fixation of P, sedimentation

- **Description**

The plant is designed for two batches in a day. The treatment of one batch takes 12 hours. Other adjustments like three or four batches in a day are also available if it is needed. Wastewater treatment takes place in sequencing batch reactor (SBR). The reactor has three tanks – equalizing tank, process tank and sludge thickening tank. Equalizing tank is the first step for wastewater in SBR. The purpose of tank is collecting wastewater for the next batch. Equalizing tank has coarse bubble diffusers to avoid settling of solids and pump for pumping wastewater to process tank. The activated sludge process takes place in process tank. There are fine bubble diffusers for aeration, a pump for excess sludge and a pump for effluent. The excess sludge form process tank is pumped into sludge thickening tank. Sludge settles to the bottom of the tank and surplus water flows from the top of the tank to equalizing tank. Sludge is stabilized by coarse bubble diffusers.

The information is presented for both pilots:

- Sludge formation amounts and how many times sludge has to be collected: Sludge formation is 1 m^3 /month and sludge is 3…4 times/year collected
- Description of regular mainetanance needed: Checking the pumps and level sensors.
- Amount of households connected to the technological system:
  Kolgaküla village: The pilot object is the separate sewage treatment system for two apartment houses (33 inhabitants in total).
  Valkla village: The pilot object is the sewage treatment system of two apartment buildings (49 inhabitants).

- *What is necessary for the project execution?*

Funding

- *Who is the main investor?*

The main investors are Kuusalu Soojus Ltd and Kuusalu Municipality

- *What is the tender procedure for project execution? Can you explain procedure in details with the choice criteria.*

No need in tender procedure

- *Give characteristic of the Company realizing the project after tender procedure.*

Kuusalu Soojus Ltd/Keskkond & Partnerid Ltd

- *Beginning of the execution: signing agreement between investor and Company – explain all the terms of agreement from Investor and realizing Company sides, with scope of work.*

Signing agreement.

- *What is the estimated costs distribution between earthworks, machinery and man-work in the building process?*

Table 1. Kolgaküla village pilot:

Piece of work	Total price, €			Notes
	Minimum	Average	Maximum	
Technology		9200		Valkla WWTP (the price of package plantt)
Installation		7160		Installation of WWTP
Construction*		24000		*exchange of sewerage piping (constrution and earthworks together)
Earthwork				
Electric work		1000		Electric work and material
Consulting				
Supervising		400		
Decommissioning				
Other services				
Total		41760		

Table 2. Valkla village pilot:

Piece of work	Total price, €			Notes
	Minimum	Average	Maximum	
Technology		9200		Valkla WWTP (the price of package plant)
Installation		7160		Installation of WWTP
Construction*		15500		*exchange of sewerage piping (construction and earthworks together)
Earthwork				
Electric work		650		Electric work and material
Consulting				
Supervising		400		
Decommissioning				
Other services				
Total		32910		

- *What kind of materials, installations and devices will be used in the building process?*

Table 3. Kolgaküla village pilot:

Material and energy inputs for	Item	Unit	Quantity	Notes
Construction	Tank, GRP, V=15 m3		1	Unit pcs
Construction	Reinforced concrete anchor blocks		3	Unit pcs
Construction	Sand	m^3	15	
Construction	Techical equipment		1	Unit pcs

Table 4. Valkla village pilot:

Material and energy inputs for	Item	Unit	Quantity	Notes
Construction	Tank, GRP, V=15 m3		1	Unit pcs
Construction	Reinforced concrete anchor blocks		4	Unit pcs
Construction	Sand	m^3	15	
Construction	Techical equipment		1	Unit pcs

Picture 28. Materials, transportation - the building process in Kolgaküla village pilot.


Picture 29. Installation - the building process in Kolgaküla village pilot.

Picture 30. Materials - the building process in Kolgaküla village pilot.

Picture 31. Materials, installations and devices used in the building process in Kolgaküla village pilot.

Picture 32. A. Materials, installations and devices used in the building process in Valkla village pilot.

Picture 33. B. Materials, installations and devices used in the building process in Valkla village pilot.


Picture 34. c. Materials, installations and devices used in the building process in Valkla village pilot.


Picture 35. d. Materials, installations and devices used in the building process in Valkla village pilot.

- *Is there any investor supervision?*

Supervisor (Vetepere Ltd).

- *If all changes in project by building company are agreed by designer of the investment? If yes, please explain changes in details (changes of materials, equipment, localization etc).*

There were no changes

- *Completing the investment, technical and technological acceptance of the investment by the commission consisting of the representative of investor, supervisor, executor, designer and people from our project.*

Yes

- *What criteria object should fulfil during start-up of objects?*

None

1.32.2. Problems encountered during the building and their solutions.

- *What changes and problems contains as-build project?*
- *From building process and mechanical parts please describe which elements are agreed with project design and which are not agreed.*
- *What was the most difficult problem?*
- *Who and how solved the problem?*

There were no problems

1.33. Activities after the finalization of building process.

1.33.1. Overall conclusions on the building process.

- *What were the problems and other challenges in the project? What did you learn? What were done differently compared tho the project plan?*

There were no significant problems. Due to bad quality of pipelines, they were renovated as well. Adjusting the SBR operation takes time.

- *What was properly or improperly designed and realized?*

The designed project included air-hoisting, but during realization it was changed to pumps that are cheaper and more reliable.

- *Do these new structures meet habitants and your expectations? Ownership of the installations?.*

Kolgaküla village pilot: Residents now have to pay for wastewater (they did not pay before). In addition, they must cover the co-financing of the construction of the WWTP.

Valkla village pilot: Residents must pay half the price for wastewater, but we must not forget the 10,000 euros they must pay as co-financing for the reconstruction of the WWTP.

Ownership of the both installation is by the municipalities.

- *conclusions of the building process*

Kolgaküla village pilot:
T Kolgaküla (Kolco) is an ancient village, which was first mentioned in written records in 1290. The population of Kolgaküla is around 185, with 64% of working age, 21% under age 18 and 15% over age 65. The village is sparsely populated, the density being 0.1 persons per hectare. The village crosses Baltic Klint. The bare fields of the alvar are windy and poor, and the berm of the klint is partially covered with hazelnut trees in a mixed forest, surrounding mostly by pine and spruce forests. Forests account for about 65% and agricultural areas 33% of the total area of Kolgaküla. The river Valgejõgi borders the village on one side, on the other side lies a marshy and dense spruce forest as well as Lake Lohja and a flooded clay quarry.
The pilot object is the separate sewage treatment system for two apartment houses (33 inhabitants in total). The existing wastewater treatment system (BIO-50 and 2 oxidation ponds) constructed at the end of the 1970s was mainly designed for organic matter removal. The wastewater biological treatment solution (BIO-50), is no longer working properly and currently not used. Thus, wastewater is directly discharged into the oxidation ponds (2500 m2) and discharged into Punsu creek.
After construction of the new sewage treatment facility, the treated effluent will be also discharged into Puntsu creek. It should be noted, that in Kolgaküla, groundwater is unprotected or weakly protected in most of the local municipality’s territory.

Picture 36. Kolgaküla village pilot before construction.

Picture 37. Kolgaküla village pilot before construction of WWTP and renovation of pipelines.

Kuusalu Municipality initiated the renovation of outdated wastewater treatment facilities. Kuusalu Soojus OÜ will realize the construction and provide maintenance for the new WWTP. Tallinn University of Technology will help other partners by providing knowhow in how to design and construct advanced biological wastewater treatment system (sequencing batch reactor (SBR), activated sludge process) in order to efficiently remove the organic load, decrease the load of nutrients into the environment, and bring the general quality of the effluent into compliance with the national regulations.

Construction of new WWTP and renovation of local pipelines was conducted in February 2018 and adjustment of the SBR operation should be completed in April-May 2018.

Picture 38. Kolgaküla village pilot during the construction of WWTP and renovation of pipelines.

Picture 39. Kolgaküla village pilot during and after construction of WWTP and renovation of pipelines.

Picture 40. Kolgaküla village pilot after construction of WWTP and renovation of pipelines.


Picture 41. Kolgaküla village pilot after construction of WWTP and renovation of pipelines.

Valkla village pilot:
Valkla is an ancient village. In 1241 it was registered in written records that there were 40 “smoke” in the village. Today, the village population is around 480, incl. 145 Valkla Social Welfare House residents. Seventy percent of the population is of working age, 13% are under age 18 and 17% over age 65. The area of Valkla is 1676 hectares. Agricultural areas account for about 62% and forests for about 37% of the total. Valkla creek flows through the village and ends up in the Gulf of Finland (Kolga Gulf). The creek is 12.5 km long and the catchment area is 46.5 km², most of which is located in the Valkla area. The village is sparsely populated with a population density of 0.3 persons per hectare.

The pilot object is the sewage treatment system of two apartment buildings (49 inhabitants). The wastewater biological treatment system (EKE-B 21) constructed in the beginning of the 1970s mainly for organic matter removal is outdated. Thus, the households’ sewage is collected into concrete holding tank and gully-emptier trucks transport it to the nearest WWTP twice a week. After construction of the new wastewater treatment facility, the treated effluent will be discharged into Valkla creek. Notably, in the village, groundwater is unprotected or weakly protected in most of locality. Moreover, Valkla creek is a salmonid waterbody and the mouth of the creek is a protected area.

Picture 42. Valkla village pilot before construction of WWTP and renovation of pipelines.

The renovation of the outdated wastewater treatment facilities was initiated by Kuusalu Municipality and realised by Kuusalu Soojus OÜ. TTÜ helped other partners by providing knowhow in how to design and construct an advanced biological wastewater treatment system (sequencing batch reactors (SBR), activated sludge process) in order to provide efficient organic load removal, decrease the amount of nutrients loaded into the environment, and bring the general quality of the effluent into compliance with national regulations. Construction of new WWTP and renovation of local pipelines was conducted in November 2017 and adjustment of the SBR operation was completed in March 2018.

Picture 43. Valkla village pilot before construction of WWTP and renovation of pipelines.

Picture 44. Valkla village pilot during the construction of WWTP and renovation of pipelines.

Picture 45. Valkla village pilot after the construction of WWTP and renovation of pipelines.

Picture 46. Valkla village pilot during the construction of WWTP and renovation of pipelines.

Picture 47. Valkla village pilot during the construction of WWTP and renovation of pipelines.

Picture 48. Valkla village pilot during the construction of WWTP and renovation of pipelines.

Picture 49. Valkla village pilot during the construction of WWTP and renovation of pipelines.

Video: https://www.youtube.com/watch?v=mfLEstnb7ho

1.33.2. Technological, economic, environmental, social and enviro-hygienic data acquired from the renovated wastewater treatment plants.

- *Current technological data acquired from the renovated wastewater treatment plant.*

Kolgakula: Kuusalu Municipality initiated the renovation of outdated wastewater treatment facilities. Kuusalu Soojus OÜ will realise the construction and provide maintenance for the new Kolgakula WWTP. Tallinn University of Technology will help other partners by providing knowhow in how to design and construct advanced biological wastewater treatment system (sequencing batch reactor (SBR), activated sludge process) in order to efficiently remove the organic load, decrease the load of nutrients into the environment, and bring the general quality of the effluent into compliance with the national regulations. Construction of new WWTP and renovation of local pipelines was conducted in February 2018 and adjustment of the SBR operation was completed in April-May 2018.

Valkla: The renovation of the outdated wastewater treatment facilities was initiated by Kuusalu Municipality and realised by Kuusalu Soojus OÜ. TTÜ helped other partners by providing knowhow in how to design and construct an advanced biological wastewater treatment system (sequencing batch reactors (SBR), activated sludge process) in order to provide efficient organic load removal, decrease the amount of nutrients loaded into the environment, and bring the general quality of the effluent into compliance with national regulations. Construction of new Valkla WWTP and renovation of local pipelines was conducted in November 2017 and adjustment of the SBR operation was completed in March 2018.

- *Current economic data acquired from the renovated wastewater treatment plant: What is the energy efficiency compared to the old system?*

Kolgaküla; at the beginning of the project there was no proper wastewater system and no costs for inhabitants. Even the costs increased a lot in Kolgaküla pilot, owners didn't express dissatisfaction in interviews.

In Valkla, in the old system common holding tank was emptied twice per week. Owners considered that the costs were rather much (3,6 €/m^3). After the changes in Estonian pilots, in both villages (Valkla, Kolgaküla) the price is the same based on the wastewater produced (2,47 €/m^3).

- *Current environmental data acquired from the renovated wastewater treatment plant: What are environmental benefits of the new system?*

Kolgakula: The study's results have shown that during the treatment process the wastewater is treated efficiently and vary: suspended materials 71-76 %, biochemical oxygen consumption in 7 days (BOD7) 71 -84 %, total nitrogen (Nt) 50 – 98 %, total phosphorus (Pt) 96- 98 %. The values tended to increase for all indicators of wastewater cleaning efficiency (the function is positive, and the determination coefficients are R2= 0. 20; R2= 0.78; R2=0.35 and R2= 0.15).

Valkla: The study's results have shown that during the treatment process the wastewater is treated efficiently and vary: suspended materials 58-70 %, biochemical oxygen consumption in 7 days (BOD7) 63 -87 %, total nitrogen (Nt) 37 – 98 %, total phosphorus (Pt) 98 %.

- *Current social data acquired from the renovated wastewater treatment plant: Are the expectations of the end-users met? What is their opinion? Did the inhabitants participate in the building process?*

According to inhabitants interviews there were no problems during the building process. In large systems such as in Leitgiriai, Valkla and Kolgaküla companies built the systems. In Valkla and in Kolgaküla installations of package plant took two weeks and building and changing the pipelines took another two weeks. From the company's point of view, the fact that the same company built similar systems for two villages made the processes easier and cheaper.

In Valka and Kolgaküla the inhabitants interviewed were satisfied with the maintenance service included within the new system.

In Valkla and in Kolgaküla, the only problems that inhabitants have had since far have been economic. However, in Estonian pilots the head of the apartment associations didn't report any advantages for the community; the life of the inhabitants has not changed. However, inhabitants are satisfied with the new system since it is better for the environment, modern and in Valkla also the maintenance and sludge management costs decreased.

- *Current enviro-hygienic data acquired from the renovated wastewater treatment plant: Comparing and discussing the differences between the analysis results of the old and new system (table).*

Kolgakula: After renovation Kolgakula WWTP ammonia, nitrites and nitrates nitrogen values in Punsu River the same 100 m after the wastewater discharger like 500 m. BOD7 values after renovation of Kolgakula WWTP were significantly higher 100 m after the wastewater discharger than 500 m.

Studies have shown that renovation of Kolgakula WWTP has positive impact into Punsu River water status, wastewater is treated efficiently

Valkla: After renovation Valkla WWTP nitrogen total, ammonia and nitrates nitrogen, electrical conductivity concentration and BOD7 values in Valkla River were the same 100 m after the wastewater discharger like 500 m.

Studies have shown that renovation of Valkla WWTP has positive impact into Valkla River water status, wastewater is treated efficiently.

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