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A new solution to municipal wastewater treatment in Armenia

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Abstract: After Armenia's independence, the domestic wastewater treatment process was paralyzed during 1990 to 2010 due to the economic crisis. All operating 22 treatment plants became outdated long ago and were not operational. Since 2010, the government of Armenia has tried to restore the wastewater treatment process. Treatment plants employing mechanical treatment were constructed in five cities in recent years. The biological treatment process has not been still restored. This paper presents the rehabilitation of domestic wastewater biological treatment process at a community level. The work was carried out in Parakar rural community with 10,000 inhabitants. Before the project implementation, the community was sewered, but it did not have a treatment plant. Wastewater was partially flowing through the residential area of the community spreading stench and causing serious sanitary conditions, and partially was flowing into an irrigation canal passing through the community, mixing with irrigation water and flowing to agricultural lands. As a result, about 100 ha agricultural lands were degraded. With the combined efforts of Country Water Partnership NGO, JINJ engineering consulting company, GEF's and DFID's financial support, and substantial investment by the community, a combined wastewater treatment system was built for the first time in Armenia, using conventional and natural treatment technologies. The treatment plant consists of a screen, an artificially aerated lagoon, a settling lagoon, a naturally aerated lagoon and a sludge bed. This domestic wastewater treatment plant allows the reduction of biological oxygen demand (BOD) concentration by 60-70% and that of suspended solids by 85%. As a result, thanks to the construction of this plant, the community has obtained its own treatment system, providing sanitary cleanliness throughout the community area, adding about 11.7 L/sec to irrigation water at the expense of treated wastewater. The system is independent on weather conditions and climate changes, and has already contributed to the recovery of about 60 ha of agricultural lands, providing food security for the population.

Key words: Wastewater treatment plant, conventional treatment, natural treatment, aeration, sludge.

1. INTRODUCTION

After Armenia's independence, the domestic wastewater treatment process was paralyzed due to the economic crisis. All treatment plants in operation prior to the outburst of this crisis very soon appeared in physically worn out condition and stopped operation. Since 2010, the Government of Armenia has tried to restore the wastewater treatment process. For this purpose, in five cities of Armenia, five municipal wastewater treatment plants (WWTP) were built and put into operation during 2012-2015. These WWTPs carry out only mechanical treatment of wastewater, whilst the biological treatment process is still waiting for its time.

2. A NEW APPROACH TO DOMESTIC WASTEWATER TREATMENT

The first attempt in Armenia to fully treat wastewater and reuse the treated wastewater was made in Parakar community by JINJ engineering consulting company and Country Water Partnership Armenia NGO. With the financial support of Global Environment Facility (GEF) and the Department for International Development (DFID), as well as with significant input by the community, a combined WWTP for treatment of domestic wastewater was constructed for the first time in Armenia, using alternative treatment technology.

The project was carried out in Parakar rural community of Armavir region. Parakar village, with population of 10,000 inhabitants, is located at a distance of 12 km to the west of the capital city of

Yerevan. More than 60% of the village was sewered, but the community was not served by a treatment plant. In the past, the wastewater produced by the village was pumped to the main sewerage collector of the Yerevan WWTP through two consecutive pump stations. However, when the treatment plants and the pump stations stopped operating, the wastewater was spread out in the village area, flowing into the irrigation water network and mixing with irrigation water. In some areas, wastewater was coming out to the surface, spreading through the streets and yards, causing a smelly and nasty environment. Because of irrigation water pollution, the cultivation of the private agricultural lands stopped. As a result, the village appeared in a severe anti-sanitary condition and about 100 ha agricultural lands were degraded.

Taking into account the given situation, we set two goals: first, to carry out community wastewater treatment, and second, to reuse the treated wastewater as irrigation water.

Studying the international experience (TEC 2009; 2012), an objective was set to turn to application of natural treatment technologies instead of using conventional treatment methods requiring heavy investments and highly qualified operation staff. The natural treatment technologies are notable for their low construction and operation costs, while providing the required level of wastewater treatment.

It should be noted that one of the main tasks was the selection of the WWTP site. It was advisable that it should be located in a place where elevations will allow wastewater collection and transportation by gravity, on the one hand, and adjacent to the irrigation canal to allow filling the treated wastewater into the irrigation network without additional costs, on the other hand. At the same time, the application of the natural treatment technology required the allocation of the largest possible area of land for the construction of the plant (EPA 1988).

However, the land allocated by the municipality for wastewater treatment plant construction, in spite of being close to the irrigation system, did not fulfil the area required for the application of the fully natural wastewater treatment technology. This situation served as a basis for considering the combined use of conventional and natural treatment technologies.

Based on the allocated land surface, climatic conditions and financial limitations, a plant operating by combining conventional and natural treatment technologies was proposed and developed. This was notable for the low construction and operation costs and simplicity of the structures.

The full design package of the proposed plant was developed by JINJ Company. The plant is mainly composed of the following process and auxiliary structures:

- Screen chamber;
- Pump station with submerged pumps;
- Biological lagoon with artificial aeration;
- Secondary settling tank;
- Clarifier with low aeration;
- Biological lagoon with natural aeration;
- Sludge beds;
- Air blowing station and air distribution system;
- Wastewater and sludge transportation pipelines; and
- Other auxiliary structures.

The process layout of the WWTP is shown in Figure 1.

The project was implemented in two stages, depending on the availability of funds. In the first stage, as the active phase of the first level treatment, an artificially aerated biological lagoon, a screen, a pump station, an air blowing station and a secondary clarifier were constructed. Construction under this stage was implemented during 2010-2012 (UNDP 2014). During the second stage, a naturally aerated biological lagoon, a low aeration clarifier, and a sludge bed were constructed. Construction under this stage was implemented in 2013-2014.

The plant was planned to provide wastewater treatment at a level which would allow maintaining the wastewater the nutrients highly important for agriculture, including phosphorus and nitrogen, and treat the wastewater from organic solids and chemical pollutants, and reusing it for irrigation purposes.

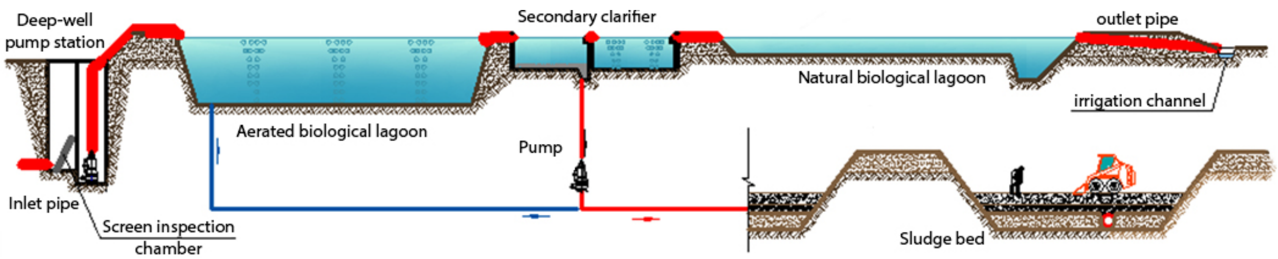
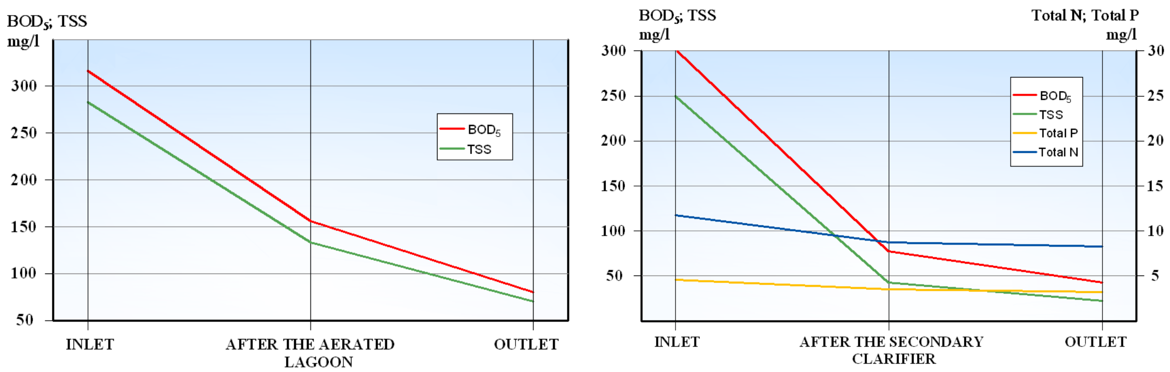


Figure 1. Process layout of the WWTP

During the operation of the two stages of the plant implementation, wastewater samples were taken from different points (influent, effluent, individual structures according to water movement) and monitoring was made to check the wastewater quality indicators, which served as a basis for the justification of the selected treatment technology.

Figure 2 shows the average parameter values of the wastewater flowing into the plant, outflowing from the secondary clarifier and the effluent of the plant for the first (2012) and second (2014) stages, accordingly.



(a) *(b)*

Figure 2. Wastewater treatment indicators for 2012 (a) and 2014 (b)

Laboratory analyses were made for BOD_5, TSS, N and P indicators. Therewith, the samples were taken in different seasons and for various operating regimes of the plant.

As it is seen from the graphs, the monitoring results for the first stage (Figure 2a) showed that the BOD of the influent varied in a range of 260 – 320 mg/L, and that of the effluent was in a range of 78 – 84 mg/L. The second stage monitoring results (Figure 2b) evidenced that the BOD_5 was reduced by about 85%, TSS by approximately 90%, and total N and P were reduced to a certain extent, although our objective was rather to maintain them in the wastewater.

As a result, the community has its own treatment system, and about 11.7 L/s additional irrigation water at the expense of treated wastewater, independent on weather conditions and climate changes, is provided. Since 2012, about 60 ha of depraved agricultural lands have been recovered and food security for the population is ensured, thanks to cleaning of the irrigation system and improvement of the irrigation water quality.

Application of such a treatment solution differing from the conventional treatment method significantly reduces the construction, operation and maintenance costs. This technology allowed Parakar community to construct a local treatment plant at relatively low capital investments. All costs for this project, including design, construction, technical supervision, commissioning of the plant, staff training and monitoring, as well as the community's public relations activities did not exceed 210,000 Euros, of which around 160,000 Euro was spent for the construction of the plant. The net cost of the plant operation (without profit and investment payback) for treatment of one cubic meter of wastewater is about 0,035 Euros, while if estimated for minimum 10% profit and investment payback in 15 years, the plant operation costs amount to 0,07 Euros/m^3.

This approach stems from the principles of the National Strategy for sustainable sanitation in Armenia, developed with the support of OECD in 2004. Among a series of recommendations, the following two ideologies are outlined in the Strategy:

1. Consider the wastewater as a valuable water resource: Wasteful use of fresh water resources already causes water resources management problems, which will become even more acute in the future under climate change impacts. In this case, the treated wastewater could be considered as a constant and sustainable resource and a water demand management tool for some sectors.
2. Treat today as much as you can: This principle will allow implementing the wastewater treatment process in a staged manner and encouraging and supporting any initiative aimed at the process. This will also allow creating favourable conditions for attracting funds without limitation. On the other hand, obtaining tangible results in certain stages can serve as a stimulus for new investments, thus speeding up the process.

A typical example of these two ideologies is the Parakar treatment plant construction project, which, as mentioned above, was carried out in two stages and with the financial support of different donors and the community. On the other hand, due to the construction of the plant, not only the degraded lands were restored, but also the irrigation system obtained additional water valuable for irrigation.

Adoption of the principle of application of alternative treatment technologies and stage by stage construction of wastewater treatment plants will allow covering more settlements in the current projects with involvement of the same investments, which will contribute to harmonious development of settlements and application of equitable distribution approach.

3. CONCLUSIONS AND FURTHER ACTIONS

In spite of the short period of operation of the wastewater treatment plant constructed in Parakar community of Armenia with the combination of conventional and natural wastewater treatment technologies, there are already serious positive outcomes at hand:

1. The community acquired a wastewater treatment plant, which was constructed with relatively small investments and has low operation costs;
2. Operation and maintenance of the plant does not require highly qualified staff; it is rather simple to operate even for a non-skilled rural resident;
3. Municipal wastewater is removed from residential area and its treatment at the required level is implemented;
4. Sanitary conditions in the community area are improved and the possibility of epidemic outbreaks is prevented;
5. The treated wastewater is used as irrigation water, providing an additional 11.7 L/s.
6. The degradation of agricultural lands is prevented and 60 hectares of degraded lands have been rehabilitated during a short period;
7. Dewatered and dried sludge is used as a high-quality organic fertilizer in agriculture;
8. Thanks to the new rehabilitated wastewater treatment system, additional jobs are created in the community;
9. The sanitary-hygienic conditions and food security of population are improved.
10. A new approach of combining conventional and natural domestic wastewater treatment technologies was developed and implemented, which, along with a number of other characteristic parameters, also considers the factor of the land area allocated for the plant

based on the provision for the desired treatment level.

Based on the positive experience of the wastewater treatment plant constructed and already operating in Parakar community, it is planned to build similar plants also in a number of residential areas of Armenia. The selection of their process scheme, ratio of the conventional and natural technologies in combination will be determined depending on the allotted land area.

To increase the biological treatment efficiency in Parakar wastewater treatment plant, it is envisaged that in the future, as the next stage of the project, water hyacinth will be grown in the biological lagoon with natural aeration, which may have a positive impact on reducing the coli index of wastewater.

The project results were presented at national and international levels, allowing the expansion of application of this approach in Armenia, as well as in other countries with similar conditions.

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REFERENCES

TEC (Global Water Partnership Technical Committee) (2009) Managing the other side of the water cycle: Making wastewater an asset. Background Papers No. 13, Akiça Bahri,

TEC (Global Water Partnership Technical Committee) (2012) Integrated Urban Water Management. Background Papers No. 16, Akiça Bahri,

EPA (1988) Constructed Wetlands and Aquatic plant systems for Municipal Water treatment. Design Manual, EPA/625/1-88/022

UNDP (2014) Local Solutions to Wastewater Problems. Online document: http://www.am.undp.org/content/armenia/en/home/ourwork/environmentandenergy/successstories/local-solutions-to-wastewater-problems/