ASPECTE TEHNICE, ECONOMICE ȘI SOCIALE INOVATOARE PRIVIND EXECUTAREA STAȚIEI DE EPURARE A APELOR UZATE DIN ORAȘUL LIVADA

INNOVATIVE TECHNICAL, ECONOMIC AND SOCIAL ASPECTS REGARDING THE EXECUTION OF THE WASTEWATER TREATMENT PLANT IN LIVADA TOWN

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ABSTRACT. The objective of the project entitled *"The extension and rehabilitation of water and waste water infrastructure in Satu Mare County„* from within *"Sectorial Operational Programme Environment"* (SOP ENV), was the achievement of the sewage systems, which totals 175 km of new sewage network, 27 km of rehabilitated sewage, the construction of 3 sewage treatment plants and the extension of 2 sewage treatment plants. The main theme of this study is the presentation of the sewage system in Livada town, from the standpoint of new technologies being used, respectively in the light of materials and innovative equipment used, that have contributed to the achieving a new, modern network of waste water collection, pumping stations and treatment plants of waste water which should serve 4984 population equivalents. The treatment plant is an automated station *(compact mechanical gear, classical biological gear)*, where operating is achieved in a continuous flow *(local or at SCADA central dispatch level)*, and through the big number of equipment *(sensors)* which monitor in continuous flow the quality of waste water, a complete image of the efficiency of the treatment process can be formed. The improvement of the quality of the treated water will be observed through a comparative analysis of the physico-chemical parameters of the effluent and influent before and after achieving the wastewater treatment plant. Through the multitude of data that is being registered in SCADA, a research study can easily be achieved. Sensors monitor the waste water quality and the treatment process efficiency. An evaluation of the costs of sewage system components was achieved aiming to optimize the price of wastewater treatment plant and to estimate future development costs. Another aspect covered in the study was achieving an analysis of risks regarding operation of the wastewater treatment plant. The difficulties and issues that can appear in the process of adjusting the treatment plants in view of framing the loadings into parameters set by NTPA are presented, respectively Water Rights Permit, as well as in respecting operating costs, undertaken by the Entrepreneur at the time of submission of the offer. In the final part of the study, the measures that can be taken in developing new projects within the programme *"Large Infrastructure Operational Programme"* (POIM) are presented. These measures are based on previous experience, gathered in the implementation of projects POS-MEDIU regarding the construction / rehabilitation / extension of the sewage system.

KEYWORDS: wastewater treatment plant, new technology, project, evaluation of the costs, analysis of risks.

1. INTRODUCTION

According to Government Decision no. 352 of 21 April 2005 in Annex 1, Article 5 *"entire Romanian territory is designated as a sensitive area in urban agglomerations of more than 10.000 inhabitants, must ensure urban wastewater collection and treatment through their advanced level sewers at a tertiary stage in order to remove nitrogen and phosphorus before discharging into natural receivers"*, which improves the quality of wastewater discharged from

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treatment plants into the environment and will move from NTPA-002 *(which regulates the requirements that must be satisfied by the wastewater discharged into the local sewerage networks and directly to the treatment plants)* to NTPA-001 *(which sets limits on pollutants load in industrial and urban wastewater for disposal in natural receptors)*. According to the European Directive 91/271/CEE, the localities with more than 10,000 equivalent population, should own performance wastewater treatment plants which can achieve the elimination of nutrients by December 2016, and for 2,000-10,000 equivalent population agglomerations by December 2018. The wastewater treatment plants, financed by European funds have the role of reduction of organic substances, nitrogen and phosphorus in the waters collected from urban sewage networks. Wastewater treatment is a complex process based on physical, chemical and biological processes and uses materials in which dissolved and dispersed substances in the aqueous medium are retained and neutralized so that the discharge into the environment will not harm people, flora and fauna. Treatment technology is a sequence of unit processes each designed to hold a certain category of objects in the aqueous medium. In these sewer networks both domestic water and meteoric water are collected as well as industrial waters. In the case of the smaller urban agglomerations, where there is no industry, the wastewater is composed only of domestic and meteoric waters. The wastewater collection requires a minimum number of pumping stations, thoroughfares/pressure pipes with a minimum length, by which it is achieved the minimum number of crossing rivers, roads or railways. Also, the investment and operational costs for the construction of pumping stations and pressure pipes *(if necessary)* have to be lower than the costs of constructing a wastewater treatment plant in every town [1].

The Livada sewer system includes total constructions and plants which carry wastewater *(the interior plant, the junction block, the exterior sewerage network, pumping stations)*, purges and evacuates purged water into the emissary *(river Racta)*. The interior installations of buildings generally connect to a compound network, called interior network which discharges into the exterior one, by means of a junction block and an inspection chamber, called water main connection, which serves for control and interventions [2-4]. The pumping stations are built in cases where terrain configuration does not allow gravitational sewerage of water, because the flow rate is insufficient. In the town of Livada the sewerage system takes domestic water from the population, and rainwater leaked into the sewerage, *(there is no process water)* over to the wastewater treatment plant [4-5].

The wastewater treatment plant represents the total constructions and installations by which advanced treatment of domestic, rain and industrial water is achieved, through correction of the physico-chemical parameters frequently monitored *(pH), chemical oxygen demand (COD), 5-day biological oxygen demand (BOD), ammonium (NH_4^+), total nitrogen, phosphates, extractable substances, materials in suspension), monthly monitored physico-chemical parameters respectively (sulphide, hydrogen sulphide, sulphates, phenols, filtered residue, nickel, lead, chromium, zinc, copper, chlorides, detergents)* which provide quality for wastewater, thus the characteristics of evacuated treated water match the regulations in force, depending on characteristics of the receiver [6-7]. Reference standards for the wastewater treatment plant are reference costs established by regulations, with the role of guidance into promoting investments financed from public funding. These standards are used for substantiation of the necessary public fund for investments, substantiation for technico-economic indicators for the public investments, and for similar public investment evaluation board guidance. It is important that the sewerage system has a number of pump stations that is as small as it can be, and power-pipes as short as they can be, for the reduction of investment and operating costs [3-7].

The project entitled *"The extension and rehabilitation of water and waste water infrastructure in Satu Mare County„* from within *"Sectorial Operational Programme Environment"* (SOP ENV), carried out during 2009-2017. The objective was the achievement of the sewage systems, which totals 175 km of new sewage network, 27 km of rehabilitated sewage, the construction of 3 sewage treatment plants and the extension of 2 sewage treatment plants. From this investment, the paper talks only about the sewage system from Livada agglomeration, which contains the sewage network and the wastewater treatment plant.

The paper examines, in its first part, the technological process of wastewater treatment plant, consisting of: *the mechanical stage, the biological stage and sludge treatment*. Then, in the second part, physico-chemical parameters of the wastewater and of the treated water were presented, for the establishment of the efficiency of the wastewater treatment plant and their evaluation compared to permitted legal limits. In the third part costs, maintenance and materials were evaluated, considering the investment costs, with respect to designing and execution of the wastewater treatment plant [8]. In part four an analysis of risks that can appear in the wastewater treatment plants was done. The costs of the wastewater treatment plant are estimated considering its sustainability and are presented in the five part. In the last part of the paper are presented new developing directions with other wastewater stations through POIM Programme.

2. EXPERIMENTAL METHODS

Biochemical oxygen demand *(BOD)* of wastewater represents the quantity of oxygen needed for aerobic biochemical degradation of total organic solids for 5 days and 20°C, which is the standard *(biochemical oxygen 5 days)*. Chemical oxygen demand *(COD)* measures the carbon in all categories of organic matter by determining oxygen consumption of potassium bicarbonate in acid solution.

Total nitrogen occurs as free ammonia, nitrite, nitrate and organic nitrogen. Total solids mean the sum of suspended solids and liquefy solids.

For BOD the standard analysis are *ISO 5815/1991, for COD - ISO 6060/1996, ammonium - SR ISO 7150-1/2001, nitrates - SR ISO 7890-3/2000, nitrogen - ISO 6777/1996, phosphorus - SREN 1189/2000, total suspended matter - STAS 6953/1981 [9,10,11,12].*

The Livada wastewater treatment plant laboratory, equipped with high performance equipment, achieves daily usual monitoring, and more complex analyses, with a rare frequency *(Figure 1),* are performed by ANAR accredited laboratory from Satu Mare. The Livada wastewater treatment plant laboratory is equipped with therombalance, analytical balance, laboratory oven, laboratory furnace, niche, spectrophotometer, incubator *(thermostate)* for CBO_5 analysis, micrpscope, portable pH-meter and oxygenometer, laboratory glassware *(Inhoff cones)*. Quality requirements of the treated water are established through HG nr.188/2002 *(NTPA 001)*, modified and completed with HG nr.352/2005, as well as with the

Fig. 1. Wastewater treatment plant facilities with laboratory equipment

Fig. 2. Sampler for the daily and hourly collecting of the influent and effluent

operating license issued by *"Romanian Water"*. The samples which are about to be collected and analysed are gathered from several points of the technological flow, in order to obtain the information necessary to lead the purging process in optimal conditions, and the reinsertion into emissary of a purged water, that would correspond to current legal requirements [2].

It requires the continuous monitoring of operating parameters due to varying conditions, process and quality caused by economic polluters to ensure safe and efficient operation. Momentary sampling is not enough, but even the daily averages for the early detection and warning of possible deviations or abnormal conditions, requiring technical equipment that is able to process large amounts of data on-line and to monitor treatment processes 24 hours a day, with the help of the automatic influent and effluent sampler *(Figure 2)*.

Monitoring of the physico-chemical parameters is achieved instantly through temperature sensors, pH, nitrate, nitrite, phosphorus that monitor the influent and the effluent of the wastewater treatment plant *(Figure 3)*. The wastewater treatment plant is provided with touch screens which monitors the physico-chemical parameters measured by the help of sensors from biological basin. There are also portable touch screens that can be mounted with ease in the existing supports, in many points of the wastewater plant.

3. THE TECHNOLOGY OF THE SEWAGE NETWORK

The Livada urban agglomeration currently includes only Livada town, and in the future it is expected that the Livada Mica and Adrian villages would join. The sewerage system of the Livada urban agglomeration serves 4,824 people, which represents approximately 75.4 % of the total population of the urban agglomeration *(6,400)*. Wastewater flow that was collected and treated, measured at year 2015 level was 612,228 cubic meters. The number of damages which appear on average on the course of one year in the sewerage network is 44 flaws per 100 km, and the infiltrations in the collectors are estimated at 282,047 m^3/year that represents 46%. The Livada urban agglomeration wastewater collecting system has a total length of 22.87 km *(Figure 4)*. The collecting of wastewater is done in a divider system, and the network was developed in stages, so that presently sewerage networks over 20 years old exist, but also new networks, carried out in the last two years. The number of flaws

Fig. 3. Types of sensors used in the plant

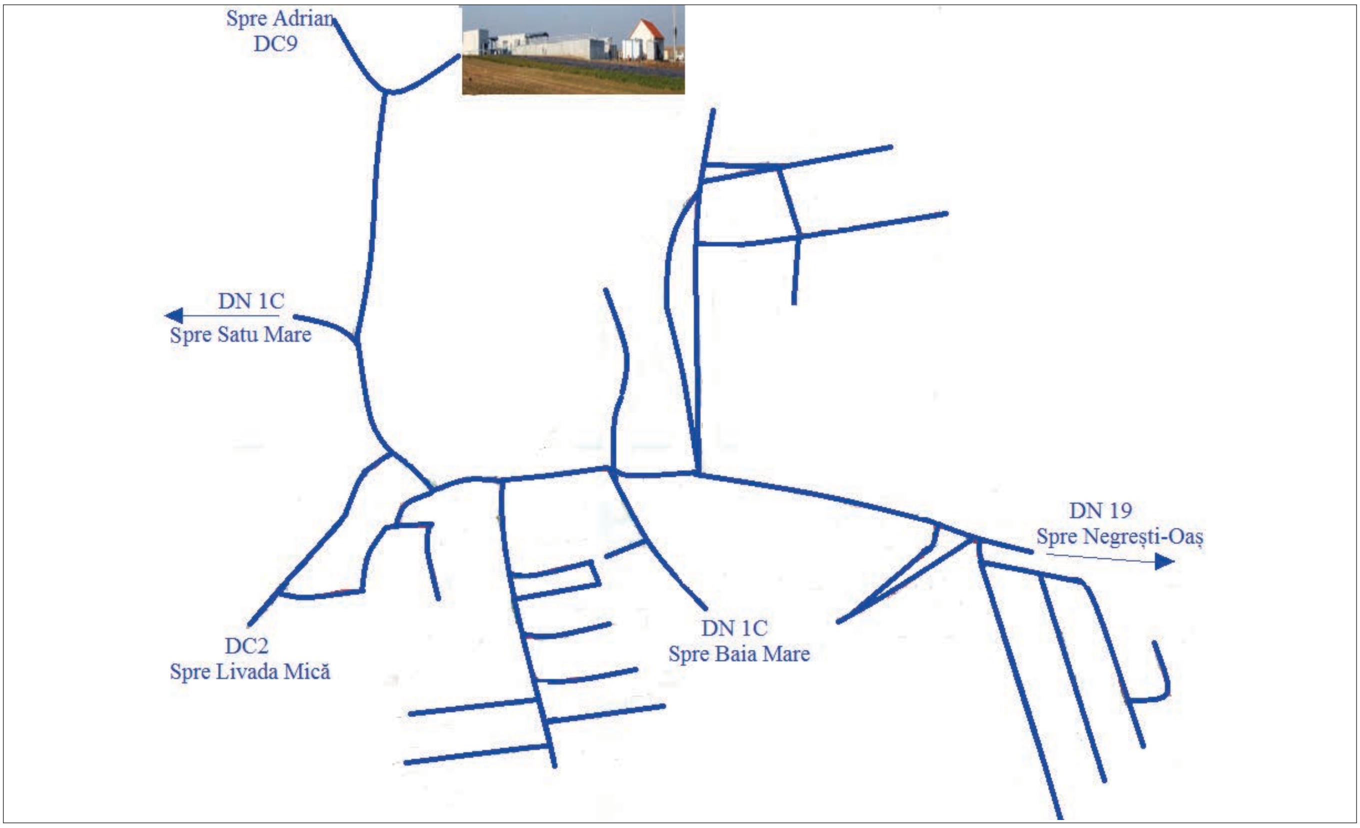

Fig. 4. Situation plan of the Livada wastewater treatment plant

Fig. 5. Diagram of the Livada wastewater treatment plant

per 100 km sewerage network was 43.78 in 2015. Because of the structure of the natural terrain, in certain areas of the urban agglomeration wastewater pumping is necessary. In this regard, in the sewerage networks there are 16 wastewater pumping stations with 12 and 36 cubic meters/hour, according to FIDIC red project. The pumping stations discharge lines are carried out from PEID and have diameters of 110 mm and a length of 0.98 km.

The wastewater treatment plant *(Figure 5)* with advanced carbon, nitrogen and phosphorus removal has the capacity of 33.4 l/s. The Livada wastewater treatment plant is a performance ministation which is designed for 4,950 equivalent inhabitants. The wastewater treatment plant is made up of the primary treatment, the biological treatment and sludge treatment parts according to figure 4. The wastewater treatment plant is equipped with state-of-the-art equipment, and the technological parameters are monitored by means of a high performance SCADA system and yellow FIDIC. The equipment of the laboratory allows monitoring of the physico-chemical parameters required by the given operating permit, issued by *"Romanian Waters"*.

The mechanical stage *(Figure 6)* consists in the process of eliminating large solid material *(tree branches, plastic materials, glass)* by means of rare grills. The Livada wastewater treatment plant uses an innovative primary treatment system, that gathers into one compact system the fine step screens, the sand trap system with the grit treatment equipment and the fat separator. The retention of fine scrapes *(paper, textile materials, leaves)*, that pass the rare grills and sand separation is important in order to prevent damage to the pumps that feed water in the biological stage. It is important that the separation of fats and oils is achieved before the biological treatment phase, so that to do not influence the biological treatment process. This compact rare grills-sand trap-separator system is also very useful for maintenance and operation [3-4]. The plant is equipped with a by-pass, with the purpose of additional water quantity retrieval.

The biological treatment point has the purpose of reducing organic substances, nitrification, denitrification, extended biological reduction of phosphorus and aerobic stabilising of sludge by extended aeration with sludge age hydraulic control, and is divided across two lines, each containing the anaerobic, anoxic, aerobic compartments, with a continuous flowing and internal, respectively external recirculation sys-

Fig. 6. Primary treatment stage

Fig. 7. Biological treatment stage

tem, according to figure 7. The advantage of hydraulic control of sludge age consists in the reducing of the energy consumption and also in the increase of the sludge quality. The simultaneous nitrification-denitrification process was not used because the process requires a volume of basine with 20% higher than that of the process chosen with distinct redox zones *(the kinetics of rapidly biodegradable substances are approximately 3 times higher than that of slow biodegradable particles)*. In addition, denitrification can be precisely and optimally controlled by varying the internal recirculation flow that is direct proportional to the nitrate concentration measured in the effluent of the biological reactor. The energy consumption of such a system is lower *(about half compared to system for the nitrification / simultaneous denitrification)* because there is no need to mount mixers to ensure the movement and mixing of the entire volume of the biological reactors. On the other hand, in the case of the nitrification-simultaneous denitrification process can not be achieved the control of the amount of nitrates to be denatured and implicitly the control over internal recirculation [13]. The solution is also good in terms of using a lower flow and lower load. Each anaerobic and anoxic tank is provided with one low speed mixer, for continuous mixing of the biomass [14]. The biological purge extended aeration process, achieved in anoxic compartments, implies an age of 25 days for the sludge, nitrification of the influential ammonium taking place. Performing the nitrification is a precondition for achieving the denitrification, and depends on temperature, sludge age, and the ratio between the volumes of aerated and non-aerated zones, since the anaerobically-autotrophic nitrifying bacteria develop only in the aerated zones of biological reactor but die in the entire available volume. Denitrification is possible only in the complete absence of the oxygen. In case of the presence of oxygen in the substrate, heterotrophic bacteria will primarily consume the available oxygen because it has a higher oxidation state than nitrates resulting in higher energy for bacterial catabolism than the use of nitrates as electrons acceptors. The sources of donor electrons could be the organic substances from the influent and also the endogenous residues resulting from the death of bacteria. The organic substances in the influent can be classified as follow: *soluble substances, biodegradable and slowly biodegradable particles*. Denitrification will be carried out mainly by heterotrophic bacteria, thus wasting some of the electron donor source derived from the influent, which is so highly diluted and less loaded with organic substances [15, 16, 17]. Therefore in the case of a process with distinct redox zones, the filamentous bacteria do not develop *(fact confirmed by microscopic analysis)*. In the anaerobic compartment, the chemical reduction of phosphorus through precipitation with ferric chloride *($FeCl_3$)* is achieved *(Figure 7)* for the coagulation of colloidal particles, improvement of the quality of flocks and sedimentation in the secondary settler *(clarifier)*. The wastewater treatment plant is perfectly adjusted and automatized to reduce the phosphorus, this is realised mostly in the biological stage and if only the charges are to big, it is used the chemical precipitation by ferric chloride. The calculus of the coagulant dose necessary for the chemical precipitation of phosphorus shall be achieved in proportion to the effluent flow rate, by on-line measurement of the phosphorus concentration in the effluent. Following the hydraulic control of the age of the sludge, through extraction of the excess sludge at MLSS concentration, out of the bioreactor, directly from the connecting pipe between the biological reactors and secondary settling tanks, excess sludge will be evacuated directly into the mechanical thickening unit [18]. The diffusers required periodically clean up becouse of the costs of the electrical power for the aeration that represents about 60% of the electric power costs.

The secondary settling tanks are longitudinal, with sludge collecting system by suction and pumping into a lateral channel. The extracted sludge with the volumetric pumps with lobes set on the gangway of the mobile bridge, will be transported through gravity towards the box header, from the entrance to the biological reactors. The mobile bridge is equipped with a surface scraper for collecting and evacuation of foam into the excess sludge thickening unit. Depending on the measured concentration of the ammoniacal nitrogen and of nitrates automated control of the flow of the internal recirculating pump will be achieved, and the oxygen concentration that shall be maintained in the aerobic compartment will be determined. Depending on the necessary concentration of the dissolved oxygen, the local PLC will control the revolution of the volumetric air-blower [19].

The rectangular shape of the basins was used in order to do not lose too much space that is quite limited considering the use of two lines for each stage of wastewater treatment.

Sludge treatment appeared following the purge of water is a biomass that includes semi-fluid and olfactory residues, in which solid materials between 0.25% and 12 % are to be found, according to the applied treatment [20]. Sludge treatment is centered on reducing the quantity and volume of the sludge, in order to reduce evacuation costs and in order to reduce health risks during the evacuation. The sludge that appears contains organic compounds, heavy metals, pathogenic microorganisms, biodegradability resistant [21]. Excess sludge is mechanically concentrated, with polymer addition, from the MLSS concentration to a 5% concentration in mechanical thickening units. By the hydraulic control method of the sludge age, the excess sludge is extracted at the MLSS concentration of the reactors. Mechanical thickeners of sludge were used in order to reduce the volumes of dewatering sludge buffer-basins. This solution was used because was not enough space for the introduction of the gravitational thickeners equipment.

The dehydration undertakings formed through centrifuge *(Figure 8)*, imply drying of the sludge at a concentration of 25%, then, through drying on the covered drying beds, sludge is obtained, with 35% dried substance [22]. The drying centrifuges have lower maintenance costs than band filters.

Fig. 8. Sludge treatment stage

The Livada wastewater treatment plant ***SCADA system*** implies a workstation placed in the wastewater treatment plant control room and two redundant servers, one of which is placed in the wastewater treatment plant control room, and the other one in the Satu Mare dispatch. The server placed in another location will simultaneously be a workstation too and will ensure fiber optic transmission of the signals measured from the wastewater treatment plant towards the central dispatch and, also, reception of the control instructions from the central dispatch in order to be locally executed *(remote control)*. The SCADA system is composed of PLCs for each of the wastewater processing lines, PLCs for every sludge processing line, PLC for the electrical power station, touchscreen operating panels, monitoring for parallel viewing of the water line *(Figure 9)* and sludge line *(Figure 10)* and printers. Alarms, events, and reports are being monitored.

Figure 9 shows the SCADA screen with the water line. In SCADA a certain nominal flow can be set over which the wastewater is by-passed, or a certain concentration *(optimal value)* of ferric chloride can be adjust depending on the phosphate concentration. SCADA allows also the adjusting of the external recirculation coefficient depending on the suspended solids in the effluent and also on the flow into the reactor inlet. A correlation between the internal recirculation coefficient and the nitrate concentration can be obtained and, depending on the optimum value of the nitrate, the speed of the internal recirculation pumps is adjusted.

Figure 10 shows the SCADA screen for the sludge line. By setting the concentration of solide slurry of the thickened sludge, it is possible to calulate the flow rate of the thickened polymer for a certain thickened sludge flow. Also, by setting the solid slurries of the dehydrated sludge, it is possible to calculate the polymer needs for performing the sludge dehydration.

To seal the pipes crossing parts of the biological basin, we used the new sealing system, sil-link *(Fi-*

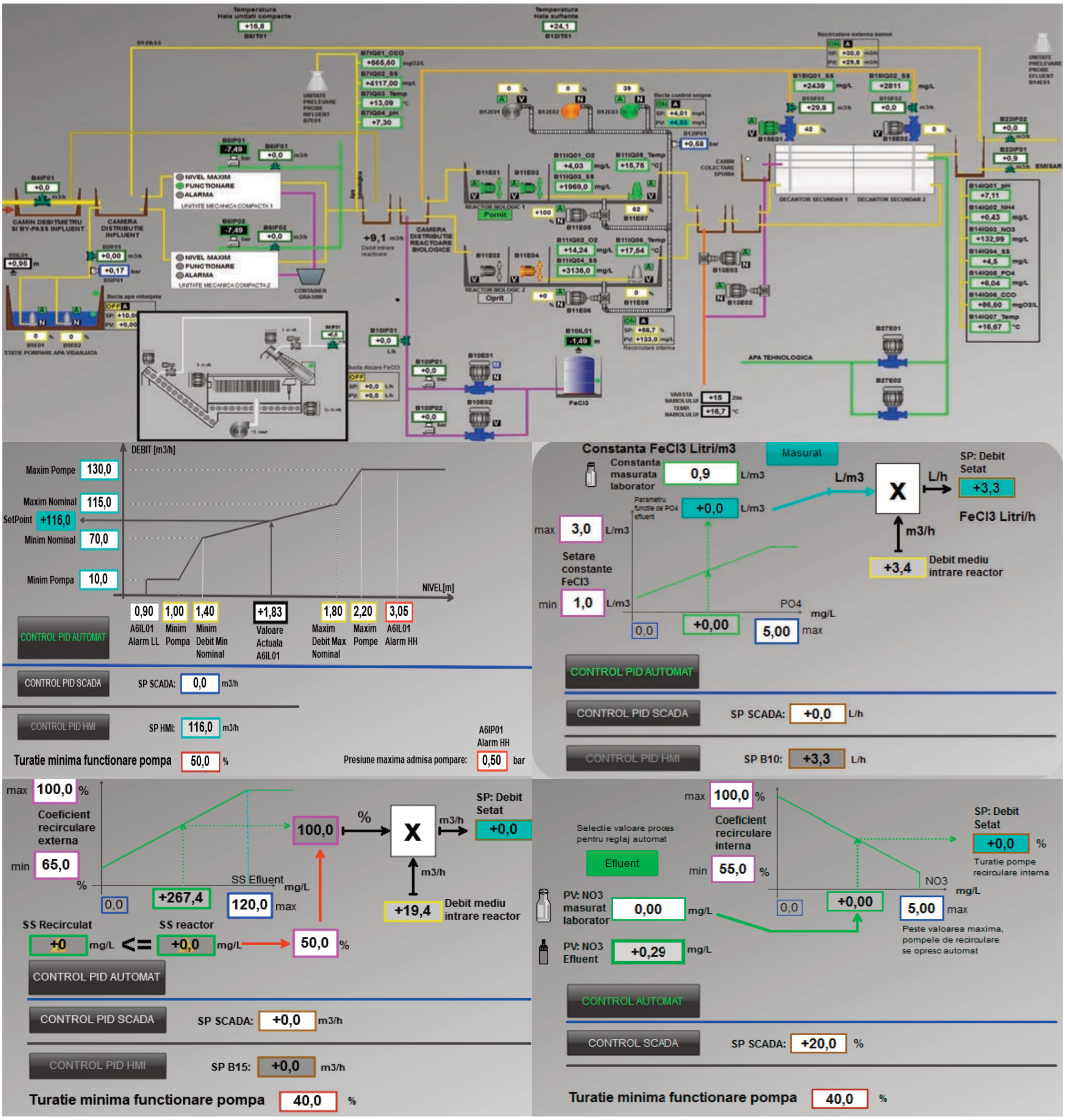

Fig. 9. SCADA system - Water line

gure 11), which is mounted on the pipe and than, the screws are jointed in the same time, to perfectly sealing.

The electrical generator *(Figure 12)* assures the continuity of charging with electrical energy in case of power outage of the wastewater treatment plant, necessary for a 24 hour functioning. In the wastewater treatment plant there is LED illumination that is economical, but at the same time provides very good illumination. Also the lighting system is very performant and efficient.

The wastewater treatment plant is equipped with an innovative vitiated air elimination system, from within the mechanical treatment rooms, the blower room and the mechanical treatment building, through catching with the help of a ventilation system and

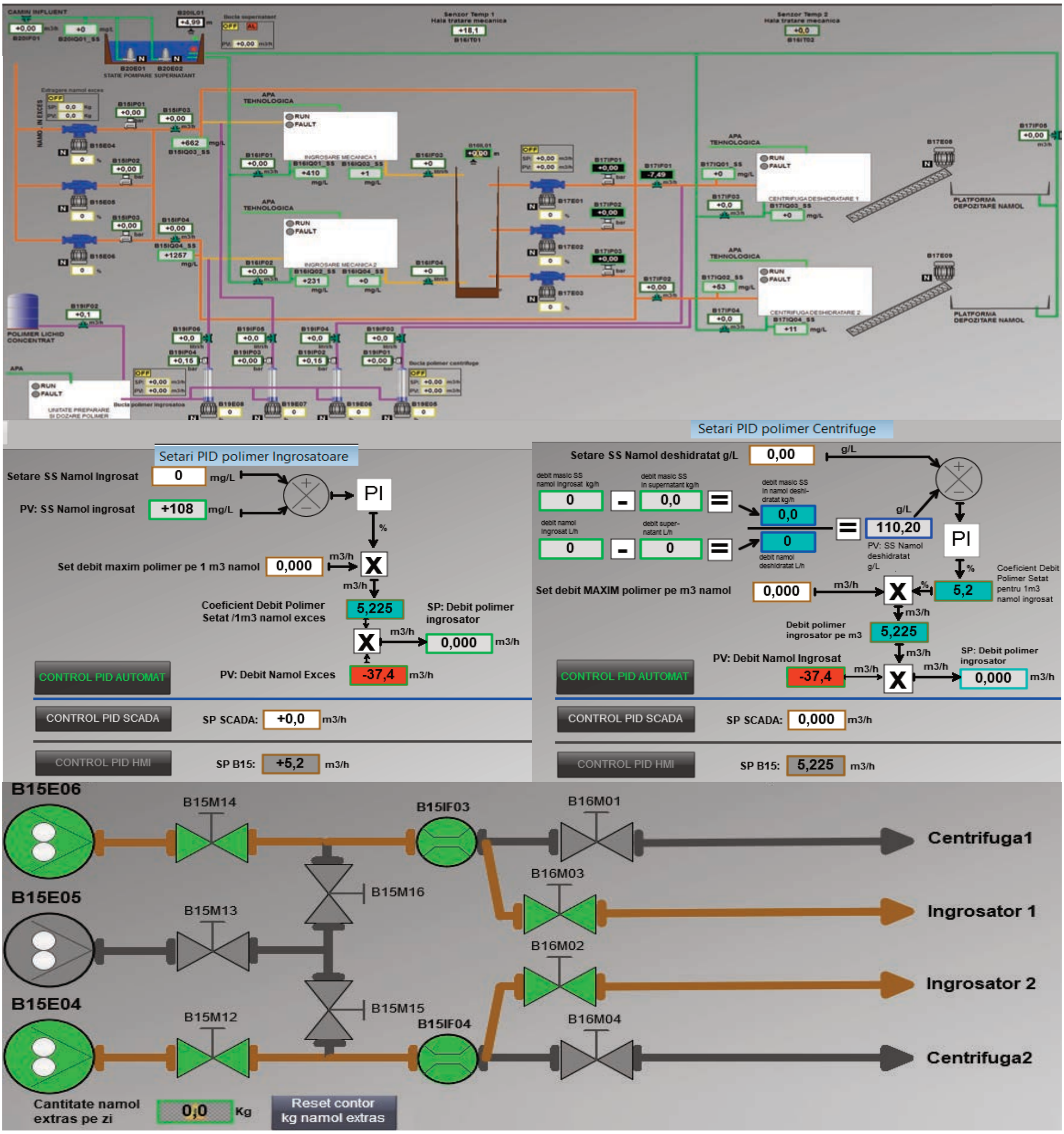

Fig. 10. SCADA system - sludge line

Fig. 11. Sealing system used in the wastewater treatment plant

Fig. 12. The electric generator, lighting system and lightning protection

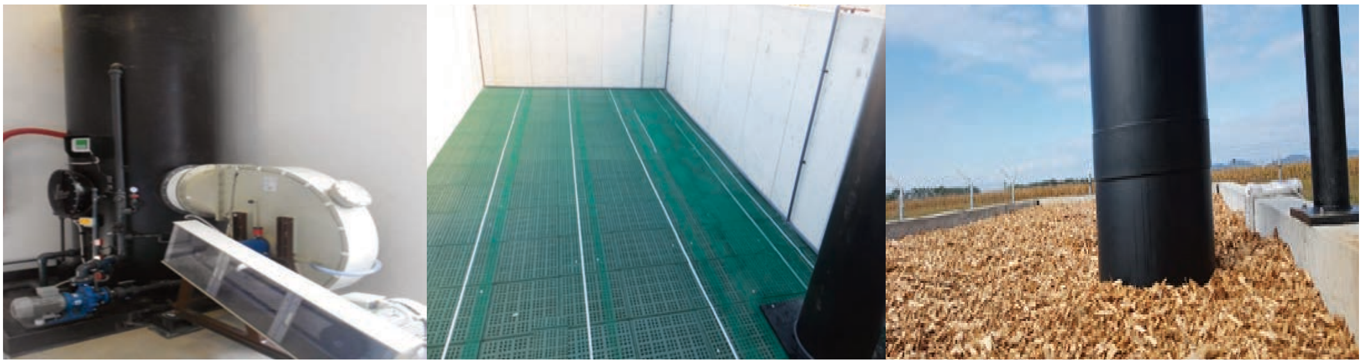

Fig. 13. Ventilation system

then neutralising with the help of a scrubber *(biofilter)* placed in the blower room *(Figure 13)*.

4. THE EVALUATION OF THE EFFICIENCY OF WASTEWATER TREATMENT PLANT LIVADA

The efficiency of the treatment plant is given by the capacity of the treatment process with respect to diminishing charges from the effluent towards the influent, reason why the physico-chemical parameters of the influent and the effluent are being monitored [23].

In figure 14 is shown the evolution of physico-chemical parameters of the wastewater at the entrance of the wastewater treatment *(influent)* and the effluent of the wastewater treatment. Monthly averages were calculated from the daily averages collected by the sampler for the physico-chemical parameters of the effluent and influent, according to figure 14.

The analysed physico-chemical parameters were: *chemical oxygen demand (COD), biochemical oxygen demand (BOD), total suspended solids (TSS), ammonium, total nitrogen and phosphorus, in mg/L in influent and also in the effluent of water treatment plant.*

High concentration of BOD that indicates the amount of oxygen required for oxidation of colloidal and dissolved organic matter and dissolved organic material [27, 28]. BOD and COD are decreasing considerably after the biological stage, and thus placing themselves inside the allowable legal limit. Nitrogen, ammonia and total nitrogen have a greater value in the mechanical stage effluent than in the influent,

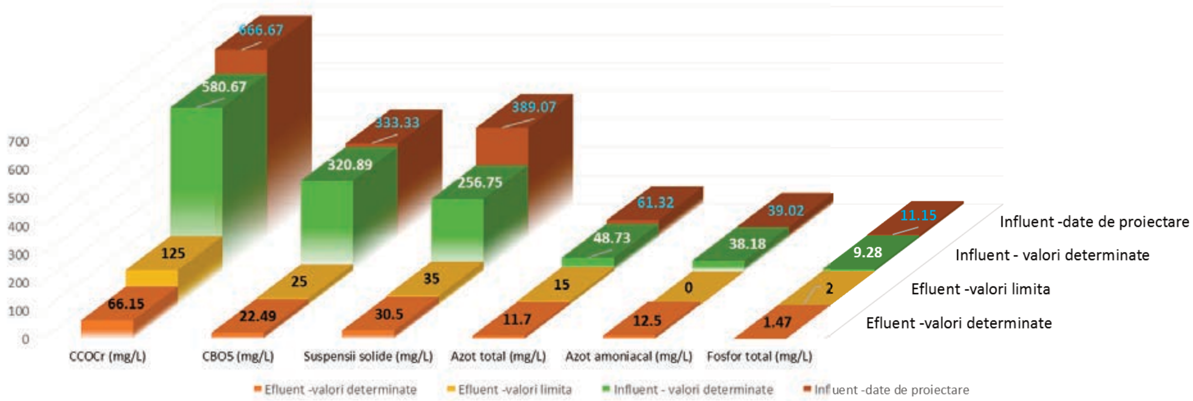

Fig. 14. Monthly averages of the physico-chemical parameters for the influent and effluent of the wastewater treatment plant

due to multiplication of bacteria, following that after the biological stage to reduce the nitrogen loading. From the microbiologically standpoint, were observed amoebe, filamentous bacteria, free ciliates *(small Anfilepides, Paramecium caudatum)*, fixed ciliates *(vorticella microstoma, Opercularia)* and denitrifying bacteria.

5. THE ANALYSIS OF RISK

International tendencies in the past years put a special stress on the management of risks, which, at the moment when they are identified and assessed, will be at the foundation of future necessary investments. Mandatory, studies and analyses must be very

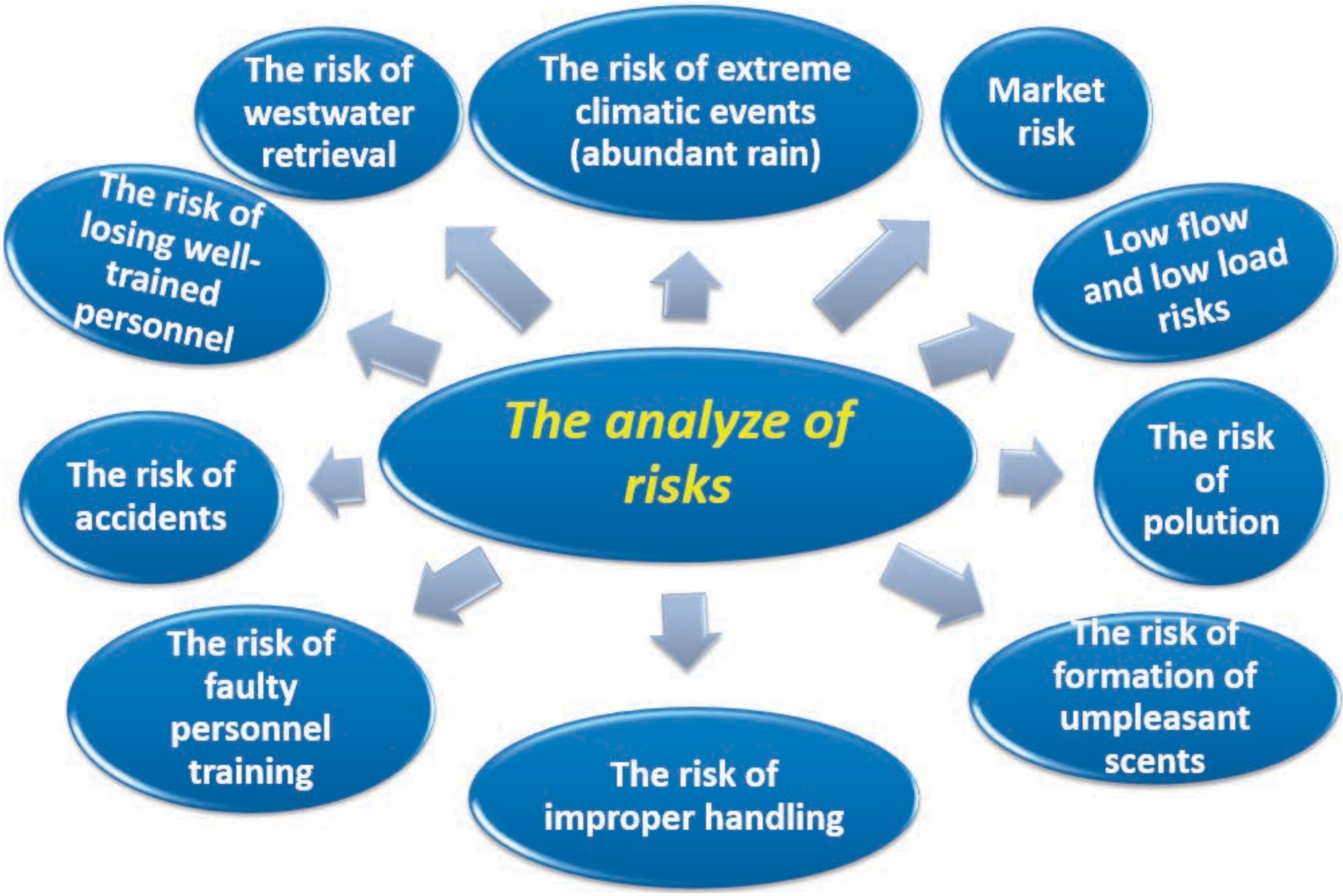

Fig. 15. The scheme of analysis of risks that may occur in the wastewater treatment plant in Livada town

well founded, in order to replace subjectivism, that predominates in decision making. Risks are split into two big categories: *risks that affect the resource and can contain natural hazards, and those caused by man, and the category of risks that water companies have to confront (Figure 15).*

The risk of extreme climatic events *(abundant rain)* is low, considering the fact that, in Livada, in the last 50 years, such extreme climatic conditions have not been found, but, in the case that it happens, the plant cannot take over the entire quantity of water, which is why the water surplus is by-passed and a loaded, untreated quantity of water can reach the emissary.

Market risk is low, because an acceptable security regarding the quality of the sewage takeover system is being permanently assured, there is no risk of supplying improper services, the unsatisfaction of clients and the payment refusal for ensured services being eliminated, financial uncertainty being excluded.

Low flow and low load risk is high, especially in the small localities where the population connected to the sewerage is low due to the lack of the own sanitary groups of the residents in the small towns. For this reason does not enters in the sewage an adequate amount of domestic water and the sludge load in the waste water is not sufficinet *(there is not an enough sludge load)*. Consequently there is a low load of sludge in the biological basin and both the nitrification and denitrification are affected and may have reprecurssions on the reduction of nitrogen in the effluent.

The risk of polution is low considering the fact that the Livada sewage treatment plant is placed on a field and a long way away from the first houses *(approximately 300 m)*.

The risk of formation of unpleasant scents is low in the sewage treatment plant because scents are captured and neutralized from every technological room.

The risk of improper handling is relatively low because the Livada sewage treatment plant is fully automated and operation is ensured by specialised personnel 24/7. In SCADA any kind of error that can appear can easily be tracked. Intervention upon malfunctions regarding the operating of the treatment plant can be handled both locally inside the plant, as well as at the SCADA central dispatch.

The risk of faulty personnel training in the domain of the WWTP is relatively high, because this training is difficult and costly, schools specialised on this theme being non-existent, and specialisation is achieved at work.

The risk of losing well-trained personnel is medium, in the hypothesis where personnel is being drawn by other companies, even in consulting. Not achieving personnel training in a proper way can lead to the treatment plant's dysfunction and cause extra costs.

The risk of wastewater retrieval inside the sewage treatment plant can appear because of the faulty wastewater retrieval, or following some malfunctions appeared within the sewerage network [22].

The risk of accidents is diminished, because of the possibility of switching to local position in order to avoid accidents, in the case of decoupling of equipment, in this way at the local dispatch that machinery can't automatically restart. Furthermore, accidents that follow an interruption-restart of the power supply, because of automatic decoupling of the generator, are excluded.

In conclusion, the prevention of such situations leads to establishing an efficient management, qualified and competent personnel, as well as good working conditions, and institution of infringement liability or criminal liability *(in case of toxic substances discharge into the sewerage network)* for damage done to the environment, is intended to determine the operator to take pecuniary compensation and develop practices for diminishing the risks of producing damages upon the environment.

6. THE ANALYSIS OF COSTS

Within the programme POS-MEDIU, the sewage network of 22.8 km was realized at a cost of 15,919,510.21 LEI, the investment costs for the wastewater treatment plant 7,372,504.64 LEI. From this amount 37.80% represents buliding constructions, 38.40% equipment price, 4.91% represent assembling work, 7.97% landscaping, 4.5% projection and other expenditures 6.42% according to figure 16a. Guaranteed costs presented in figure 16b, totaling 182,536 LEI refers to annualy costs of electricity which is 57.84%, ferric chloride 38.91%, polymer 2.86% and water 0.39%.

In order to establish the sewerage system reference costs, unit costs of similar investments achieved in the foregoing years were used, costs that were verified compared with cost standards [23]. The costs of the wastewater treatment plants are according to the quality of the water incoming, its chemical and biological charge as well as according to the quality of treated water [24-25]. The cost of the wastewater treatment plants include the costs of the construction work, grills, other technical components, pipes and interior installations *(hydraulic, electrical)*, pumping installations, devices for measuring and control, automation and SCADA.

For determining price evolution according to flow

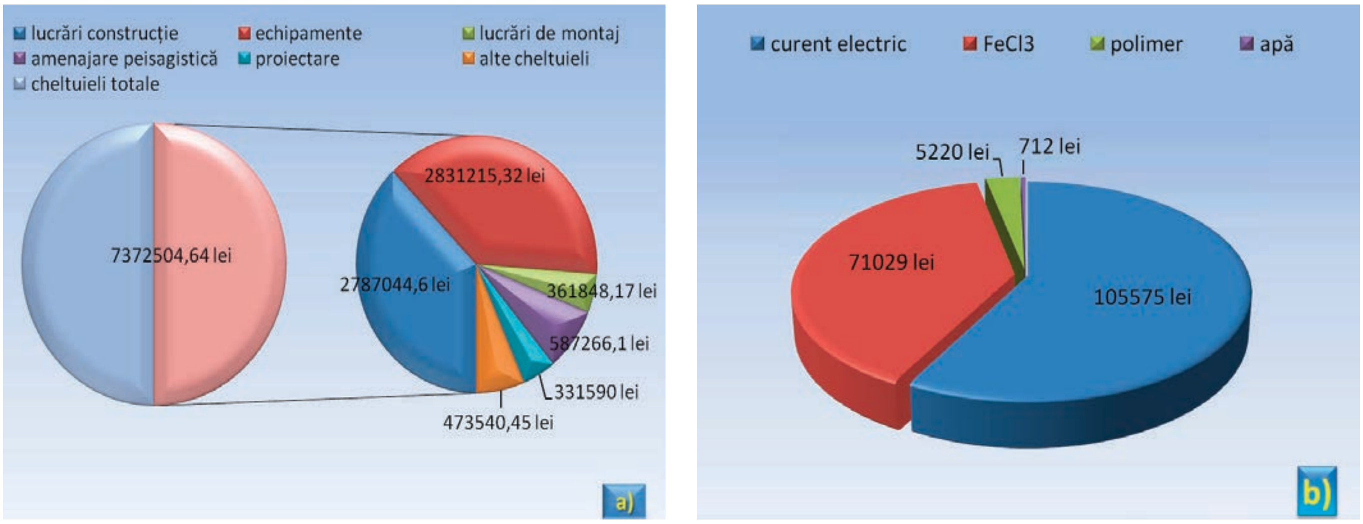

Fig. 16. The prices distribution according to investment (a) and according to guaranted projected consumptions for materials for a year (b)

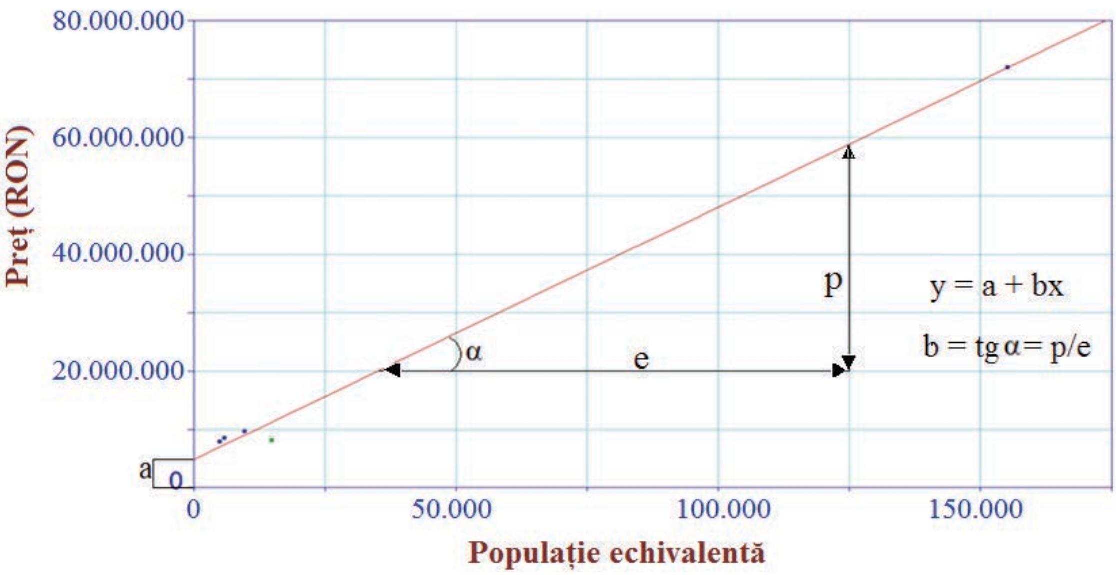

Fig. 17. Reference prices of treatment plants

Table 1. Calculation of unit price depending on the equivalent inhabitants by application of the relation 1

EP	4000	5000	6000	7000	8000	9000	10000	15000	20000	100000	150000
Price x 100 (RON)	6554	6987	7420	7853	8286	8719	9152	8152	11317	48122	69772

per hour, the data from all the investments done on POS Mediu concerning wastewater treatment plants were used. After elimination of extreme values the evolution graph of prices of the wastewater treatment plants according to their volume *(cm^3/hour)* the number of population was represented.

The line drawn through points is given by ecuation nr. 1, with correlation coefficient R=0.996.

Price = 4822.3 + 0.433·EP (1)

Data was obtained by interpolation of the values determined based on the functions that were obtained following processing of values obtained based on previous experience following similar work performed on POS Mediu.

Data obtained in this manner helps with calculus of future values of newly carried out investments, concerning the obtainment of even more precise results or the justification of the determined reference prices. The more data is being used the more the results that are obtained are closer to the market price.

7. FUTURE PERSPECTIVES

Within the *programme "Large Infrastructure Operational Programme"* (POIM) to meet the priority of Axis 3 accomplishment, the main objective is the development of environmental infrastructure in terms of efficient management resources through the development of specific investments in the water and wastewater in the district of Satu Mare. Specifically, it is wanted to continue the investment strategy initiated by ISPA and SOP ENV, on the extension of operation area to agglomerations between 2,000 and 10,000 E.P. and to promote the solidarity principle to support low developing settlements by the tariff policy. In the new programme are provided 5 wastewater stations in small towns between 2,000 and 10,000 E.P.

8. CONCLUSIONS

The study is a comparative presentation of technological and financial aspects regarding the efficiency of the wastewater treatment plant in Livada town realised trough POS-MEDIU program. The quality of wastewater depends on the degree in which the physico-chemical parameters are reduced in the different stages of the treatment until the evacuation in the emissary. The mechanical stage works, based on innovative compact systems, extended biological reduction of phosphorus and aerobic stabilisation of sludge by extended aeration with sludge age hydraulic control.

The new sewage network built of 22.8 km is going to collect residual water from all the inhibitants of Livada town, also rain water. The wastewater treatment plant is a performant station projected for 4,950 equivalent inhabitants, that reduces the carbon, nitrogen and phosphorus successfully.

The treatment plant works efficiently, decreasing considerably the amount of COD, indicating that the mechanical stage works very well. It is also noted the decrease of BOD and also of the load of nitrogen and phosphorus in the effluent compared to the corresponding values in the influent showing that the organic compounds, the nitrogen and phosphorus load diminished and falls within the allowable legal limits increasing the quality of wastewater discharged into the Racta River.

The highest costs in operating the stations in the wastewater treatment plants are for the purchase of materials and utilities, especially electric power.

By interpolation, the costs of wastewater treatment plant built/rehabilitated through POS-MEDIU programme, for Satu Mare district using a linear function, resulted investments of 6.5 milions RON for the wastewater treatment plant projected for 4,000 E.P.

up to 70 milions RON for projected wastewater treatment plant for 150,000 E.P. This calculation comes in the help of future values of new investment realized, to obtain the result and more over to justify determinated references prices. The more we use more data the more we obtain closer results to the market prices.

Knowing the unitary prices of the wastewater treatment plants and the areas with the bigest requisitions for the extension of wastewater treatment plants capacities, or the necessity to construct new wastewater treatment plant, an analyse of the options can be realised, to establish the optimum solution to provide high quality sewage services, in the new projects of POIM programme.

Therefore, the treated wastewater evacuated in emissary achieves the quality standardars required by the given operating permit, issued by *"Romanian Water"*. The measures that can be taken in developing new projects within the programme *"Large Infrastructure Operational Programme"* (POIM) are presented. These measures are based on previous experience, gathered in the implementation of projects POS-MEDIU regarding the construction/rehabilitation/extension of the sewage system.

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